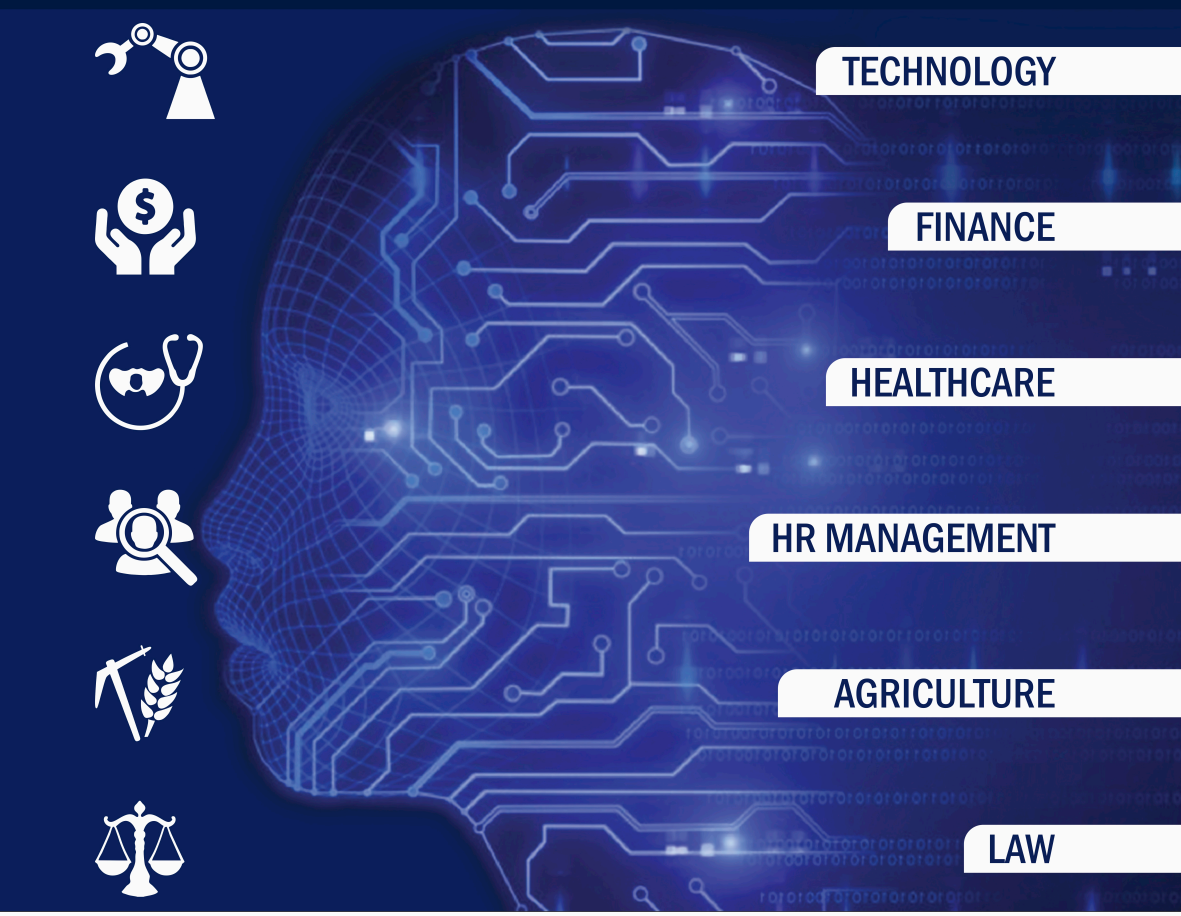
ARTIFICIAL INTELLIGENCE

RESHAPING LIFE AND BUSINESS



Dr. Prabhat Kumar

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DR. PRABHAT KUMAR

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Preface

Artificial Intelligence (AI) has a history of nearly seven decades of development, during which many great scientists and researchers contributed in its journey towards making machines intelligent. After a brief lull, termed as the 'AI winter', when all progress relating to its development had virtually stalled due to technological limitations and shortage of funds, AI started its second inning in the 2000s. Since 2010, AI has been progressing well, as technologies have advanced and researchers have been coming up with exciting new developments. While the US has an overall lead in this nascent area, the game has really turned interesting because the Chinese government has come out with an aggressive plan to become the world leader in AI by 2030.

Aggressive global competition in this nascent technological area is good news for the AI industry. The competition between nations and the realization that mastery of AI will impact power equations, is giving the necessary fillip to the tech companies and the startups to accelerate their work. As a result, they will develop products and services that will be useful for local and global markets.

India has not kept pace in the AI race, and as it stands, we do not have the advantage that we had gained in the software era. If India wants to sustain its quest to be among the top league of nations, they had better get their act together. At least 30% of its $ 167-billion software industry is at risk in the new AI-led world. Many of our IT-enabled service centers and customer support services could perish in the coming years. India's policy makers have to look at the industrial landscape with a fresh approach. The old set of institutions may not serve the new-age technological requirements that call for developing a greater footprint in AI. Private players serving global markets have to come abreast with these new technologies if they are to retain their customers. The government also has to adopt a pro-active and facilitative approach to promote the AI industry.

This book on 'Artificial Intelligence' is intended not only for the experts, but particularly for those who wish to learn how AI will impact their lives and business in the coming years. While the technologies within the AI domain may be complex, the author expects that by going through this book, even the uninitiated will be able to understand key features of AI and what it bodes for the future.

This book talks about many of the new AI products and services being released in the market. We are already seeing a spurt of voice assistants, AI-enabled televisions and other gadgets and smart homes. Many more devices will come to the market at a faster pace in the future. People must be ready to embrace this brave new world. Human society as a whole may witness greater prosperity with new engines of productivity growth. Various other social, ethical and political challenges including significant risk to humanity are also discussed in this book. Hope readers enjoy the contents.

In writing this book, I received invaluable support from many friends and well-wishers. I would like to thank Prof. M P Gupta, Head of Department of Management Studies (DMS), at IIT Delhi and Prof. Sushil, Prof at DMS, IIT Delhi. I am deeply obliged to Vishnu Dusad, Managing Director, Nucleus Software Exports Ltd, who went through substantial part of the manuscript, Ciby Cyriac James at the American Society for Quality, who refined my thoughts on AI and V K Gupta, K K Gupta and Vishnu Gupta, who supported me in this work. Further, this book would not have been possible without the constant support and encouragement from my wife Anjali. Thanks are also due to my family members, Divya, Amit, Devesh and Jayesh, for their support.

Last but not the least, I thank Manish Jain and his entire team from M/s BPB Publications, who have worked tirelessly to get this work in print.

Any feedback on this book is welcome. It will help me in improving the future editions.

PRABHAT KUMAR

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CHAPTER 1

Artificial Intelligence: How AI is Reshaping Life and Business

Whoever becomes the leader in artificial intelligence will become the ruler of the world.

—Vladimir Putin

Introduction

Artificial intelligence (AI) has arrived. AI is a transformational technology which is powering change throughout the world. Our lives are set to change dramatically over the next decade. The way we work and the way we interact among ourselves will change forever. AI is disrupting everything in our lives and embedded in the new disruptive technology is INTELLIGENCE.

In all likelihood, you have already availed AI-enabled services earlier and you are therefore not in an unfamiliar territory while reading this book. If you have searched for the cheapest airfares between any two destinations on Google, then you have already used services from AI-enabled Google's flight search engine. If you have used Google Maps or Microsoft's Bing, then you have used services developed with a large amount of data through machine learning and computer vision. If you are a user of Gmail, then Google Cloud, by using machine learning, has blocked 99.9% of your malicious e-mails. Thus, you are already a part of the global AI-community.

Artificial Intelligence[1], with its sub sets of Machine Learning, Deep Learning, Neural Networks, Pattern Recognition, Natural Language Processing, Virtual and Augmented reality, besides Robotics, coupled with other new technologies like Internet of Things (IoT), Blockchain Technology and 3D Printing is revolutionizing businesses and societies. AI is run by algorithms[2] which can learn, perceive and engage in problem-solving, language processing and logical reasoning. In addition to the speech recognition and natural language applications in processing, generating and understanding, AI is also used for other recognition tasks (pattern, text, audio, image, video, facial recognition etc.), autonomous vehicles, medical diagnostics, gaming, search engines, spam filtering, crime fighting, marketing, remote sensing, transportation, music recognition, classification, and so on.

In the intelligence-led technology revolution, both technology and non-technology businesses are thus impacted in a small or big way, whether in the manufacturing sector or services sectors like e-commerce, finance, insurance, human resources, logistics, tour and travel or the healthcare systems.

AI applications in healthcare are being used in radiology, cancer treatment, drug discovery, hospital administration, ophthalmology and for treatment of diabetes. Machine learning is being used by doctors in Nigeria for early detection of birth asphyxia—the third highest cause of under-5 mortality in Africa. OrCam of Israel has used AI and computer vision to develop a handy wearable device, OrCam MyEye, which can be used by persons with vision or reading difficulties to read text and identify faces and products. AI applications in finance include instant loan grant, recovery of loans and fraud detection. Researchers have even delved into an unlikely area

1 Artificial intelligence is planting human-like intelligence in machines or computers that can perform one or more tasks the way humans do.

2 An algorithm is a process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.

of building construction and have pioneered new techniques for manufacturing thin concrete shapes using algorithms. Computer vision and deep neural networks are being used for monitoring construction at the sites.

The emerging world of AI will see every human activity changing. IntelligentX of UK is trying to achieve AI-brewed beer. Prose from New York wants to use AI in customized hair products. Weedguide, a San Diego based search engine is using AI and machine learning for personalized recommendations for medical and recreational marijuana community. Samsung electronics is planning to develop a multi-device platform, where different AI-enabled devices would seamlessly communicate with one another for a personalized experience. The company has also opened a new AI center at Montreal.

Machine learning-based forecasts may one day help deploy emergency services and inform evacuation plans for areas at risk of an aftershock, like earthquake.

Voice Assistants (VAs) have emerged as important interactive tools for users, who can use them for setting alarms, reminders, listen to songs of their choice, and so on. AI programed VAs like Apple's Siri, Amazon's Alexa and Microsoft's Cortana, as well as Zo, Ruuh and Riina are providing an interactive platform to the customers to answer their queries. They may be slowly replacing or working intelligently with human workers at call centers.

AI, in combination with Internt of Things (IoT), is also changing our homes, which are getting smarter with deployment of sensors, thermostats, and floor-heating controllers and other similar devices. Autonomous systems are taking over maintenance of our homes.

Opportunities in the age of AI are abundant. Almost every week now, new applications are being released and transformative new techniques are being applied in discovery of new products and services. Workplaces are getting crowded with AI applications.

AI can do a lot of things better than a human can, not just routine tasks, but also more complex ones, if there is enough opportunity for the AI system to learn them. For example, AI could be helpful in sentiment analysis of psychiatric patients having suicidal tendencies so as to prevent suicides by early detection and follow-up treatment. The number of suicide deaths, particularly in the age-bracket of 15–40 years is quite high. The situation among women in India is very disappointing, with India having 37% of the total global number. Rama Akkiraju, a distinguished engineer and Master Inventor at IBM (Watson) is working on inferring people's personalities, emotions, and intentions using social media data and machine learning techniques.[3] Sentimental analysis is currently being used by e-commerce companies to gather customers' responses to products offered and by National Health Scheme (NHS) of UK for gathering feedback from users on the quality of services provided.

Businesses are now expected to provide intelligence in all their work, processes and deliverables. The customers expect that the services they receive are based upon intelligence. For example, it is no longer sufficient to send generalized email messages to all for advertising for a new home, insurance or banking services. The AI-led platform enables the industry to provide highly customized service offerings to an individual customer. This is being used in personal finance or e-commerce to target specific customers with specific product recommendations.

Governments also want to exploit opportunities to use AI to improve public services. The Regional Transportation Commission of Southern Nevada, the Nevada Department of Transportation and the Nevada Highway Patrol tied up for a pilot program with Waycare, an Israeli tech startup, to study traffic conditions on Interstate 15 highway, west of the Vegas Strip and could improve highway safety by reduction in crashes

3 "An A-team for AI" by Jonathan Sperling, *Fortune*, July 01, 2018 (Page 44), http://fortune.com/longform/element-ai-startup-tech/.

by 17%. Waycare used AI and deep learning in collaboration with enforcement agencies and deployed cameras, sensors and used in-vehicle information and traffic data to develop prediction model to reduce congestion on the freeways. Drivers were then instructed to slowdown for safety purposes[4].

The Indian government entered into an agreement with Google for flood-forecasting, one of the recurring disasters in India. Google will use AI, machine learning and spatial mapping for effective management of water resources.

There is an immense potential of AI applications to solve a multitude of problems. The journey has just begun, but progress may be coming fast.

AI and Robotics

Robotics works on knowledge from several disciplines including AI and help to free humans of routine work including their daily chores. According to IDC report, worldwide spending on robotics hardware, software, and wider services will reach $230.7 billion by the year 2021.[5]

Robots are revolutionizing our personal lives and work places. More than fifty different types of home robots have emerged for doing different things at our homes. The US market for home robots is set to quadruple to more than $4 billion by 2025.[6] There are home robots helping children to play and learn,

4 Artificial intelligence improves highway safety in Las Vegas, November 22, 2018, PHYS ORG (https://phys.org/news/2018-11-artificial-intelligence-highway-safety-las.html)

5 Worldwide Spending on Robotics Forecast to Accelerate Over the Next Five Years, Reaching $230.7 Billion in 2021, According to New IDC Spending Guide (https://www.idc.com/getdoc.jsp?containerId=prUS42880417)

6 Gurman Man, July 24, 2018, 'The US market for home robots is set to quadruple to more than $4 billion by 2025' Bloomberg, Technology (https://www.bloomberg.com/news/articles/2018-07-24/big-tech-is-throwing-money-and-talent-at-home-robots)

teaching kids to learn English, robots that are taking better care of the elderly, robots for cleaning houses, and there are robots for making twenty different varieties of salads. In China, iPal, a babysitter robot speaking in two languages gives math lessons, tells jokes and interacts with the children through a tablet on its chest. Parents can also monitor their children through iPal, which can be linked through a smartphone app.

Robots are being deployed in an unlikely area of delivery of letters and parcels by the postal services, as the Norwegian postal service, Posten-Norge, has done by entering into an agreement with Buddy Mobility, an automation company. Deutsche Post, the German postal service is also using a similar electric delivery robot, called PostBot, which helps relieve the load of the deliverer.

Robots have also become co-workers and in some cases are even replacing humans completely at the manufacturing shop floors, in warehouses and in food delivery. They are handling dangerous jobs where humans fear to tread. Robots will emerge in newer areas to provide convenience. The Italian company Vespa is building Gita, a robo-carrier, with embedded sensors that will roll over with the person walking alongside wearing a white belt, which has a camera attached to it. Gita can carry up to 40 pounds of weight and it can be used by businesses to help transport supplies around construction sites and factories[7].

Robots are bringing advantages of convenience, efficiency and cost effectiveness.

Other Technologies of Digital Transformation

Digital transformation of work places is an important agenda of modern corporations. While a decade back, it may have been just a fad, today it has become a necessity for survival of businesses.

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7 Vespa's Maker Created a Robot to Carry Your Things, *Fortune*, 2nd February 02, 2017 (http://fortune.com/2017/02/02/vespa-piaggio-gita-robot/)

AI has now created another source of deeper transformation of digitalization. Simultaneously, there are other technologies, like Internet of Things (IoT) and Blockchain, which are also powering that change process to everything going digital. 3D printing, another technology of the new age is helping in many ways. Houses can be built fast and at much lower cost. 3D printed houses can be constructed for providing shelter in emergency as well as for regular living.

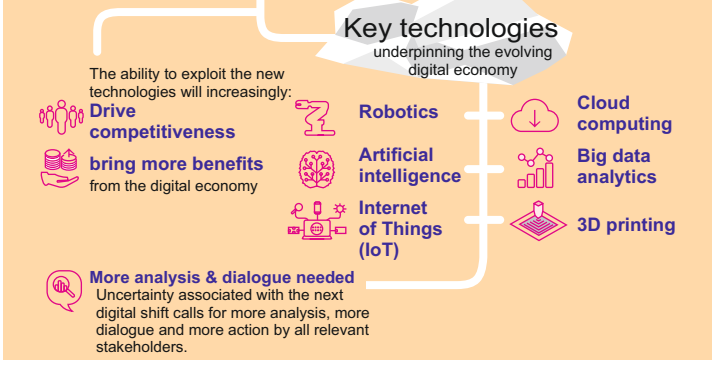

Figure 1.1: *Key Technologies (Source: Xorlogics)*

Application of AI in tandem with IoT enabled programing and block chain can create a powerful impact in managing healthcare, for example. A diagrammatic representation of the key technologies is shown in figure 1.1 above.[8]

Size of AI Businesses Will Keep Growing

AI and related technologies will form a significant part of global GDP. IDC, a research firm estimates that worldwide spending on cognitive and AI related products will touch $19.1 billion in 2018 and predicts that organizations will spend US$52.2 billion

8 Javed Aisha, (2017) Digital Evolution Report–CyberCrime, Digitization, Blockchain and Artificial Intelligence, 25 DECEMBER, 2017(http://www.xorlogics.com/2017/12/25/2017-digital-evolution-report-cybercrime-digitization-blockchain-and-artificial-intelligence/)]

annually in 2021 with a CAGR of 46.2% over 2016-2021[9]. This will trigger billions of dollars of savings and gains from that investment.

According to a 2018 report of PR Newswire, AI global market size is set to grow from $21.46 billion in 2018 to $190 billion in 2025 at a CAGR of 36.62%. PwC estimates that by 2030, AI would contribute up to 14% of GDP, an equivalent of $ 15.7 trillion per annum to the global economy. McKinsey Global Institute[10] estimates that AI could also boost innovation by improving product and service offerings contributing another $6 trillion, 7% of global GDP by 2030. In another report of April 2018 it notes that neural networks and convolutional neural networks (both part of AI) together have the potential to create between $3.5 trillion and $5.8 trillion in value annually across nine business functions in nineteen industries. Their potential impact on the top three sectors are: marketing and sales ($1.4 to 2.6 trillion), supply chain and manufacturing ($1.2 to 2.0 trillion), risk management ($0.5-0.9 trillion), among other sectors of service operations, human resources and finance and IT.[11]

9 Worldwide Spending on Cognitive and Artificial Intelligence Systems Will Grow to $19.1 Billion in 2018 (https://www.idc.com/getdoc.jsp?containerId= prUS43662418

10 Notes from the AI Frontier, September, 2018, https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Artificial%20Intelligence/Notes%20from%20the%20frontier%20Modeling%20the%20impact%20of%20AI%20on%20the%20world%20economy/MGI-Notes-from-the-AI-frontier-Modeling-the-impact-of-AI-on-the-world-economy-September-2018.ashx.

11 Discussion paper, McKinsey Global Institute, April, 2018, (https://www.mckinsey.com/~/media/mckinsey/featured%20insights/artificial%20intelligence/notes%20from%20the%20ai%20frontier%20applications%20and%20value%20of%20deep%20learning/mgi_notes-from-ai-frontier_discussion-paper.ashx).

History of Development of Artificial Intelligence

The 1950s saw discussion on "thinking machines" besides cybernetics, information processing and theory of automation. There were different thoughts on thinking machines. First came the Turing test (also referred to as Imitation game) in 1950, developed by Alan Mathison Turing, an English mathematician and computer scientist. He published a paper on "Computing Machinery and Intelligence", where he proposed a test of a machine displaying human intelligence. The test was conducted with three connected terminals, two operated by humans and one by a machine. If a human-questioner at one of the terminals, based on a pre-set number of questions, in a repeated experiment on testing the other two, a human and a computer, within a certain time-frame could correctly judge "who was who" at the other two terminals answering those questions, then the machine could be considered as having intelligence. This test however had its own limitations. Turing's prediction of such machines becoming common by 2000 failed badly.

It was a few years later in 1955 that John McCarthy,[12] a young professor, then at Dartmouth College (US) organized a group which included some of his fellow colleagues and researchers to further develop the idea of thinking machines and launched a project which he named "Artificial Intelligence". The proposal stated:

> We propose that a 2-month, 10-man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to

12 McCarthy, J., M. Minsky, N. Rochester, C.E. Shannon, "A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence", http://raysolomonoff.com/dartmouth/boxa/dart564props.pdf August, 1955.

> simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves.

The proposal discussed topics like "How can a computer be programed to use a language", "Neuron Nets", "Theory of size of a calculation", "Self Improvement", "Abstraction", "Randomness and Creativity". These are the areas relevant for the study of artificial intelligence even today.

In another development, Arthur Lee Samuel, in February 1956 programed his IBM 701 computer to think and played a game of checkers on television, his opponent being an IBM 36-bit vacuum-tube computer. Arthur had assigned each of the 64 squares on the checkerboard a different set of machine word-identifiers and done the same with each piece on each square. In short, he had designed a digital computer to engage in the process of learning as a human being would do.

After an initial bout of hype and under-performance, AI faced a wall of real-world limitations. Progress was stalled due to limited computer hardware and storage capacity and absence of "talking machines". Funding stopped as failures mounted, which led to a period now dubbed as "AI winter".

However things started changing in the late 2000s, and the "AI winter" turned into "AI spring" as technology made smart progress. There was re-thinking on the deployment of artificial intelligence and practical applications by the industry and the scientific community. Deep learning, one of the applications of AI which could not progress earlier, was now being re-examined by the researchers and they started enquiring why it had not worked earlier. Training neural networks required advanced computing power, which was now easily available, broadband availability had improved and the cost of storage and connectivity had come down drastically. These factors together resulted in achieving commercial success in areas like identifying faces, translating languages, and understanding speech as well as conversion of voice into text and vice versa.

Lessons from the Technology Revolutions of the Past Three Centuries

Humans have witnessed many technological revolutions in their evolutionary journey from life in the caves to the present day. Technology has been the cutting edge tool that has lifted the lives of sapiens to each of the next stage, since ancient times. Since the age of enlightenment began, the scientific inventions and discoveries have continued apace at a greater speed as humans unravel their creative ability to create new things all the time. History of the past three technological revolutions offers several lessons for the fourth revolution.

While the first Industrial revolution was powered by steam in 18th century, the second wave in the 19th century was driven by electricity. The 20th century witnessed a third revolution through computing. All the three revolutions brought unprecedented changes in social and economic order with exceptional rise in productivity and prosperity of individuals and societies.

1700s saw the invention of steam engine, which changed the shape of the industry. A number of practical applications and utilities arose on the strength of steam power, locomotives etc., which completely changed the lifestyle of the people. New businesses arose in transportation, logistics and trading of goods and services etc.

The next wave of technological change came in 1800s when electricity was invented, which again changed the way businesses were conducted and people had to reorganize their lives. Simply put, they got extra hours for work, enjoyment and doing business because they were not simply dependent upon sunlight. Again new industries and new businesses arose which absorbed the rising population not only in the Western world but in other parts of the globe as well. Overall within a span of hundred years, the population of the world grew from one billion to nearly three billion. All these extra hands got absorbed in the upcoming industries that came up on the

backbone of electricity.

The third wave of technological change came in 1900s when computing was invented. Entirely new industries cropped up with computing as their foundation. Additionally all other industries had to accommodate computing as their primary platform which changed the way they did their business.

In the last seven decades, we have seen how the mainframe computers were replaced by Desktops which again got replaced by Laptops and how Internet revolution led by the DARPANET of the US revolutionized the entire communication process for the businesses and the citizens. Large number of industries came up from 1980 to 1995 with the onset of the Internet revolution. In the late 1990s, mobile networks with handsets again changed the communication process. Next came smartphones with the screens on the mobile handsets. The watchword of business and personal communication was now crammed into hardware of the smartphone devices, which in its revolutionary journey since 2007-08 has squeezed the world in a palm sized simple to use device.

Now, in the fourth wave of technological change, computing has been replaced with INTELLIGENCE. The new revolution is expected to be much stronger and is going to have a bigger impact than the steam engine, electricity or computing in the last century. This is what Sunder Pichai, CEO of Google had to say on artificial intelligence, while speaking at an event in San Francisco in January, 2018:

> "Artificial Intelligence is going to have a bigger impact on the world than some of the most ubiquitous innovations in history. AI is one of the most important things humanity is working on. It is more profound than electricity or fire."

The important trend from the previous three waves of technological change is that industries and industrial applications through a series of inventions with practical day to day usable devices emerge gradually over years, decades and centuries. The steam power was first demonstrated in the

invention of Thomas Savery, an engineer and inventor, who patented in 1698 a machine that could draw water from flooded mines using steam pressure. It was almost seven decades later, that James Watt was granted a patent for his invention of steam condenser in 1769. The inventions based on steam continue till date, though many of these go unnoticed.

This time, things would be no different. It will take years or decades before the intelligence based industries take shape and new product and service offerings come to the market. So, the market opportunities for the entrepreneurs and businesses are going to expand in future.

Future Developments in Artificial Intelligence

Academicians, practitioners of the art and the businesses have been talking for some time now about the 4th Industrial revolution based on INTELLIGENCE. The journey since the middle of 2010s has begun on a serious note and the next decade will completely transform everything on the planet in an unimaginable way. There would be several successes in the future, some of them in anticipated ways and many 'Eureka' moments and no doubt there are bound to be some failures as well.

We are just at the beginning of the curve of the new change. Entrepreneurs are doing lot of innovative work in applying the new technologies to invent new products and services. Start-ups everywhere, whether in the Silicon Valley, New York and other cities of the USA or London in UK, or Beijing, Shanghai and Shenzhen in China as also in Bengaluru, the silicon city of India have acquired a new energy for technological innovation[13]. The academic institutions in different countries are setting up in-house innovation centers to promote start-ups by the young students in their campuses. The race to create the next Unicorns (billion dollar companies) is hotting up through application of

13 Startup stories are discussed in chapters 6 to 10 of this book.

AI and the other new technologies for development of products in finance, insurance, health, e-commerce and many other sectors.

Start-ups that have invigorated a new competition in the new age industries have also energized the angel investors, who are putting in money with a great zeal, with the hope that their investments in the new tech sector would grow and fetch the kind of returns it did in the previous computing and internet boom.

AI is changing every industry to meet the competition in the way they do their business. Many old and established players who may not be having the necessary resources are facing the heat as the big players have larger financial and other resources to push them out. Business models of the AI age are different from the old ones. The nature of competition is also changing. Global players like Amazon in e-commerce can give profits a miss caring little about the quarterly profits as long as they keep growing in revenues and keep acquiring new customers.

AI technology overall will keep on evolving over the next 4-5 decades, as already some futurists predict that machines may develop human level intelligence by 2040-70. Whether machines will achieve human cognitive ability (referred to as Artificial General Intelligence or AGI) or not, only time will tell. But the developments in AI will continue for several decades and new industries based on AI would take shape and new products and services would continue to flood the market.

What the Big Tech is Doing in AI

Some of the world's biggest and the famous companies from around the globe such as Alphabet, Amazon, Apple, Facebook, IBM and Microsoft (referred to in this book as 3AFIM) and the Chinese quartet of Alibaba, Baidu, JD.Com and Tencent (together referred to as ABJT) besides companies like Salesforce and Intel are actively engaged in adopting the new technologies and in hiring the top talent in the AI pool to develop new products and services in different areas to create new markets

and industries and serve their customers better.

The giants of the pre-AI age have all become heavy users and inventors of AI and the other new technologies like robotics. 3AFIM are investing heavily to become the leader in the next generation of businesses led by AI. Even non-IT companies like the investment giant Berkshire Hathaway, America's biggest bank JP Morgan Chase and the consumer product company Johnson and Johnson are investing heavily in AI to serve their customers.

The American big tech has come out with a large number of product and service offerings in a short time frame. Amazon for example is using AI tools in managing warehousing operations, logistics and has been investing in self-driving vehicles and other new businesses. Alphabet is investing heavily in the AI sector. It acquired Deepmind, a London based company which developed AlphaZero, the game-playing AI which has beaten the world's best chess-playing computer program. It took just four hours to learn the rules of chess before beating the world champion chess program, Stockfish 8, in a 100-game match up. The repurposed AI has repeatedly beaten the World's best Go player. AlphaGo has been generalized so that it can now learn other games. It may be noted that a ccomputer program was able to beat the best human chess players ever when IBM's Deep Blue supercomputer defeated Kasparov in 1997. Deepmind has deep talent resources in AI. Microsoft is using AI in its various products including cloud based offerings. The details of the AI programs of the big tech have been discussed in subsequent chapter 5.

China has emerged as a big player in AI. Its new age companies like the e-commerce giant Alibaba and the social media heavyweight, Tencent have re-invented the industrial landscape and created huge business monopolies in China keeping the US competition out of reach for the local markets. The Chinese government policy has also helped the local players to emerge as global competitors (though it would be unfair to attribute their success entirely to the Chinese government's support). Alibaba

and Tencent, each of them worth at one time over $400 billion were once talking to each other on friendly terms, but are now poaching each other's territory in e-commerce and e-payments etc. Together, China's new age companies are giving a big push through AI.

New Competitive Advantage of AI

For quite some time now, the growth engine of the economy is being driven by investments in the technology sector. For example, if we compare the investments made in the US in the first quarter of 2018 with those made in the previous decade, the major driver of investment now has been the top five technology companies, namely, Amazon, Alphabet, Apple, Intel and Microsoft, whereas in the previous decade, the top five investors were Chevron, Verizon, AT&T, Exxon Mobile and General Electric[14].

The new technologies of artificial intelligence, Robotics, Internet of Things (IoT) and block chain are also providing new competitive advantage to businesses. Vladimir Putin of Russia has rightly stated that "whoever becomes the leader in this sphere of the new technologies like artificial intelligence will become the ruler of the world". The plans of the Russians are not much known in the public domain. Russia however has been a key player in the technology business and it appears that they are doing a lot in the area of deployment of the new technology in military space.

Digital technologies are becoming a source of national and international competition. Countries like the US and China are running neck and neck in a competitive race to gain an upper hand. China cornered 48% of total dollars flowing to AI startups globally in 2017, (as against just 11.3% in 2016) surpassing the US, which received 38% of the total.

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14 'A boom like no other', *The Economist*, May 26th 2018, (page 23-26 at page 25) , Source: Bloomberg (Capital spending plus R&D)

The US government in 2016 published a policy paper titled 'Preparing for the Future of Artificial Intelligence' expounding the impact of artificial intelligence across multiple industries. The Chinese government has come out with a policy document, in July 2017 titled 'China's Next Generation Artificial Intelligence Development Plan', which seeks to achieve the goal of becoming a global innovation Centre by 2030. China aims at advanced manufacturing, integration of Internet, big data and AI with the real economy. An action plan for 2018 – 20 and 2020-25 has also been etched out as a complement to Made in China 2025 strategy. UK government through House of Lords Select Committee on Artificial Intelligence came out with a paper titled 'AI in the UK: ready, willing and able?' in April, 2018. The report deals with multiple issues in the context of the emerging technologies and recommends focusing in certain key areas to develop AI industries. UK has developed a thriving AI business center in London, which has become a global hub for AI research.

China is the new focus of attention on AI with their industry, academia and government working in tandem with single-minded devotion. In order to meet an aggressive China, the US President Donald Trump has assured the US technology industry of less interference from the government and the regulators. US government has been making all out efforts to encourage their own industries and the start-ups and is also investing heavily in the deployment of AI in military technology to stay ahead in the race.

Germany, France, UK, Japan and India have also drawn up their own action plans. Germany has also come out with an AI plan and is betting big on robotics and AI in manufacturing sector, its traditional stronghold. Japan is also developing on robotics and its national champions like Hitachi is moving towards developing products with AI features. France also is looking at AI as a serious business.

AI, the Next big Opportunity

AI is also a big opportunity for economic growth. It can raise productivity by 2-2.5% point, which otherwise has stagnated over the last decade or so. While there may be disruption of jobs, particularly at the lower end in short term, yet AI may prove to be the biggest job creator in the long run. It will improve the overall quality of life for the people and solve many of the unsolved riddles of life.

Hype and Reality of AI

"Books will soon be obsolete in schools," Thomas Edison, the famous inventor announced in 1913. He believed that soon they would be replaced by silent films. The dotcom era created mega hypes in the late 1990s and early 2000s. Brick and mortar retailers like Walmart were going to become history, yet they have survived after two decades and some have transformed to give a tough fight to the pure e-commerce companies like Amazon, which is acquiring brick and mortar retailers to expand their footprint.

Hype and technological inventions are close companions. John McCarthy in 1955 had set a target of finishing everything in just two months with a ten-man committee, i.e., in 20 man-months. However, nothing much happened even in the next fifty years. That is the kind of over-estimation, particularly the scientists are used to making.

Whenever a new technology is growing, there is a wide imagination for applying the new technology to find new solutions. Some of these may materialize, some may not. Yet the pace of technological growth cannot be stopped. Many applications may emerge that will exceed the expectations. There is in the beginning a hype, an over promise and subsequently an under-performance on account of certain grey areas of technological development and their application. Notwithstanding any hypes around the new technology, the world around us will surely and certainly change in significant

ways in the next 5-10 years.

4th Industrial Revolution – A Big Opportunity for India

While the US and China are battling out for supremacy, India too has high stakes in AI industries, to empower its US$ 170 billion IT industry. In the previous wave of computing revolution in the late 1990s, it lapped up the new opportunity in the marketplace that had emerged with the Y2K crisis, which created tremors in the Western world. The fear of the computer systems installed by the airlines, the banks et al, shutting down on the midnight of 2000, since those systems were designed only up to the year 1999 and not for the new series of 2000, created a big opportunity for Indian techies in the US where systems were to be fixed hurriedly in a short period of time. There was not enough local manpower available in the US and fixing the bugs had to be carried out at a lower cost and therefore the opportunity of outsourced work to India created the Bangalore brand. That brand has been steadily growing in the last nearly two decades. Now the challenge is to grab the new opportunity offered through AI and other technologies and leverage the software power.

Every new technology brings with it a new opportunity and the new revolution of AI and Robotics is no different. The new technologies could offer an opportunity for India's teeming millions who are entering the workforce every year. Therefore it is of utmost importance that all the stakeholders involved namely the government, the industry and the customers initiate their own well thought out responses for taking advantage.

This time, the dice however seems to be loaded against Indians. Whereas the US and China have come out with their national plans for promotion of AI, the Indian government has not moved with the pace required. Niti Aayog's policy document released in June 2018 adopts a defensive posture and does not intend to make the country a leader in AI space. In order to match the competition and the opportunity the new age industries offer, the government has to make a conscious effort

with a determined mindset to develop a national framework for promotion of artificial intelligence and other new technologies to modernize its economy.

Want to Solve a Problem, Think AI

AI can provide solutions to various kinds of problems. When we have a problem in hand, we need to think innovatively as to which of the technologies either individually or in combination with other technologies can solve the problem in hand. While machine learning, deep neural networks can be universally applied in a vast genre of problems, where images are involved, we can think of computer vision. Natural language processing can provide voice based solutions for customer information, while robotics can even be useful to us in the space technology, marine based solutions. Cameras, sensors can be used in combination with deep learning. In nutshell, to solve a problem we have to think systematically, step wise and apply the relevant technology.

Continuous Improvement

In the journey towards development of the new technology, there is bound to be some hype, some successes, failures and some surprises. But technology will never die so soon. There will be continuous improvements and new entrepreneurs will emerge to solve the problems that will crop up along the way. Even in the development of chatbots, one of the simple AI based customer interactive tool, there are problems. We remember Aimbots, which could answer simple questions according to a hardwired answer-tree. Modern Voice Assistants are more sophisticated as they pull information from many sources, and understand the intent of questions, perhaps a little better than they used to, when the only thing they really understood were keywords. These Voice Assistants and chatbots are now open for solving many problems.

The AI industry itself will undergo metamorphosis. More and

more of the existing products and services will integarate AI as one of the key features. But there may come a time when an AI company will provide a host of solutions like SAP does today. Future will evolve through continuous improvement, innovation and creativity.

Will AI Pose a Threat to Sapiens?

Whether artificial intelligence will pose a serious challenge to the humans as a whole because of the very nature of the new technology? There are indeed serious concerns expressed by many scientists, practitioners of the art and others. Many ethical, social and political issues have arisen with the use of AI and other new technologies. Autonomy given to machines when humans delegate decision-making to algorithms could have serious consequences, particularly in military applications. Missiles could fire on their own on mere perceived threat.

Then there are other equally important social issues raised on application of AI. Whether the new technology will work for just the elite and/or the digitally savvy population or whether it would be deployed for the benefit of the society as a whole? Lot will depend upon the way these technologies are designed and new solutions to the social problems found. Whether the discrimination and biases of the current age will persist? Whether the customers will get better services and whether people at large will get the opportunity of training and acquisition of the required skill sets for the AI age? Answer to such questions would depend upon the policy framework of the governments and the private players.

Concluding Remarks

Artificial Intelligence and other new technologies bring with them new hopes, new opportunities and new challenges. The equilibrium of the existing processes and the way we conduct our business is set to be disrupted. It may be delayed by resistance, but finally the whole world will adjust itself to the

new wave. Countries, societies and businesses planning proactively will stay ahead or else they will lose the opportunity and become laggards.

As with every technological revolution of the past, the human race faces both an opportunity and a threat. We increase our power to create unimagined opportunities and create comforts, and at the same time, unleash power that can cause discomfort. Ultimately humans need to apply wisdom in the age of intelligence.

CHAPTER 2

Understanding Artificial Intelligence and Associated Technologies

Artificial Intelligence

What is artificial intelligence (AI) and how is it defined? What are the different technologies covered under the main category of AI? How is it different from the other technologies? There are many more such questions.

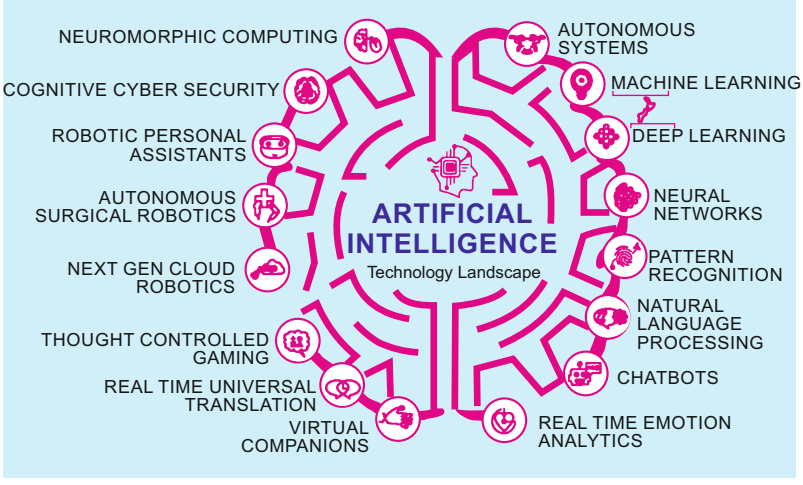

Figure: 2.1 *Artificial Intelligence: Technology Landscape*[1]

1 Miller Jonathan (2017), 'Demystifying AI' - Callaghan Innovation, New Zealand's innovation agency (2017), Callaghan Innovation (2017)

Here, an attempt has been made to define artificial intelligence and cover answers to all such related questions.

Definition and Scope of Artificial Intelligence

Artificial Intelligence has been defined and understood in many ways, as it encompasses a vast field within its ambit. Perspectives of AI also vary based upon many factors and actors involved. Therefore, no definition of AI can be so comprehensive that it will cover all the dimensions of AI. Here are some definitions discussed.

> *Artificial intelligence is planting human-like intelligence in machines or computers that can perform one or more tasks the way humans do.*

Another definition of AI is:

> *AI may be defined as a computerized machine that exhibits intelligent-like behavior.*

A definition from perspective of solving problems: *AI which is capable of rationally solving problems to achieve its goals in the real world circumstances.*

Planting human-like intelligence in machines, so that they can become an exact replica of human beings in abilities and performance is a mammoth and virtually an impossible task. That will also be interfering with the creation of God. This raises the question whether machines can replicate all or at least some of the human intellectual abilities. While the former is referred to as *General AI*, the latter is *Narrow AI*, which is discussed later.

The US Association for the Advancement of Artificial Intelligence (AAAI) defines AI as *"the scientific understanding of the mechanisms underlying thought and intelligent behavior and their embodiment in machines"*.

As *per Techpedia*[2], *Artificial intelligence (AI) is an area of computer science that emphasizes the creation of intelligent machines that work and react like humans. Some of the activities computers with artificial intelligence are designed to do include: Speech recognition, Learning, Planning and Problem solving.*

Stuart Russel and *Peter Norvig*[3] in defining AI have used the following taxonomy with regard to systems that: (1) think like humans (e.g., cognitive architectures or neural network); (2) think rationally like humans (e.g., logic solvers, inferences optimization); (3) act like humans (e.g., pass the Turing test via language processing, knowledge representation, automated reasoning and learning); and (4) act rationally like humans (e.g., intelligent software agents, embodied robots that achieve goals via perception, planning, reasoning, learning etc.).

Frank Chen[4], a venture capitalist defined AI in terms of five different aspects: logical reasoning, knowledge representation, planning and navigation, natural language processing, and perception.

In the Industrial Strategy White Paper[5] of UK government as approved in Select Committee report on Artificial Intelligence of House of Lords (UK), AI has been defined as follows:

> *"Technologies with the ability to perform tasks that would otherwise require human intelligence, such as visual perception, speech recognition, and language translation."*

Another definition of AI is: "Any technique that enables

2 https://www.techopedia.com/definition/190/artificial-intelligence-ai

3 Russell Stuart and Peter Norvig , Artificial Intelligence: A Modern Approach (3rd edition) Essex, England ; Pearson, 2009

4 Chen Frank, ' AI, Deep Learning, and Machine Learning, A Primer' Andreesen Horowitz, June 10, 2016, http://a16z.com/2016/06/10/ai-deep-learning-machines

5 Department for Business, Energy and Industrial Strategy, Industrial Strategy: Building a Britain fit for the Future

computers to mimic human intelligence, using logic, if-then rules, decision trees, and machine learning including deep learning."

The following definition of AI is rather a complex one:

> *"It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable."*

One more way of defining AI is: *"AI refers to an artificial creation of human-like intelligence that can learn, reason, plan, perceive, or process natural language to bring immense socio-economic opportunities, while also posing ethical and socio-economic challenges."*

The above definitions cover the full range of meanings that can be ascribed to what artificial intelligence can do.

General AI and Narrow AI

General AI

If a machine can demonstrate human-like intelligent behavior as advanced as a human being across the full range of cognitive tasks, then that is called General AI, also referred to as Artificial General Intelligence (AGI).

Scientists have been trying to replicate the functioning of human brain, but so far success has eluded them. In the foreseeable future, one has no illusion about General AI applications not emerging any time soon. No one can imagine that AI robots or any other automated device eleven in number with two rival teams will enter a football ground and start playing football with a referee robot in the middle of the ground. So, any imagination about General AI happening any time soon at the full-scale cognitive level of humans will at best remain a work of imagination and a matter of deep scientific enquiry.

Narrow AI

Narrow AI, on the other hand, exhibits some aspect of human intelligence and that application area, specific to one or two particular objects can be done extremely well. Such tasks could be as simple as language translation, or more complex ones as autonomous driving, image recognition, playing a game like GO or Chess.

The companies engaged in AI industry are inventing and marketing Narrow AI applications, in diverse fields such as finance, social media and advertisement, e-commerce, health and agriculture.

Different Technologies under Artificial Intelligence

AI covers a wide landscape of different technologies and these are: Machine Learning, Deep Learning, Neural Networks, Pattern Recognition, Computer Vision, Natural Language Processing, Autonomous Systems, Robotics, Chat bots and other technologies.

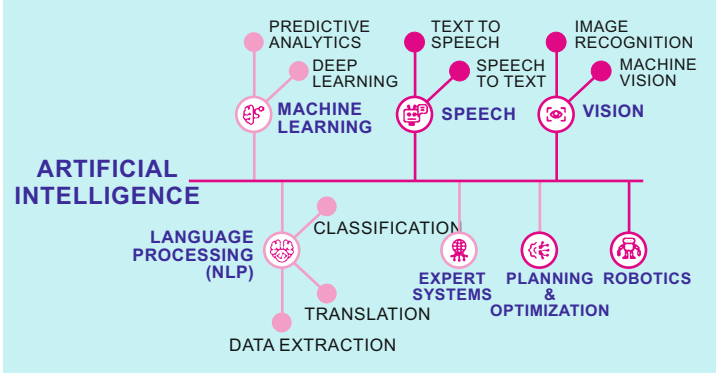

Figure 2.2: *Different technologies under artificial intelligence*

The subject of Machine Learning (ML) also covers Deep Learning (DL) and predictive analysis in its domain. Similarly, natural language processing (NLP) has three subject areas

of information extraction, classification and clustering and translation. Speech would cover both speech to text and text to speech. Then there are experts systems, planning, scheduling and optimization and robotics. Lastly AI also covers the area of Vision which includes Image Recognition and Machine Vision.

What does AI involve?

Artificial intelligence involves a sub set of different things. It involves a technique that enables computers to mimic human intelligence using logic. It involves data crunching and application of sophisticated algorithms[6] with vastly superior computing power. It can process vast quantities of data in minutes or even seconds and give you the results. It excels at finding patterns that can make better predictions without any explicit programming.

AI computers can now see, hear and speak other than texting. The outcomes are much more efficient, quicker and cheaper. AI involves a number of other things that it does.

What AI can do?

AI can be applied in large number of applications. AI programs for example, can run through thousands of contracts in just a few minutes and give results instantly, which dozens of advocates would otherwise take days and weeks to read the contracts manually. Job of forecasting becomes much more reliable, affordable and widely available which otherwise in the pre-AI age was not possible or could be achieved at a much higher cost. With the use of AI, customer services can be improved vastly by customization, personalization and by using the tools that will generate higher satisfaction among the users.

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6 Algorithms is a set of mathematical instructions or rules that, especially if given to a computer, will help to calculate an answer to a problem (https://dictionary.cambridge.org/dictionary/english/algorithm)

There are a host of other things that AI is capable of doing and here is a sample list of other services.

- *Face identification through matching of millions of photographs*
- *AI can improve quality of manufactured goods as it can detect tiny flaws through computer vision systems*
- *AI can predict failure of equipment in critical industries like Airlines, Oil and energy*
- *It can create Digital twins (virtual assets), to run simulations on how weather and other factors affect machinery*
- *Use of Robots in factories to enhance efficiency, competitiveness and deploy them in dangerous areas of work*
- *It can improve supply chain, inventory management, warehousing, better management of global shipments, managing finances, payment to suppliers*
- *Free up workers from routine tasks like back office work.*

Specific applications of AI

AI is applied in a wide range of products and services. Examples of AI in fintech are: credit score systems, instant loan disbursal based upon algorithm of customer details with their risk management profile and issue of debit and credit cards. Similarly in the area of computer vision, examples would include fingerprint identification and facial recognition. In health, we have solutions for better diagnostics, reading of images, cancer research and drug discovery.

Voice-based personal assistants, like Siri from Apple, Alexa from Amazon, and Cortana from Microsoft and now personal digital assistant from Google have picked up the most and are now quite popular.

Life in the age of AI will be vastly different within a span of 5-10 years, as AI is making rapid progress in different segments of the market in manufacturing as well as services. Companies are researching on innovative solutions, some of which are discussed here.

Smart AI Cities

Cities will become smarter and people's homes and their workplaces will be enabled by AI applications and services. The roads will become smarter and information about traffic conditions will travel seamlessly. The vehicles on the road will communicate with the sensors and devices placed along their expressways. The buildings will become smarter and there will be predictive analysis using machine learning or deep learning for anything happening in an unpredictable way for which emergency evacuation may be required.

Fully Automated Homes

Modern AI homes are having smart gadgets and smart devices which provide comfort and convenience on a much grander scale. Builders are making smart homes with all smart AI enabled devices. Homes are getting connected with Internet of things (IoT) where different devices and equipments interact with each other through broadband connection. Different types of sensors are being used in various devices which monitor temperature, humidity, air quality etc. and fix or set them as per convenience of the user. More and more devices would run remotely and through voice command of the user.

Smart homes are having AI enabled kitchens, where predictive analysis technology is used to take care of the daily needs for stocking consumables, eatables, vegetables, and milk etc. Appliance makers like LG, Samsung and others have come up with AI enabled refrigerators, washing machines and kitchen equipments. That takes the worry out of their users as they get advance information about their requirements like buying groceries.

Facial Recognition Technology

Also referred to as facial biometrics, facial recognition essentially involes capturing image of a human face with a digital camera

or sensors. It measures facial structure, distance between eyes, nose, mouth and jaw edges. Then the algorithms measure numerous points on the face down to the submillimeter. The image pattern can then be compared for a match with other images stored in a database. Ever AI, a US based startup claims an accuracy rate of 99.84%. Facial ID is used by Apple to unlock smartphones. Airports may soon start using this technology for faster clearance of passengers.

Facial identification technology has very large number of applications in retail personalization, payment authentication, besides application in cashier-less stores, public transportation, and even government offices. Companies in China are using facial ID for recording attendance and for serving coffee in the restaurant. This facial ID is being used for security and surveillance purposes and detect terrorists. Chinese government is using this to investigate crime and catch criminals. While SenseTime of China is the most valued startup in this domain, others like Megvii of China is using this technology for spa treatment. Reconova, another startup is producing China's first HD network camera with a built-in chip for facial recognition. Facefirst, another startup is offering solution for reatil surveillance where shoplifting can be reduced.

Wearables to Monitor Health

Personal devices like wearables which monitor blood sugar, heartbeat, BP and other critical health parameters are already available, but they would become common place in the next 2-3 years, as costs keep coming down. The wearables, in case of emergency will connect the users through smartphones to their personal doctor or hospital, which will render emergency services to the patient. Many lives can be saved by using such devices particularly for critical patients with high BP or having heart problem.

Study of AI – A Multi- Disciplinary Approach

Study of artificial intelligence involves a multi-disciplinary approach with knowledge from computer science, neuroscience, mathematics, anthropology, history, psychology, philosophy, economics, linguistics and many other disciplines. Study of technology, computer science and biology is one part of developing artificial intelligence tools, appliances and other devices. But to make a commercial success out of such AI programs, study of liberal arts such as psychology, sociology and philosophy may be equally important. Legal compliances with respect to data privacy and security are other essential ingredients. Study of philosophy is important to derive methods of reasoning, logic and a study of minds of the people to do sentimental analysis with AI. Study of philosophy and cultural aspects of the people involved are important to drive businesses in social media, e-commerce, communications etc. Study of psychology of customers is important in promoting marketing for sale of the goods and impromptu buying.

Facebook would like to assess for example, how people react to certain situations or certain messages. Attempt is to make something viral so that a social media company can gather more customers and capture the market space, which will lead to flow of more advertisements and will generate revenues.

Therefore knowledge from disciplines other than technology is equally important to make a success out of products and offerings being made.

AI and its Sub-sets

Artificial intelligence has several subsets as discussed below.

Most important aspect is Machine Learning (ML), a sub-set of AI which makes use of algorithms that makes inferences from data to learn new tasks. Then there is Deep Learning (DL), which is a sub-set of machine learning which involves developing algorithms in layers to create an artificial neural network that can learn and make intelligent decisions on its own. Computer

vision is another field which is applied in facial recognition, diagnostics etc.

What is Machine Learning (ML)?

Arthur Samuel, one of the pioneers has defined Machine Learning as a *"field of study that gives computers the ability to learn without being explicitly programmed."* Machine learning, simply put is a process of automation where certain rules or procedures are derived through a set of training data, which can be used for making predictions from future data sources. Machine learning is dynamic and modifies itself as it is exposed to more data and does not require human intervention to make certain changes. Machine learning relies on statistical methods to discover a decision procedure, as opposed to 'expert systems' where rules are framed with the experts of the domain area, which are then converted into a software program. In machine learning, no programs are explicitly entered into a computer.

Machine learning is important for AI or else it would require writing millions of lines of codes with complex rules and decision-trees.

How is Machine Learning applied

The step-wise procedure for application of machine learning is explained below.

- First we need a data set, which is grouped into two parts, one as training data set and the other as test data set.
- Then a model of possible decision-making rules is selected.
- An objective function has to be defined for assessing the desirability of an outcome which is dependent on choice of various parameters.
- Now the model has to be trained by way of adjusting the parameters to maximize the objective function.
- After training the model, the same has to be tested with the test data set to evaluate on the accuracy and effectiveness

of the model.

- Once the model has been trained properly, the same can be generalized for application on any future data. Robust models will commit less error and as the model is being tested dynamically in real time, it goes on improving to make better predictions in the future.

The above steps has been explained in the diagram below.

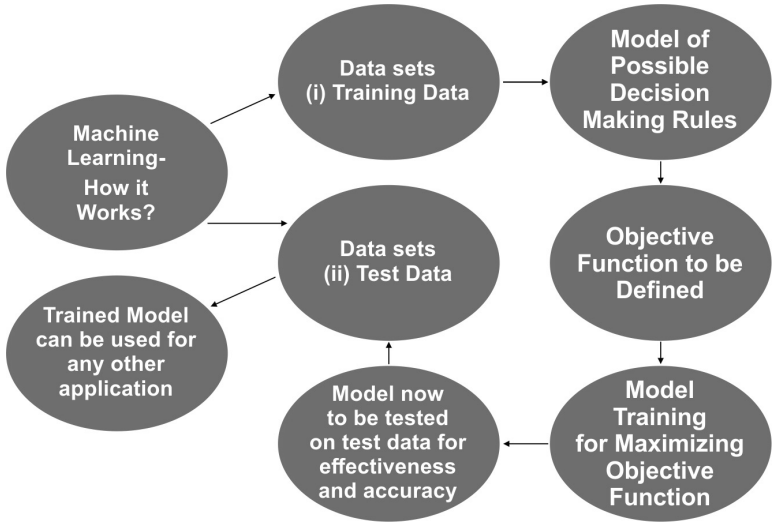

Figure 2.3: *Process of Machine Learning Explained*

Suprevised and Unsupervised Learning

Machine learning can be expressed as certain method for automated analysis of structure in data and deals with two main strands of work: (i) supervised learning; and (ii) unsupervised learning. This is similar to data mining but focuses more on autonomous machine performance rather than enabling humans learn from the data.

In supervised learning, the data sets are labeled and that labeling is done under human supervision, which is time consuming and slows down the process. For example, in image

recognition, a large set of data may have to be fed as training data, but the system may still finally make an error. So, the correct recognition requires human hand holding, under the supervision of an expert. This may have its own ramifications including human bias. In 'Unsupervised learning', the image can be recognized by the system automatically, without any human intervention. But, unsupervised learning may be years or decades away. In between these two types of learning is reinforcement learning, or semi-supervised learning.

Reinforcement Learning

Reinforcement learning relies on decision making rather than pattern recognition as in machine learning. It can be more useful for advancement of AI for executing actions on the ground. With the advancement of deep learning, reinforcement learning which did not succeed earlier has found a new lifeline. The success of AlfaGo, developed by Deepmind was largely on account of reinforcement learning whereby initial training was given by an automated agent with a human expert database, which was subsequently refined by laying a large number of games against itself through application of reinforcement learning.

Examples of Machine Learning

Machine Learning is used extensively as one of the most common areas of AI application. It is used where software programming may be difficult to write, for example, in fraudulent banking transactions. Some of the examples from various sectors are given below in the table.

Table 2.1: Examples of Machine Learning

SNo	Sector	Functionalities where AI used
1	Finance	Loan disbursal, wealth management, risk analysis, fraud detection, customer 360° review
2	Marketing	Social media analysis, advertisement optimization, recommendation engines and customized targeting
3	E-Commerce	Market segmentation and targeting, recommendations for products and services, demand forecasting, pricing and supply chain management
4	Telecommunications	Maintenance of networks, predictive analysis, customer login records, smart media analysis, record of business transactions through the network etc.
5	Healthcare	Patient diagnostics, alert based on health record of patients, emergency services, diagnostic services, prediction of any disease based upon health records

Neural Networks—Study of Biological Neurons

The whole basis of development of artificial intelligence rests on the study of biological neurons and neural networks. Artificial neural networks are statistical models directly inspired by and partially modeled on biological neural networks. They are capable of modeling and processing non-linear relationships between input and output in parallel. If we can understand the natural biological neurons of functioning of the human brain, replication of some part of activity of the brain can be done through machine learning and deep learning.

A typical human brain has about 100 billion neurons (or nerve cells) and many more neuroglia or glial cells that support and protect the neurons. Each neuron connects to 10,000 other

neurons passing signals to each other through 1000 trillion synaptic connections, which would be an equivalent to a computer with a 1 trillion bit per second processor. Storage capacity of human brain could vary between 1 to 1000 terabytes.

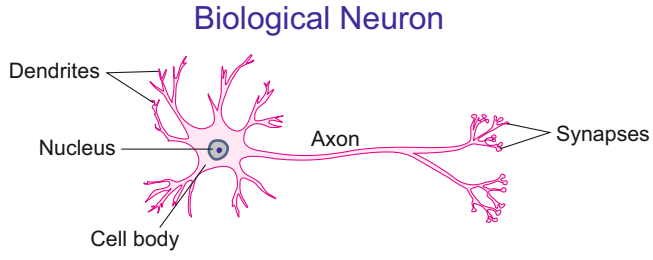

Figure 2.4: *Biological Neuron*

In the figure 2.4 shown above, dendrites receive signals from other neurons; the cell body aggregates all the signals to generate an input and when the input reaches a particular threshold limit, the neuron fires and travels down the axon, to reach other neurons. Synapses are the point of interconnection between one neuron and others. Signal transmitted depends upon the strength of the connections. Neural network is a highly connected network of billions of neurons and trillions of their interconnections, which model is being exploited in deep learning models of AI applications. The processing speed and time in neural networks is very fast and response time is mostly in just a few seconds.

A simple diagrammatic representation of activity in human brain related to the biological neuron and artificial neuron is reproduced below. While in the biological neuron, the activity is as explained below, in the artificial neuron, in1, in2 or in3 goes into the network as an input and we get an output through machine learning or deep learning process.

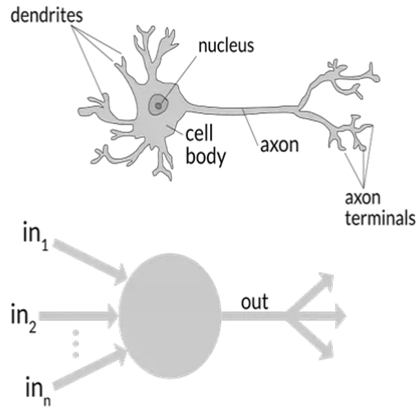

Figure 2.5: *Artificial and Biological Neuron*

First of all, neural networks are trained through learning algorithms. Then, it learns by adjusting its weights and bias (threshold) iteratively to yield desired output. These are also called free parameters. But before learning process happens, the neural network is trained first.

Different types of Neural Networks

There are different types of neural networks from simple clear perception to the most complex of the Boltzmann Machine. In the single layer perception, we have an input layer which is converted into an output with simple connection from the input layer to the output layer. In between the input and output layer stands the hidden layer where the process of deep learning is engineered to get an output. From the simple to the most complex layers, schematic diagrammatic representation has been made below. Connections between the input and output layers could become increasingly more complex as the network is deployed for solving more complex problems, for getting an output.

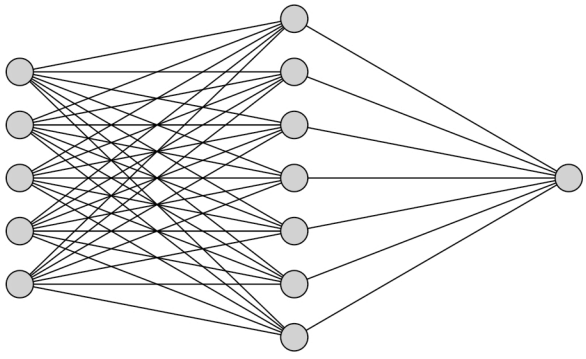

Figure 2.6: *Neural Network Explained*

As in Figure 2.6 above, between the input nodes and the output nodes, there are hidden nodes. They may be simple or complex, depending upon the type of problem in hand.

Then there are different types of architectures of neural network as explained in the next diagram.

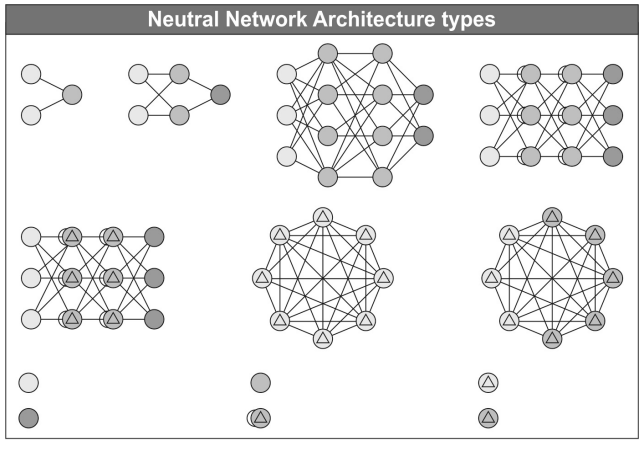

Figure 2.7: *Different types of Neural Networks*

Application of Neural Networks in different areas

Neural network can be deployed in different applications in different sectors. For example, in banking, the application could

be for document reading, credit evaluation, and credit scoring and fraud detection. In financial security, neural network applications can be developed for stock trading advisory function, bond rating, analysis of market trends, getting various reports and investing (based upon market trends of different businesses). In speech recognition industry which mainly caters to personal identification, neural network application can be developed for conversion of speech to text and text to speech synthesis, wobble classification, speech compression and speech recognition.

Deep Learning (DL) and how does it work

Deep learning is a subset of machine learning and is a set of algorithms that are more accurate and requires more hardware capacity and training time. Deep learning is also referred to as deep artificial neural networks or sometimes as deep reinforcement learning. These are machines' perception of images, text, sound and time series and are used for image recognition, sound recognition, recommender systems, etc.

Deep learning uses structures consisting of a set of units, just like the neurons of the human brain. Each unit combines an input value to produce an output value, which is passed on to the next neurons downstream. In the middle between the input and output layer is a hidden layer. Deep network has several hidden layers, which allows deep neural networks to extract features of the data in a feature hierarchy. Where complex patterns are involved in the data set, deep learning then uses hundreds of layers with large number of units in each layer to discover a pattern in the data set and pass on from one layer to the next through more mathematical operations. Computations become more complex for complex problems and that also demands more powerful graphic processing units (GPUs) and computing power.

Deep learning has accelerated the performance of the AI technology. It is a different software model, which runs on a different computing model. It achieved superhuman level of

performance and beat human-coded software in 2012 and in 2015. In 2012, Alex Krizhevsky used AlexNet, a neural network in deep learning for computers to recognize images by itself and beat the software experts who tried to achieve the same by writing a software computer vision code. AlexNet was trained with a million images on GPUs.

How is Deep Learning different from Computer Programs?

While computer programs run on a set of rules executed sequentially, deep learning is a new software model where billions of software-neurons and trillions of connections are trained, in parallel. Here, computers are writing their own software with deep neural network (DNN) algorithms and learning from examples. This new software model needs a new computer platform to run efficiently.

Accelerated computing is an ideal approach and the GPU is the ideal processor. As *Nature* recently noted, early progress in deep learning was "made possible by the advent of fast graphics processing units (GPUs) that were convenient to program and allowed researchers to train networks 10 or 20 times faster. A combination of factors is essential to create a new computing platform for performance, programing productivity and open accessibility.

Besides, deep learning, other approaches to machine learning are: decision tree learning, inductive logic programming, clustering, reinforcement learning, and Bayesian networks.

Applications of Deep Learning

Deep learning (along with neural networks) is the backbone of AI and large number of applications has been developed by using the methods of deep learning. DeepMind's Alpha Go algorithm beat the former world champion Lee Sedol at Go in 2016.

Facial recognition and autonomous vehicle technology (image

related), customer relationship management and targeted advertising (text related), voice search and translation from speech to text and text to speech (sound related) are examples of deep learning. Similarly in healthcare, deep learning predictions related to health data of patients, sensors and finance could be developed.

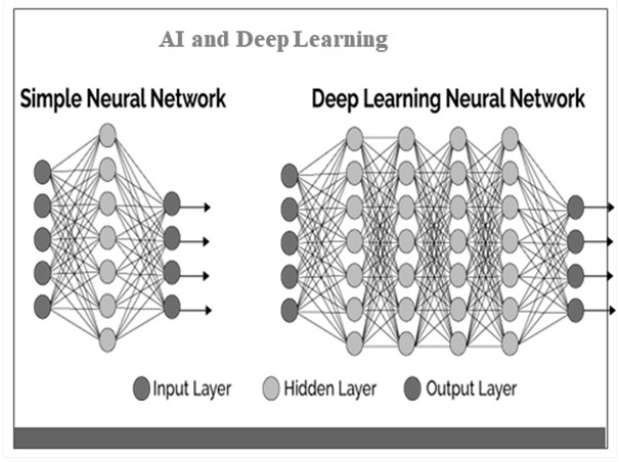

Figure 2.8: *Different types of Deep Learning Neural Networks*

Deep Learning mixed with IoT

Deep learning with IoT provides greater accuracy in tasks such as object classification. Since neural networks used in deep learning are trained rather than programmed, applications using this approach are easier to develop and take better advantage of the enormous amount of imaging and video data available in today's systems. Deep learning also provides superior versatility because neural network research and frameworks can be re-utilized across a larger variety of use cases compared to computer vision algorithms, which tend to be more purpose-specific.

Computer Vision

Computer vision deals with the collection of data pertaining to the images. It deals with methods of acquiring, processing, analyzing and understanding images and general high dimensional data from the real-world in order to produce numerical or symbolic information for example in the form of certain decisions.

Computer vision helps going through large database of pictures and images and extracts meaning from such pictures or images. It is through deep learning that computers understand images (better than humans).

Authentication by means of facial recognition and thumb impression through image recognition technology for using smartphones and getting access to social media by companies like Facebook, Apple and Alibaba are now quite common. Aadhar in India has one of the largest databases of India's citizens. Many controversial issues on citizens' right to privacy have arisen in the context of collection of data through personal identification.

Computer vision has applications in two specific areas: (i) Machine Vision; and (ii) Embedded vision.

Computer Vision vs. Machine Vision

Computer vision and machine vision are part of the same genre of technologies, but refer to two different types of applications. While computer vision involves capture and automation of image analysis with a wide range of theoretical and practical applications, machine vision involves use of computer vision in an industrial application. The components of a basic computer vision and machine vision system are generally the same, namely:

- An imaging device, usually a camera that contains an image sensor and a lens.
- An image capture board or frame grabber may be used (in

some digital cameras, a frame grabber is not required).

- Lighting appropriate for the specific application.
- A computer, or smart camera, where the processing happens in the camera.
- Image processing software.

As per Automated Imaging Association (AIA), machine vision encompasses all industrial and non-industrial applications in which a combination of hardware and software provide operational guidance to devices in the execution of their functions based on the capture and processing of images. *Machine vision*, for example, is used in high-end surveillance, biomedical or life sciences applications and to improve an internet search engine's ability to provide image-based recognition in search. Machine vision involves certain functions or outcomes based on the image analysis done by the vision system, which uses software to identify pre-programmed features. The system can be used to trigger a variety of set actions based on the findings.

For example, in a bottling facility in the food and beverage industry, the vision system can be used to identify a host of things. It can check on the following: empty bottle is free of damage and foreign objects, correct fill level, use of right label, placement of the lid or cap, or whether identifying code is appropriate or date stamp has been added to the bottle in the desired location. Depending on what the system software has been coded to do, the system can trigger a variety of actions based on a variety of findings. For example, it can send certain products down a specific packaging line, or re-route defective products or even stop a production line.

Embedded vision, on the other hand has large number of applications in retail, defense, health, education, automotive and consumer goods etc. Embedded systems could be deployed in smart phones, personal computers and even in cloud technology.

Computer vision and AI have given birth to a new kind of visual intelligence engine, which can be used for various

purposes. Enterprise-grade business models are emerging with the technology from open source and certain pre-trained models for commercially-scalable solutions. *Digital Globe* has launched an open data initiative called SpaceNet that provides commercial satellite data, labeled and hosted on the AWS cloud platform. *ImageNet* is an open database of images for training AI models.

Orbital Insight, Descartes Labs and *RS Metrics* are building solutions that allow anyone to analyze satellite imagery and perform geo-analytics using computer vision and AI. Increase in the availability and improvement in the level of details of satellite imagery and the advancements in AI and computer vision have created unique business models that now offer new solutions to various sectors from agriculture to finance and investment, oil and gas etc.

Satellite imagery can help farmers with precision agriculture. Similarly, oil & gas companies can use these in discovery of new energy resources, or aiding environmental agencies with monitoring the impact of humans on environment. Some interesting applications that have emerged are:

- Shipping companies or investment firms can now count the number of ships arriving and leaving ports to gauge trade volume of a country.
- Global oil storage volume that tracks and identifies oil storage tanks across the world, including those not in the public records to provide a more accurate measure of oil volumes.
- Measuring metal and commodity production by tracking metals stored outside smelters and storage facilities.
- Tracking a bounded area with alerts and updates provided when something changes in that specific area (change detection) or getting historical changes for that specific geographical portion. This was typically the domain of defense and security satellites which is now being provided to anyone.

- Predictive capabilities around any of the features being tracked, whether it is oil reserves, metals, or cars parked.

Application of Computer Vision and Mobile

Smartphone enabled companies can tap into a crowdsourced mobile workforce that can go into the field and capture images of products, places, and objects, and upload these images to a computer vision platform, which categorizes and tags these images, and performs additional analysis informing market research outcomes.

Premise[7] has pioneered the blending of AI and computer vision to mobile crowdsourcing. It offers crowdsourced market research for a variety of industries, including government, retail, finance & investment and healthcare. It has a network of smartphone users spread across the world.

Some of Premise's interesting case studies include:

- Capturing data on the percentage of un-electrified homes in Sub-Saharan Africa, including the location, roof size, presence of generators, transformers, and other key variables. This was used by a Global 100 company and its investors to monitor the impact of its energy investments.
- Standard Chartered uses Premise to create food price indicators in Nigeria and Ghana, providing a real-time feed on food prices at the shelf level, allowing its clients to make better investment decisions.
- Identifying the density and location of political posters for election candidates in Brazil to provide a real-time analysis about how the election campaign was proceeding, complementing and providing an alternative analysis to

7 Kaul Aditya, Artificial Intelligence and Computer Vision Enable the Next Generation of Visual Intelligence Tools, April 28, 2017 (https://www.tractica.com/artificial-intelligence/artificial-intelligence-and-computer-vision-enable-the-next-generation-of-visual-intelligence-tools/)

mainstream news coverage.

Applications of Computer Vision and IoT

Computer vision blended with Internet of Things (IoT) can produce different applications for home and work. For example, household monitoring systems use cameras to provide family members with a view of what's going on at home. Robots and drones can use vision processing to map their environment and avoid obstacles in flight. Augmented reality glasses use computer vision to overlay important information on the user's view, and cars use images from multiple cameras mounted in the vehicle to provide drivers with a surround or bird's eye view which helps prevent collisions.

Computer Vision and Deep Learning

Computer vision combined with deep learning can offer a better solution in certain situations. For example, in a security camera, a computer vision algorithm can efficiently detect faces or moving objects in the scene. Then, a smaller segment of such images is processed through deep learning to verify identification or object classification. This saves a lot on computing resources than if deep learning processing was done on every frame[8].

Nvidia's Jetson TX2 hardware for AI with IOT

Nvidia has developed a hardware combining AI with IoT. Their Nvidia Jetson TX 2[9], an embedded supercomputer, delivers one teraflops of performance in a credit card-sized module. This technology will drive a new wave of automation

8 Talluri Raj,,Conventional Computer Vision coupled with Deep Learning makes AI better, November 29, 2017 (https://www.networkworld.com/article/3239146/internet-of-things/conventional-computer-vision-coupled-with-deep-learning-makes-ai-better.html)

9 https://www.nvidia.com/en-us/about-nvidia/ai-computing/

in manufacturing, drones that can inspect hazardous places and robots that can deliver millions of packages, which would be a boon for e-commerce companies.

Autonomous Vehicle Technology (Self-Driving Vehicles)

Intel CEO, Brian Krzanich statement that 'Cars of the future are going to look more like a server' has sent the tech industry buzzing on autonomous vehicle technology or self-driving cars, one of the important areas of experimentation in the auto and technology industry. The idea is that vehicles could be driven without drivers at the wheels, with no steering wheels, no accelerators and no brakes. When the technology matures, driving vehicles of all sorts on the roads would become independent of human intervention. Drivers may doze off behind the wheels but autonomous systems go on working as per user's directions, without taking any rest.

The future of self-driving cars looks so charming that all the major car manufacturers from different countries and even technology companies like Google are jumping into the fray life fish to water. What if tomorrow, those self-driving vehicles went electric? That would be the beginning of a new era that will curtail rising levels of pollution and provide mobility. It will also change the structure of the transporation industry, with some new palyers entering business. There will be new part-makers, new interior-designers and new associated industries giving a big boost to the stagnating growths in the developed world, and also meet the shortage of drivers. Some developing countries like India might get a shock, since Indians believe that self-driving vehicles are on a suicide mission to gobble up employment.

A number of experiments in self-driving technologies are being carried out in different parts of the world. In a world's first permit by the regulatory authorities to carry freight by a battery-powered self-driving truck T-pod, pilot operations going on at Jongkoping. Einride, a Swedish autonomous vehicle startup has partnered with DB Schenker, the German logistics

group to start commercial operations between by Gothenberg and Helsingborg, 200 km apart. The T-pod, which has level-4 autonomy (a human driver is present, but there is almost never a need to intervene) can run with the top speed of 85 kmph, carries 20 tonnes of weight and can travel upto 200 km in a single charge. Operators sitting anywhere can supervise upto ten T-pods at one time.

Successful experiments are emerging in other countries as well. Navya, a French company is already running 15-seater AUTONOM SHUTTLE, a driverless electric service for use on public roads and also at private sites. It uses advanced technologies and collects data through Lidar sensors, cameras, GPS RTK, IMU and odometry, which together are interpreted by a deep learning program to provide effective guidance and detection systems[10] . Another French auto parts maker Valeo successfully demonstrated its own autonomous car. The Valeo Drive4U packed with Valeo parts like ultrasonic sensors, cameras, laser scanners, and radars and Valeo's artificial intelligence systems for processing data navigated through the streets of Paris, while detecting and responding to intersections, traffic lights, cyclists, and pedestrians, without the aid of a driver. The car could operate at Level 4 autonomy. (The level 5 is the highest level of autonomy)[11].

Apple too is in the race for leadership in autonomous vehicles. It has sixty-six vehicles registered with California DMV, the third largest test fleet of vehicles, just behind GM Cruise and waymo.

In China, a little yellow horse, the size of a small washing machine, is an autonomous delivery robot, fitted with a GPS

10 AUTONOM SHUTTLE, the revolutionary first and last mile travel solution, (https://navya.tech/en/autonom-shuttle/)

11 O'Brien Chris, "How automotive supplier Valeo wants to accelerate autonomous vehicle development", November 19, 2018 (https://venturebeat.com/2018/11/19/how-automotive-supplier-valeo-wants-to-accelerate-autonomous-vehicle-development/)

system, cameras, and radar that carries small packages of daily needs like snacks, drinks and fruits for delivey at the speed of 3km/hr from the local store to the residents of Kafka compound at the outer Beijing[12]. The technology by Zen Robotics has some limitations, but will surely improve in the future. In a country where there are 100 million packages being delivered on daily basis, which is set to rise to a billion per day, robotic delivery in absence of enough manpower being available holds the future.

Self-driving tractors are being used at the farms in agriculture and within the mining area. Autonomous vehicles running within certain complexes like malls and at tourists places could be a viable option.

The origin of self-driving cars can be traced back to Francis Houdina, who in 1925 displayed a radio-controlled car and drove it on the streets of Manhattan, New York without anyone commanding the steering wheel.

California state in the US was the first to permit driver-less cars and Google started experimenting as early as in 2008. Michigan, Paris, London, Beijing and Singapore have all permitted experimentation, now.

Hardware and Software Required

In the technology on experiment now, there is a combination of sensors, cameras, radars and Lidars (Laser Illuminating Detection and Ranging) that together drive the autonomous vehicles on the road. This is how the system works:

- Cameras can see the markings on the road and capture an overlapping view of the surroundings
- Radars measure distance and velocity of the object with

12 AFP and Kelsey Cheng, The robots that deliver food to homes: Adorable autonomous machines carry drinks, fruit and snacks from supermarkets to residents in Beijing (https://www.dailymail.co.uk/news/china/article-5965065/In-China-yellow-robots-deliver-snacks-home.html)

the help of sensors and then sends a signal to the processor to stop or move out of the way.

- Sensors generally perceive the environment and are also used for lane-keep assistance, blind-spot monitoring and collision warning.
- Lidars are used for building a 3D map which allows the car to detect potential hazards by reflecting a laser beam off from surfaces sorrounding the car to detrmine the distance and profile of that object.
- Then there is sophisticated software or control algorithm which processes all the data in real time as well as behavior dynamics of other drivers, pedestrians and various other objects.

The system also learns from the previous experiences. Based on input data, they take decisions on route guidance, braking or speeding.

Autonomous Vehicles Versus Modern-day Cars

Modern day cars have their origins in 1890s when experiments were conducted for turning steam, electricity or gasoline based fuels into mechanical power for driving a horseless carriage on the road. When a 79-mile long contest was held in 1894 for the first time for a drive between Paris to Rouen by Li Petit Journal, a French Newspaper, seven dogs were run over and a cyclist was injured. Gottlieb Daimler's technology of internal combustion engine had won the race as nine of the seventeen successful vehicles had travelled the full length of the journey and four of them won the first spot.

In the first ever contest of self-driving vehicles for a 179-mile race, organized by DARPA (Defense agency of the US government) in March, 2004 at Mojave desert, only twelve out of twenty one vehicles crossed the start line and none could complete their journey. In the next contest for 132-mile journey held in October 2005, five of twenty three vehicles crossed the finish line with Sebastian Thrun of Stanford University in the lead. In the third

contest in November, 2007, six of eleven contestants completed their course in a much more complex environment meandering through complex road signs.

Big Players betting on New Technology

The investment game in autonomous technology has become more competitive as number of players entering this field keeps growing. While companies like Amazon and Alibaba are looking at delivery of parcels through autonomous vehicles, others like Uber and Didi Chuxing see a big business in personal transportation with an eye on disrupting the existing transportation industry. Toyota has also jumped in the ring by proposing an inevestment of $500 million in Uber for getting a share of pie in the new technology. Toyota rather wants to use AI and automation to make existing cars safer and more enjoyable to drive[13].

Uber and Didi also visualize a day when personal ownership of cars would become irrelevant as cars would be available on demand. In China, a small delivery van is run by a robot that can deliver food packets within a distance of about ten kms. Google Chauffeur software is slated to arrive in the market by 2020. Tesla is having Autopilot which works on camera sensors.

Volkswagen, the German car company is working on driverless car, though their current emphasis is on electric vehicles. In Potsdam, west of Berlin, it is working on future models of cars, including adapted versions of SEDRIC, the company's self driving vehicle. With new virtual reality platform, new designs can be tweaked within seconds.

Both the auto and technology companies are vying for a place under the sun in an attempt to become the leader in the market place. Number of patent filings are growing. Ford Motors (with 103 patents) and Google (with 100 patents) are running neck to neck in number of patents granted. Toyota and Uber each have

13 'Speed Limited', The Economist, May 19th, 2018, page 57

77 patents, while Baidu of China has also got 42 patents just behind General Motors and Wymo. Here is the latest report on filings.

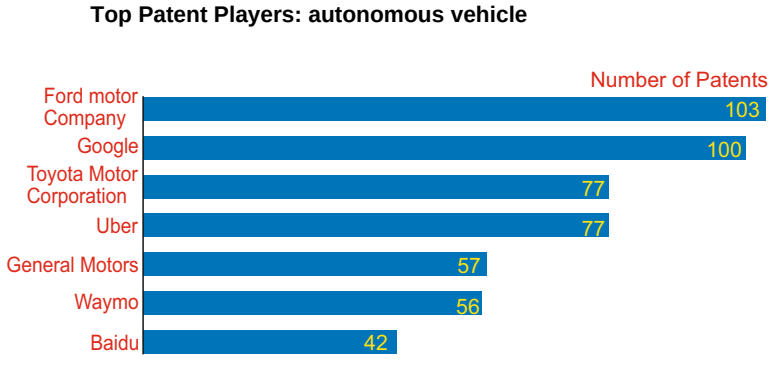

Figure 2.9: *Patent grants to major corporations (Source: C B Insights[14])*

As can be seen from the chart above, big players are in the race of this technology. Waymo, a unit of Alphabet plans to launch a robotaxi service in Arizona. It struck a deal with Fiat Chrysler Automobiles for purchase of 62,000 minivans to be deployed as robot taxis. The minivans are plug-in hybrid variants with Waymo's self-driving hardware and software built in.

Other players in the game are also hurrying up. General Motors is also planning to launch fully autonomous taxi service in 2019. Volkswagen through Moia, its new ride-hailing service will make such vehicles in 2021. Ford too is planning to mass-produce such cars. Honda is buying a 5.7% stake for $750 million in Cruise Motors, a subsidiary of General Motors, and would contribute an additional amount of $2 billion over the next 12 years.

Technological limitations will surely be perfected since a

14 Research Briefs, August 20, 2018 (https://www.cbinsights.com/research/uber-autonomous-vehicles-wework-china-amazon-millennials/)

number of large companies and many startups like Starsky Robotics, Embark, Peleton and Tusimple in the US are pumping huge funds in research. The governments have also realized that their own local champions must take the lead and not be left behind just because the century old regulations cannot accomodate the new technology.

There is though danger of roads being monopolized by just a few ultimately. The big players may have an advantage over others as they will have more data, which makes further improvements possible. In self-driven cars, the ultimate judgemnet is on safety and reliability. In trial runs for example, Wymo has done better than GM. There will be standards, of course that will gurantee safety. But whether just a few will have the advantage of running the industry because they have better AI technology to run those cars!

Advantages of Autonomous Vehicles

The new technology offers a big opportunity and when technology is perfected, driving could become safer and many more lives could be saved on the road. Regulators are relaxing their existing laws for experimentation with the hope that the new technology will add billions of dollars to the digital economy and will be a net creator of jobs. Humans could save time and the whole driving experiance may become more enjoyable.

The greatest advantage of self-driving technology, when perfected will be for the disabled and for those who can not drive themselves. Life for them would have more mobility.

Challenges of the Autonomous System

The technology of autonomous vehicle is capital intensive and yet to be perfected for sound and scalable solution as there are several limitations of those equipments. Further, the transportation sector is heavily regulated. A host of government agencies are involved.

Auto companies are trying to develop certain standards of autonomous vehicles which would help in quicker adoption of technology, make it safer and more secure and acceptable to the larger public[15].

There are a host of technological challenges before the self-driving vehicles take charge of transportation. Unidentified objects on the road, sensing things in the sorroundings and taking a decision when faced suddenly with a challenging situation are only some of the challenges. There are issues of huge job losses as the transporation sector in the US for example employs some 700,000 drivers. Insurance and health industries may find reduced opportunities. But, there may be less pressure on emergency response systems.

There is scepticism galore when the technology is at a nascent stage. There are many who believe that self-driving cars would cause more deaths. There was a public hue and cry when Uber self-driving vehicle, on its experimental journey in the night at Phoenix struck and killed Elaine Herzberg, a pedestrian. Uber suspended public road test for autonomous vehicles. An advocacy group called for a national moratorium on self-driving tests. A legal framework however is yet to evolve, since there has been only one lawsuit, other than those privately settled, between GM and a motorcyclist[16].

However, there are some experts like Rodney Brooks who caution that fully autonomous cars may not arrive before 2032 in any American city.

AI-powered Unmanned Aerial vehicles (Drones)

Drones or unmanned aerial vehicles (UAVs) are growing ever

15 Davies Alex,' THE WIRED GUIDE TO SELF-DRIVING CARS, JANUARY 1, 2018 (https://www.wired.com/story/guide-self-driving-cars/)

16 Korosec Kirsten, ' A New Code of Conduct', *Fortune*, May 3, 2018 (page 11-12)

more powerful and popular. They are planned to be used for delivering packets by Amazon, Alibaba and others.

Drones controlled remotely through ground cockpit are fitted with infra-red cameras, GPS and laser. Sophistication may vary according to size and cost. They can operate at different heights and can travel distances within a range.

Sophisticated drones use AI and deep learning for providing many different types of services. They can fly at higher speeds and manage obstacles better than their unmanned counterparts. Drones are most handy where real time data is required, say from industrial construction and other sites or where surveillance is required to be done. *Aerialtronics* can inspect industrial sites like cell towers and can detect faults for repair. *Intelligent Flying Machines* has built a drone that can navigate through a warehouse and match what is available on the shelves to the orders and manage the inventory system better. *CrowdAI's* services of collecting drone footage can be used by drone companies to count solar panels assessing extent of roof damage for insurance claim.

AI powered drones fitted with high-resolution cameras made by a GE subsidiary, *Avitas Systems* can be deployed for transportation, inspection and for infrastructure. The data collected can be used for analytics.

The big tech is also investing heavily in drone technology as AI enabled drones can be used for emergency response services to reach difficult terrain for dropping food for example or in search and rescue operations. Drones with AI can be used in precision agriculture for planting crops at the right time and in using fertilizers etc. At construction sites, drones can scan and map the site area much more efficiently giving the complete picture of the progress of construction, status of all the equipments and other similar variables. *Skycatch* is capturing data from UAV (Unmanned Aerial Vehicle) to analyze with AI to better manage construction at the site.

Use of AI drones for military purposes though controversial is being made for patrolling borders, military inspections,

monitoring security and carrying weapons or essential supplies. An AI technology called ALPHA developed on genetic algorithm can be used for military purposes both in offensive and defensive modes. It performs better than a human pilot and can take decisions on a fuzzy logic based on sensor data in milliseconds.

Google is working with its TensorFlow AI systems with Pentagon's Maven Project to analyze vast amounts of data collected for object recognition and spot things of interest. But opposition to such military programs has been growing and Google has decided to end such programs after the contract with Pentagon expires.

The problem however is that flying is highly regulated which limits the development of UAVs. Regulators are working out a mechanism that will solve the problem of development of this sector. Chinese pressure is working on other governments as well to relax the conditions to match the competition.

Anti-UAV Defense System

Anti-UAV defense syetems[17] (AUDS) also known as Integrated Counter Drone Management System detects, tracks or disables or neutralizes UAVs engaged in dangeraous activities like espionage, surveillance, or any other malicious activity such as terrorism. Such drones could also fly past sensitive areas at the airport, border areas etc. The system has long-range radar surveillance, cameras, infrared, target-tracking software, RF jammer system and other sophisticated controls that can jam their finctions, or take their command and even shoot down the drone in the worst possible scenario. The system can distinguish whether it is a drone or a bird.

AUDS has been developed by British firms Blighter Surveillance Systems, Chess Dynamics, and Enterprise Control Systems and

17 https://www.homelandsecurity-technology.com/projects/anti-uav-defence-system-auds/

currently the technology is available with the US, UK, France and Israel.

Autonomous Cargo Shipping

Autonomous driving technology with machine learning, augmented reality, virtual reality, data analytics, database and storage, is now being used to build fully autonomous ships to save on energy consumption, enhance safety and bring down cost. Norwegian shipbuilder Vard Holdings has started production of a fully-autonomous and fully-electric ship, the Yara Berkeland for a Norwegian chemical company, Yara with a zero-emission target.

A few startups are also using technology to build semi and fully-autonomous systems on the existing ships, which otherwise would cost a lot to replace. Samsung Heavy Industries is using Amazon's AWS cloud platform to build autonomous shipping platform for self-piloting the cargo ship.

Shone, a US based startup is designing retrofitting systems with AI and data from multiple existing ship sensors that will aid on-board crews for piloting assistance and help detect other ships and their movements in the surroundings. It will provide an anti-collision alert system.

Another startup Sea Machine Robotics is using AI and Lidar software to design autonomous remote vessel control which can be installed on existing vessels. It is testing one of its products designed for merchant and cruise ships, SM400 with Maersk.

International Maritime Organization (IMO), a UN body is addressing the issue of international regulation and has come out with a policy on MASS (Maritime Autonomous Surface Ship), which prescribes different levels of autonomy i.e. if an on-board human crew leverages autonomous technology assistance, whether a ship is controlled remotely from land or whether a ship is totally autonomous and independent.

Advantages of using autonomous technology are obvious. Cargo carriage will become less costly, there will be reduction

in manpower cost, and savings in energy, human error can be minimized to raise safety of ships and digitization will connect the different stakeholders and drive data efficiencies[18].

Natural Language Processing

Natural Language Processing (NLP) is a sub set of artificial intelligence which refers to the ability of machines to understand and interpret any natural language whether in writing or in the form of speech. NLP allows computers to read and respond in their own (natural) language the way a human being would understand. There are a number of processes involved and these are: syntax (grammatical checking), semantics (meaning of the text) and pragmatics (purpose of the text). Further it deals with phonology (systematic organization of sound in language) and morphology (relationship of words with each other).

There are large number of applications running with NLP. Digital virtual assistants are a common application, where a customer's first request is intercepted by the AI, such as Nuance's virtual assistant Nina. Then there are automative virtual assistants like Nuance's Dragon Drive AI, as a hybrid voice and NLP derived from deep neural networks running a service in multiple languages with the car maker like BMW. Drivers can access various apps and services through voice commands for music, weather, social media, navigation etc. It can send a text message to a friend for being late for the meeting, for example.

NLP can also automate call center operations and reduce cost. Through Skype translator, a live speech can be translated in

18 Research Briefs, Massive Cargo Ships Are Going Autonomous. Here Are The Companies & Trends Driving The Global Maritime Industry Forward, August 28, 2018 (https://www.cbinsights.com/research/autonomous-shipping-trends/?utm_ source=CB+Insights+Newsletter&utm_campaign=ba91154b4a-Top_Research_Briefs_09_01_2018&utm_medium=email&utm_term=0_9dc0513989-ba91154b4a-91029453)

many languages, so that people speaking different languages can communicate with each other without any language barrier. Sentiment analysis uses NLP for example in customer reviews of a product by collecting information from the social media and other channels, which can be analyzed with NLP to improve products and make recommendation to the customers based on their choice which may further increase overall customer staisfaction level. NLP can be used for various other applications such as document summarization, information extraction etc.

There are huge business opportunities in NLP. 2017 Tractica report estimates the market opportunity in NLP software, hardware, and services to be around $22.3 billion by 2025. NLP software solutions leveraging AI may see market growth from $136 million in 2016 to $5.4 billion by 2025.

Chatbots

A Chabot is an artificial intelligence program which enables a conversation via auditory or textual methods. This is based on simulation of how a human would behave as a conversational partner. Chatbots scan for keywords within the input and then pull a reply from a database with the most matching keywords, or the most similar word pattern. Sophisticated chatbots may also use natural language processing systems. Intelligent bots improve all the time with more and more conversation. They sense and judge; they think and then act to deliver most appropriate response. There are tools available from IBM Watson, Api.ai, or Wit.ai to incorporate natural language capability into a chat bot. There are social chatbots available from large number of companies. Microsoft's Chabot is named Ruuh in India, Rinna in Japan and Indonesia. In the US, it sells Zo, after withdrawing a malfunctioning Tay. In China, a Chabot called Xiaoice is hosting TV shows and sending tips on shopping to customers.

Most chat bots now interact through virtual assistants such as Amazon's Alexa or Google Assistant or through Facebook

messenger or WeChat or through organization's own website, so that they can interact intelligently with a human touch with the users. They use deep learning technology to visually screen products, say from the groceries.

Chatbots are used for customer services where some information is otherwise sought to be obtained through a dialogue. They are also used in e-commerce, analytics, communication, education etc. They have become popular as companies seek to deliver personalized services and enhance their brand image.

Virtual Assistants

Virtual Assistants are now quite popular and would become one of the most consumer-friendly products to interact with, in their own language to deliver higher level services and functionalities.

Intercontinental group of hotels (ICGH) in partnership with Baidu in China are going to deploy Amazon's Alexa in their rooms to provide better interactive services to their customers in about 100 hotels to begin with.

How do virtual assistants operate? Spyros Matsoukas, Principal Scientist at Amazon, describes how deep learning is used throughout the complex system behind Alexa, the virtual assistant from detecting the "wake word" and speech recognition to converting text to speech and natural language understanding. Challenges abound, and just in the area of understanding what the user says they include recognizing intent (e.g., "play 'remind me'" vs. "remind me to go to the play"), dealing with similar-sounding words, users correcting themselves in mid-sentence, and the need for high precision and recall. Amazon researchers constantly tweak and upgrade the type of deep learning models they use to reduce errors and improve Alexa's understanding of the user's input.

Google assistant would do a host of things including booking an appointment with the salon for a hair cut. Apple's Siri, is being used with Apple's products only for security reasons.

China too is getting ahead in the race with voice assistants from Alibaba and Tencent. Flipkart in India recently acquired Liv. com, which has natural language capability in several regional languages.

BMW will start using their own AI-enabled voice assistant, named, 'Hey BMW', in their next models BMW X5, Z4 and 8 Series cars that will come with BMW Operating Systems 7.0. Users will be able to turn on air conditioning or lights and give commands to the radio. Users can give a name to the assistant that learns user's preferences and familiarize itself with the favorite in-car settings by tapping into BMW's Open Mobility Cloud and AI. The Intelligent Personal Assistant will be available in 23 languages in a basic version next March as part of the Live Cockpit Professional. It is also compatible with Alexa. The Mercedez-Benz, Ford and a few other car makers are already using voice assistants in their cars.

Voiceprint

Each person has a unique voice, and hence a voice ID card be used as a form of identification. Voiceprint is a visual record of speech analyzed with respect to their frequency, amplitude and duration. This is another technology where a recorded voice sample can be translated into a unique mathematical matrix and stored for use. This is another form of authentication apart from iris or thumb to gain access to certain services like for phone banking. Whereas our brains can recognize voices of only 150 people or so, system can recognize more than 100,000 samples of unique voice prints.

But then there are dangers of voice as an ID. Lyrebird, a Canadian startup claims that with a minute of a voice sample, it can clone anybody's voice through algorithm created by machine learning. Cloning can be misused but could also be used in a friendly manner to read out books for the disabled or visually imapired in the familiar voice of a celebrity. Adobe's projectVoCo can edit speech (of at least 20 minutes) just like digital images.

Understanding Robotics

Robotics is a branch of engineering that involves the conception, design, manufacture, and operation of robots. This field overlaps with electronics, computer science, artificial intelligence, mechatronics, nanotechnology and bioengineering. Robots are used in factories, homes and in many other places like airports.

Science-fiction author Isaac Asimov is credited for being the first person to use the term robotics in a short story composed in the 1940s. Asimov invented the 'Three Laws of Robotics' to guide the behavior of robots and smart machines. The three principles that are valid till date are:

i. Robots must never harm human beings.

ii. Robots must follow instructions from humans without violating rule 1.

iii. Robots must protect themselves without violating the other rules.

Robotic machines can be developed with the human-like intelligence which can do a host of activities replicating action of the human brain. Sophia, humanoid robot made great news, when it appeared at Austin Texas (US) in mid-March, 2016. In November, 2017, it was named as the innovation champion by the UNDP. A rival to Sophia, Pepper[19], a walking and a talking robot made its debut in UK's parliament in October, 2018 during the hearing by an education committee (on AI and the 4th industrial revolution). It was quizzed on the role humans will play in the AI-led world in the future, to which she responded that the robots will need the soft skills humans possess. Pepper is part of 'Caresses Project' using machine learning, at the Middlesex University, for helping older people to keep in contact with their family and friends and to carry out

19 Lynn Bryan, 'Humanoid Pepper appears in British Parliament', October 17, 2018 (https://learningenglish.voanews.com/a/humanoid-robot-pepper-appears-in-britain-s-parliament/4617564.html)

common tasks.

Robots are being deployed in greater numbers in manufacturing, particularly in the area of high-tech manufacturing in the developed world. Volkswagen is already working with German Robot manufacturer, KUKA for deployment of robots on the factory floor.

Schindler has devised Robotics Installation Systems for Elevators (R.I.S.E.) which uses autonomous systems and self-climbing robots for safe and high-quality installation of lifts in the high-rise buildings. It eliminates repetitive task of drilling multiple holes in concrete walls to set anchor bolts for installation and also reduces safety risks while providing faster installation[20]. The solution is useful in building smart cities.

CarriRo, a delivery robot was on display at the World Robot Summit in Tokyo in 2018. CarriRo can zip around the streets at 6 kmph rolling along the pavements directing itself through GPS delivering packets to the destination address within a 2-km radius. With an ageing population of 28% above 65 years, robots are coming to the rescue of the Japanese in various sectors like construction and retail.

There are home robots and human support robots that are used for daily chores, facilitating human assistance and taking care of the elderly and the aged in an appropriate manner. A robot can perform a music drama as well. These are programmable machines which have been assigned a certain task in a repetitive manner by use of knowledge from various disciplines including artificial intelligence. Robotics can also be used as a teaching aid and for many other useful activities.

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20 Anna, 'Schindler debuts robotic system for lifts', October 18, 2018 (http://roboticsandautomationnews.com/2018/10/18/schindler-debuts-robotic-system-for-lifts/19463/?utm_source=Robotics+and+Automation+News&utm_campaign=439cb477e6-R%26A+19+October+2018&utm_medium=email&utm_term=0_da1848e85b-439cb477e6-510161781&goal=0_da1848e85b-439cb477e6-510161781&mc_cid=439cb477e6&mc_eid=02816cac97)

Creator, a new hamburger joint in San Francisco invented a bot that automates the whole process of preparing a burger at a much cheaper price ($6 against $18). Customers can have a burger with cheese and toppings of their choice. Robots also serve a meal to the customer. There are other robot-run restaurants like Zume Pizza at California and Spyce in Boston.

Researchers at Singapore have taught industrial robots how to assemble an IKEA chair from 19 parts. After lot of struggle and hand-holding, robot could assemble it in nine minutes[21]. This experiment though exposed chinks in complete automation.

Robots used in different Countries

As per a report of International Federation of Robotics[22], Robots are being deployed in all sorts of industries from car manufacture, capital goods to chemicals etc. The global average number of robots employed per 10,000 employees has gone up to 74 in 2017 from 66 in 2015. By region, Europe has 99, the USA 84 and Asia has 63 robots per 10,000 employees. Korea, Singapore, Germany, Japan and Sweden are the top countries in the lead. China too has raised its target to align with Make in China 2025 strategy.

Push for Robotization

AI is also spreading fast through the rising number of robots everywhere, from factory floors to our drawing rooms at homes. According to the annual report based on 2018 survey by Material handling Institute, companies are turning to robotics for competitive advantage, with adoption expected to rise from 34 to 73% over the next five years. Robots can manage the warehousing operations better and optimize the space for

21 Some assembly needed, The Economist, April, 21st, 2018 (page 12, 69)

22 Lynn Bryan, 'Humanoid Pepper appears in British Parliament', October 17, 2018 (https://learningenglish.voanews.com/a/humanoid-robot-pepper-appears-in-britain-s-parliament/4617564.html)

receiving and taking out inventory.

Advantages of use of Robots

There is a tight race among nations for deployment of robots, so this is no longer a luxury but a competitive advantage for nations. More and more deployment of robots creates a race among nations for deployment by other countries.

There are several advantages with the deployment of robots in manufacturing. With the use of robots, the quality of manufactured goods can be improved substantially as AI can detect even minor flaws in the manufacturing through computer vision systems. Robots can also be deployed for precision work in advanced manufacturing. Deployment of robots increases efficiency and overall effectiveness including cost advantage. Robots perform better and thus human labor can be freed for better quality work. Robots can be deployed in the dangerous areas of work, which could otherwise be highly risky for humans.

Robots deployed in military technology may however pose a bigger challenge, potentially threatening human species itself.

Internet of Things (IoT)

IoT helps connect a network of devices embedded with AI and sensors to talk to each other in real time so that the system as a whole becomes more intelligent. The system can be integrated so that it can be controlled from a centralized location. Common applications include home appliances becoming inter-connected and wearables exchanging information with smartphones to track health inputs, but major applications are in enterprises, which are increasing spending on IoT to gain advantages.

IoT solution is used in several industries including agriculture. IIT Kharagpur (India) has developed, a farmer-friendly web server-based platform AgriSens, for controlling irrigated fields producing various crops. The solution digitizes the agricultural field conditions of the soil. A device is planted in the field which

uses sensor nodes and has a processor and a radio unit and sensors to read data pertaining to soil moisture, temperature and water level. The other part is a hand-held device which reads the data when it comes in contact with the first device and transfers it to remote servers, where data analytics, data visualization and other processes can be conducted[23]. Both work without any internet connectivity and hence the solution could be deployed anywhere. This method eliminates manual monitoring of water conditions in the fields and raises the productivity by eliminating wasteful practices.

IoT is going to be a big driver in the future. Globally, the market size could zoom to $267 billion as per Boston Consultancy report. In India, Government of India wants to create an industry of $15 billion by 2020. Number of units is expected to grow by 30 times as per a Deloitte report.

Application of IoT

Honeywell Enterprise Solution in IoT

Large enterprises can connect data from different systems for better analytics for efficient functioning, lower energy consumption etc. Honeywell Connected Plant (HCP) offers digitalization in manufacturing and seamless integration of entire value chain from supply to end customers by combining advanced software with physical products in a wide variety of verticals. Different departments and operators working across enterprise can be integrated for real time analytics to increase efficiency. Plant can become a smarter plant with software based systems employing big data analytics. HCP can do deep self-diagnosis and operating problems can be identified days or weeks in advance.

23 http://agrisys.iitkgp.ac.in/about.html

Zenatix, India

Zenatix deploys customized hardware and sensors which provide real-time monitoring and control of physical assets through cloud-based software. It caters to BFSI and retail sectors and has built in areas such as edge processing, machine learning and AI.

Hero Electronix, a semiconductor Company has acquired Zenatix to tap into digital opportunities to expand into IoT business. Objective is to make products connect them and make them intelligent by adding software and analytical capability. It has a target of IoT business of Rs 10 billion ($ 140 million approx.) by 2022. It has planned to make an investment of Rs 4 billion ($ 55 million) by 2020 across IOT based consumer and enterprise business through own verticals, Zenatix and partnerships.

Henkel, Salon Lab, Germany

Henkel Schwarzkopf Professional SalonLab[24] is using digital technology and IoT in a highly innovative manner to revolutionize Salon experience for personal care industry. With the help of hairdressers, user-specific products and services are developed for hair care by analyzing hair at the molecular level with data driven insights. A hand-held SalonLab Analyzer which uses near-infrared and visible light sensors measures inner hair condition, moisture level and the hair color. SalonLab Consultant App connects the devices, visualizes the results and uses augmentation reality technology with a live 3D review for providing personalized colour consultation through SalonLab Customizer.

Advantages of IoT

There are obvious advantages of application of IoT: precision

24 http://salonlab.bplusd-interactive.de/

drives the processes, which become more efficient and the workplace becomes more intelligent and productive. We will have a happier workforce. Workers may get to know about their physical and mental health, when they become stressed or they need to slow down. But there are simultaneous challenges to issues of security and intrusion in workers' private lives.

Concluding Remarks

Pierre Nanterme, Chairman CEO of Accenture when asked as to where does machine learning fit into the spectrum of technologies, he stated that machine learning algorithms and analytics are here and now, whereas Blockchain is for tomorrow and Quantum Computing for day after tomorrow. AI and associated technologies are making great strides in human life. The revolution through the new technologies led by artificial intelligence will continue its journey and entrepreneurs will use it for changing life and business in the next decade. Simplification and utility of these technologies will enhance adoption rate. Here lies an opportunity and a challenge.

CHAPTER 3

AI in the 'Bull' Run

By 2020, 85% of customer interactions will be managed without a human

– Gartner

Artificial Intelligence is making a Rapid Progress

Artificial Intelligence had its roots in the 1940s and since then it has witnessed many ups and downs from 'AI winter' to 'AI spring'. But progress started on a serious note since 2000 and caught up speed since 2010. There are many enabling factors and lead indicators that demonstrate why AI started making a rapid progress in the last few years and some of these are:

- Rapid development in computing power and hardware capacity with exponential increase in communication bandwidth and reducing cost thereof
- Development of machine learning, deep learning and neural networks on GPUs
- Global demand of AI products and services in several industries
- A national awakening that AI is the next big thing
- A serial development of startup eco-system
- Heavy financial investment by the big tech
- Investment in top talent
- Rise of venture capitalists for funding the AI startups

No matter which industry we are talking about, from manufacturing to services, like finance or marketing, companies are riding high on the wave of artificial intelligence to develop

new products and services for the customers.

Here, some highlights and indicators of the above said developments is discussed to show that the AI-market is having a real bull run and that progress is likely to continue at least for the next decade.

Stanford University Report shows AI is progressing fast

Stanford University came out with an AI Index[1], which is based on an activity metrix comprising of a number of activities like venture capital investment, number of attendees in any AI conference, number of research publications etc. There is a ten-fold increase in academic activity since 1996, explosive growth in startups, and venture funding. Data from Github, a website that hosts source code shows that AI related software is being created on a grand scale and the overall interest in machine learning packages like Tensorflow and Keras is growing fast. Sentiment on news articles on job losses shows a positive outlook (ratio is 3:1 for positives and negatives).

However, the report also cautions against hype, since AI still does only rudimentary things and is nowhere close to General AI, where it can perform human level cognitive tasks in a broad range of tasks.

3 Enablers of AI: Storage, Connectivity and reduced Cost

Limitations of hardware, networks and the bandwidth that existed till 2000 were overcome since the invention of powerful Graphic Processor Units (GPUs), CPUs, servers and other powerful devices. Similarly the bandwidth availability has been

1 Hornigold Thomas, ' How Fast Is AI Progressing? Stanford's New Report Card for rtificial Intelligence', July 18, 2018 (https://singularityhub.com/2018/01/18/how-fast-is-ai-progressing-stanfords-new-report-card-for-artificial-intelligence/#sm.0001iigxww12d1f7gsfp9r2sp5u7o)

increasing and the network devices have also become smarter than before. Simultaneously, the cost of storage per unit of data and cost of usage of the bandwidth has been coming down fast. These three factors together have enabled businesses to expand their data storage capacity rapidly and deploy higher bandwidth for communication at much lower cost.

Design of AI products and services are now much better in terms of quality and cost. Further, the emergence of big data and the vast processing capacity for making a meaning out of data has enabled the next level of computation and predictive analysis. The Deep Learning which earlier could not take off suddenly found a new life after 2010. Thus has emerged the various facets of AI in vision, natural language processing and speech etc.

The stage was set for the next generation of revolution which first started with data sciences in the early 2000 and subsequently from 2010 onwards, the intelligence has got embedded in products and services that are being designed for the customers.

Hardware Revolution that led to development of AI

For years, some of the greatest AI experts like Geoffrey Hinton (teaching at University of Toronto at Canada and early pioneer of deep learning), Yann LeCun (teaching at New York University) and Yoshua Bengio (teaching at University of Montreal) could not succeed in making deep learning and neural networks work well in practice. It was in the late 2000s that they realized why they were not working. Training neural networks required massive computing resources. Developing algorithms for deep learning neural network requires not just great processing power in the hardware, but also faster processing through chips. They also required data resources and not enough of it was available.

Now, a number of companies are designing GPUs that have huge storage capacity and a number of chip makers are also designing better chips. Alphabet's tensor processing unit, Qualcomm's neural processing unit and IBM's TrueNorth

neuromorphic computing platform have all boosted the progress of AI.

With the rise in computing power and higher capacity hardware like GPUs, the big tech invented translation of languages, recognizing faces and understanding speech[2]. The AI engine of growth has thus taken off.

Performance of GPUs

Nividia CEO Jensen Huang predicts 1000X more performance for Graphic Processing Unit (GPU) by 2025. Whereas Moore's law by which the number of transistors on a chip doubled every year is no longer valid, GPUs provide the next generation architecture for massive rise in performance[3].

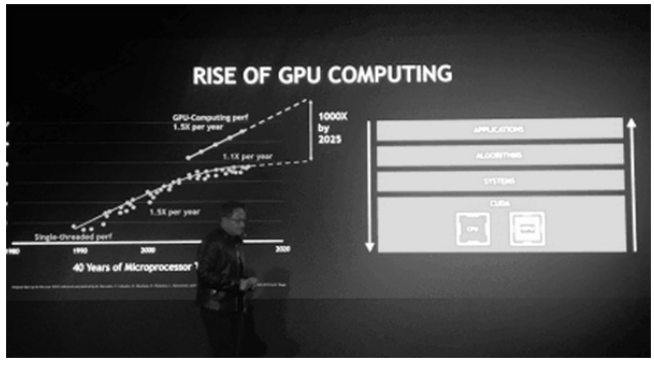


Figure 3.1: Rise of GPU Computing

GPU Performance Speedup

The graph in Figure 3.1 above shows a link between GPU/CPU speedup and the corresponding increase in the number of

2 Vauhini Vara, 'Can this Startup break Big Tech's hold on AI', Fortune, July 1, 2018 (Page 40-47 at page 43-44)

3 Wang Brian, Moore Law is Dead but GPU will get 1000X faster by 2025, June 1, 2017 (https://www.nextbigfuture.com/2017/06/moore-law-is-dead-but-gpu-will-get-1000x-faster-by-2025.html)

simulated neurons. As GPUs become more powerful, neutral networks in deep learning also become stronger enabling better predictive analysis with a more complex set of parameters for the final outcome.

All the GPU manufacturers like NVIDIA, Intel and others are focusing on increasing the power, capacity and speed of their products.

GPUs for Deep Learning

GPUs are much more powerful than CPUs. While Google Brain project deployed 2000 CPUs in a giant data center to recognize the image of cats and people by watching videos on YouTube, Andrew Ng at Stanford with Bryan Catanzaro of Nvidia could do the same with just 12 GPUs using deep learning.

AI is increasingly using deep learning techniques to handle massive amounts of text, image, and video data generated by Google, Baidu, Facebook, and other big tech companies. Since 2011, GPU accelerators are increasingly being used to train deep learning algorithms to recognize images. ImageNet Large Scale Visual Recognition Challenge has been using GPUs to train models for deep learning since 2010 and has seen the error rate for image classification drop dramatically as the use of GPUs has risen. The first GPU-accelerated deep neural network to run the ImageNet challenge came in 2012 and since then there was a big drop in the error rate. The error-rate has further dropped in the hybrid CPU-GPU machines to train their models[4].

The concepts behind deep learning for image classification can also be applied to text, voice, and video data which can be used for search, fraud detection, and a slew of other applications. Companies and individuals are continuously creating large amount of databases, which has become cheaper over the years

4 Morgan Timothi Pricket, NVIDIA RAMPS UP GPU DEEP LEARNING PERFORMANCE, JULY 7, 2015, (https://www.nextplatform.com/2015/07/07/nvidia-ramps-up-gpu-deep-learning-performance/

to store. Databases provided the first generation of software, which made it possible to pull out for various business purposes like gaming, business insight or for inventory management. Now AI is the next generation technology, which can be used for predictive analysis by using the databases.

Rising Budget for Digital Transformation

Future opportunity for businesses to grow rapidly lies in the new technology of AI, machine learning, deep learning, predictive analytics, data management and digital transformation. Budgets earmarked by companies for digital changeover are rising from year to year. As per 2017 IDC report, the worldwide spending on digital transformation is set to rise from $1.2 trillion in 2017 (up 17.8% over 2016) to $2 trillion in 2020.

Lead Indicators show AI in 'bull' run

Since 2015, there has been an extraordinary growth in the AI industry. The entire eco-system is on cloud9. Never since the dotcom boom era, there has been such a hectic activity, possibly this time because China is in the ring. The fear is not just of technical competence or the huge size of the Chinese markets, but it is the two systems, the liberal and the autocratic, competing against each other for the dominance of one over the other. The following progressions specifically indicate that the 'bull' run of AI isn't going to end anytime soon.

Rise in VC Funding

According to CB Insights, AI deals tracker, nearly $40.7 billion has been invested in about 4573 AI startups globally between Q2 2013 to Q2 2018[5].

Venture capitalists in 2017 put in a total of $10.8 billion globally

5 Artificial Intelligence Deal Tracker, October 3, 2018 (https://www.cbinsights.com/research-artificial-intelligence-startup-deals)

in VC funding of startups in AI and machine learning as per PitchBook Platform[6]. The total rose from less than $500 million in 2010 and $5.7 billion in 2016.

There are two compilations given below as per PitchBook Platform for some of the biggest funding and investors in the AI space in 2017.

Table 3.1: Biggest VC AI Funding[7]

Sr No	Startups and Year of Founding	Application Area	Amount of Funding
1	NIO (Shanghai), 2014	Autonomous Vehicle	$1.630 b
2	SenseTime (Hong Kong), 2014	Facial Recognition	$ 1.6 b
3	Ubtech Robotics (Shenzhen), 2012	Robotics	$ 940 m
4	Megvii (Face++) (Beijing), 2011	Facial Recognition	$ 607 m
5	Dataminr (New York), 2009	Enterprise Software	$ 577m
6	CrowdStrike (California)	Cyber Security	$ 481 m
7	Yitu Technologies (Shanghai), 2012	Security, Finance, Healthcare	$ 355 m
8	Unisound (Beijing), 2012	Mobile Internet New York	$ 307 m

6 Olsen Dana, 2017 Year in Review: The top VC rounds & investors in AI', December 20, 2017 (https://pitchbook.com/news/articles/2017-year-in-review-the-top-vc-rounds-investors-in-ai)

7 Dowling Savannah, 'Top-well funded Startups to watch in 2018', August 7, 2018 (https://news.crunchbase.com/news/top-20-well-funded-ai-startups-watch/

9	NEXTCODE (Cambridge, MA), 2013	Genomic Data	$ 207 m
10	Indigo (Boston), 2013	Agriculture	$ 203 m

Table 3.2: Most active VC investors in AI

Sr. No.	Venture Capital and HQ	Number of Deals	Select Investments
1	NEA, Chevy Chase, MD	19	Letgo, DataRobot, Drive.ai
2	Data Collective, Palo Alto	14	Element AI, Rigetti, Insight Engines
3	Accel, Palo Alto	13	Callsign, DeepMap, Spoke
4	500, Mountain View, CA	13	AISense, EquitySim, Aureso
5	LUX, Menlo Park	12	Orbital Insight, Veo Robotics, Mythic
6	Intel capital, Santa Clara	12	FogHorn, AEye, Mighty AI
7	Y Combinator, Mountain View, CA	11	Embark, People.ai, Mirror AI
8	Khosla ventures, Menlo Park	11	Vicarious, Deep Genomics, Replica

Angel Investors setting up Special AI Fund

Angel Investors setting up special funds for ventures in AI and machine learning shows that the future market potential of this new technology is bright. There are at least eighty venture capitalists specializing in AI and machine learning now[8]. The

8 Corea Francesco, 'Unsupervised Investments: A Comprehensive Guide to AI Investors Decision Scientist and Data Strategist' by KD Nuggets (.https://www.kdnuggets.com/2017/03/unsupervised-investments-guide-ai-investors.html)

market for the new age technology has been the brightest since the dotcom burst days. The list of venture capitalists, amounts invested in AI and the number of startups is growing every month.

NuVentures operating in India has set up an open ended fund dedicated to startups in AI and machine learning, especially in finance and healthcare[9].

Spurt in Merger and Acquisition activity in AI

Financial indicators of the past few years demonstrate that the progress of artificial intelligence has suddenly taken a spike in the last few years.

While global funding in AI sector has grown at the compounded rate of 60% annually, the pace of global mergers and acquisitions (M & A) has also suddenly gone up after 2015. The total value of deals in 2017 was nearly $22 billion, over 20 times more than in 2015.

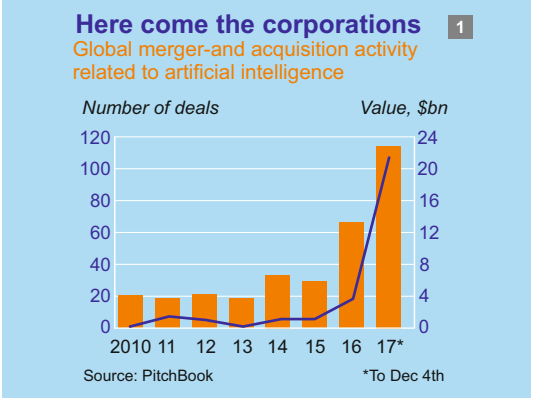


Figure: 3.2: Global M&A in AI between 2010-17

9 NuVentures plans new fund for AI, machine learning start-ups, August 3, 2018 (https://www.thehindubusinessline.com/news/nuventures-plans-new-fund-for-ai-machine-learning-start-ups/article24595864.ece)

M&A deals in AI were slow from 2010 to 2015. There were just 11, 24 and 41 deals in 2012, 2013 and 2014, while the same went up to 44, 74 and 98 in 2015, 2016, 2017 and finally 115 in 2017[10]. The total value of the deals went up from $ 1 billion in 2015 to $4 billion in 2016 and $22 billion in 2017.

According to CB Insights, the total number of startups acquired in AI was 22, 39 and 45 in 2013, 2014 and 2015, which further went up to 80 and 155 in 2016 and 2017 (first exits only)[11].

Different segments of M & A activity are: advertising/ marketing (16%), cyber security (10%), computer vision (10%). AI infrastructure, autonomous systems and IoT, conversational agents/speech/natural language processing, and other segments of AI, each with a share of 7%, Media and entertainment (5%), healthcare (4%), finance (3%), retail (3%), education (2%) and manufacturing (2%). Some other areas have also found interest in the M & A deals.

The top tech companies, like Google, Amazon and Apple have been in the forefront of the M&A activity in AI. Between 2016-17, these three companies have been involved in nearly a third of the total number of 170 deals. Intel, Microsoft and Facebook are the other tech companies that have shown a keen interest in M&A deals between 2016-17.

In India too, companies are re-structuring and merging or de-merging to take advantage of the opportunities offered by AI. Cross-Tab Group is merging their businesses into a single entity into Course5[12] to take advantage of $100 billion opportunity in data analytics and AI. The new entity that will specialize in predictive analytics, marketing insights, AI, deep learning, digital transformation etc. will help other companies move to digital platform. Its advanced suite of solutions provides faster

10 Results International

11 Research Briefs, The Race For AI: Google, Intel, Apple In A Rush To Grab Artificial Intelligence Startups, February 27, 2018 (https://www.cbinsights.com/research/top-acquirers-ai-startups-ma-timeline/)

12 https://www.course5i.com/)

insights for businesses to make better and faster decisions.

Activity of M & A at the global level is a good indicator to demonstrate that AI has been progressing well. The big tech through the acquisition process may be in a position to create better value out of the new technologies, platform or products and services developed by the startups, which may also be looking to an exit on a good offer.

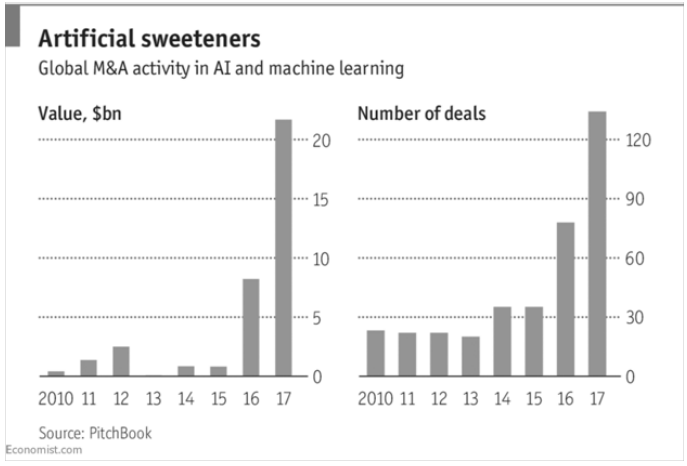


Figure 3.3: Global M&A activity in AI and Machine Learning (Source: PitchBook)

M&A Deals in Machine Learning between 2010 to 2017

According to Statista 2018, a Statistics Portal, total number of mergers and acquitions (M&A) deals in the area of machine learning has grwon from 3 in 2010 to 30 in 2014 and then to 41, 70 and 91 in 2015, 2016 and 2017 with the value of the deals going upto $16.9 billion[13].

According to VentureBeat, the number of M&A deals has risen 500% from 22 in 2013 to 115 in 2017.

13 The Statista Portal, 'Total number of deals of machine learning mergers and acquisitions (M&A) worldwide from 2010 to 2017'

Active Acquirers of AI companies grow by 300% since 2013

Another indicator for demand for AI solutions is the keen interest in the market place for acquisition of startups engaged in providing AI solutions to businesses.

The list of active acquirers as compiled by PitchBook Platform, a consultancy between 2013 to August, 9th, 2017 is given in the table below. While the number of acquisitions in AI and machine learning space in 2010-11 remained below 20, that figure has grown up by 300% to nearly 60 in 2017[14]. Alphabet (9 completed deals since 2010), Intel (8) and Apple (5) have been on an acquisition spree, while Snap and Microsoft have also been active in the space over the past couple of years.

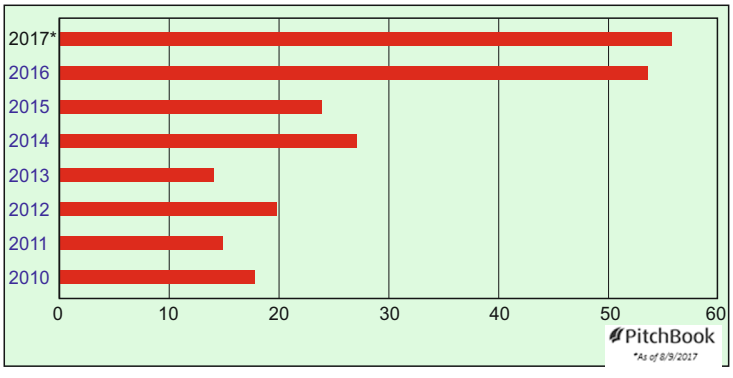


Figure 3.4: Active acquirers of AI & machine learning companies

(**Source:** PitchBook, as of 08/09/2017)

The 30 deals done in 2014 had previously served as the high water mark in the space.

14 Putz Adam, 'Number of active AI acquirers up 300% since 2013', August 9, 2017, https://pitchbook.com/news/articles/number-of-active-ai-acquirers-up-300-since-2013

CB Insight's Report on Acquisitions in AI Space

According to another report by CB Insights, a consultancy, the nine big tech companies have been behind acquisition wave since 2010. The list is led by Alphabet, which acquired fourteen companies, with the biggest being Deepmind in 2014 for $600 million, followed by Apple with thirteen acquisitions, the biggest being of Siri in 2010, whose voice recognition interface is now the embodiment of AI Assistant. Facebook, which is using AI to clean up its newsfeed, acquired six companies with Ozlo in 2017. Amazon, Intel, Microsoft and Meltwater acquired five companies each to make inroads in AI functionalities of their businesses. Twitter and Salesforce acquired four companies each.

The following information compiled by CB Insights[15] gives the year-wise acquisitions of startups by the big technology companies to lead the AI race.

Patent Filings in AI Growing

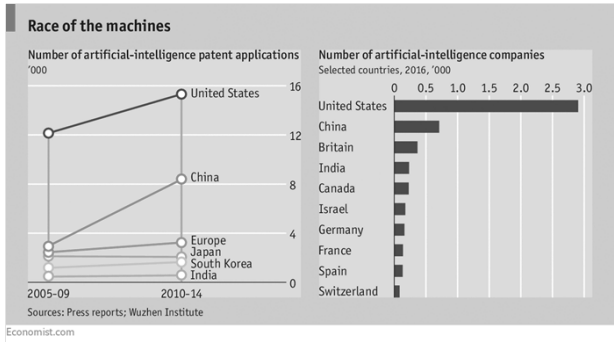


Figure 3.5: Number of AI Patent Applications and Number of AI Companies

15 Research Briefs, February 27, 2018, 'The Race For AI: Google, Intel, Apple In A Rush To Grab Artificial Intelligence Startups' (https://www.cbinsights.com/research/top-acquirers-ai-startups-ma-timeline/)

As per Wuzhen Institute press reports, the patent filings between 2005-09 to 2010-14, in AI has been growing quite steeply, particularly by the US and Chinese companies.

Another indicator is the rise in the number of AI-companies. In 2016, the total number of AI companies in the US was nearly 3000, whereas China had 700 companies (approx.). that number has tilted in China's favour in 2018.

Earnings Call- New Favorite is AI and Machine Learning

An earning call is a teleconference or webcast used by a public company to discuss the financial results for a reporting period with the press, analysts and the media highlighting financial performance of the company. Earning calls is preceded by release of financial results.

AI is the new buzzword in earning calls. While in 2015, 'big data' was mentioned more than 300 times in earnings calls and 200 times annually over a five year period, in Q3 of 2017, AI and artificial intelligence were being mentioned 700 times on earning calls, an increase of 25% on year-to-year basis.

More specific terms like machine learning and deep learning are also finding frequent mention as per the information compiled by CB Insights[16].

Even non-technology businesses like Proctor & Gamble are using AI for a variety of purposes such as advertisement campaigns and drawing insights.

16 Research Briefs, November 17, 2017, 'On Earnings Calls, Big Data Is Out. Execs Have AI On The Brain' (https://www.cbinsights.com/research/artificial-intelligence-earnings-calls/?utm_source=CB+Insights+Newsletter&utm_campaign=3c7b5411fc-WedNL_02_07_2018&utm_medium=email&utm_term=0_9dc0513989-3c7b5411fc-89185393)

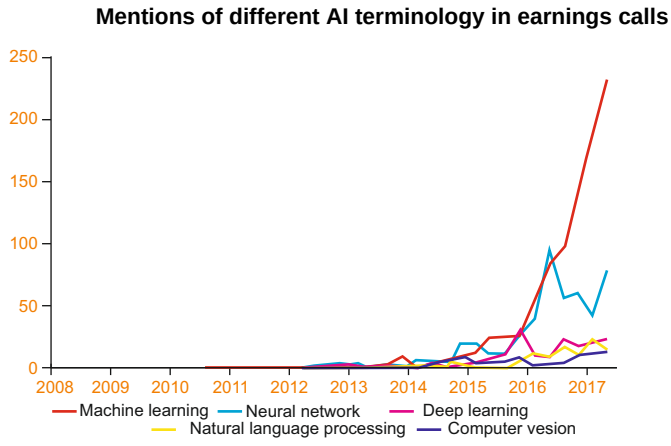


Figure 3.6: Mention of AI technology in earnings call (Source: CB Insights)

Indian AI startups are a tipping point

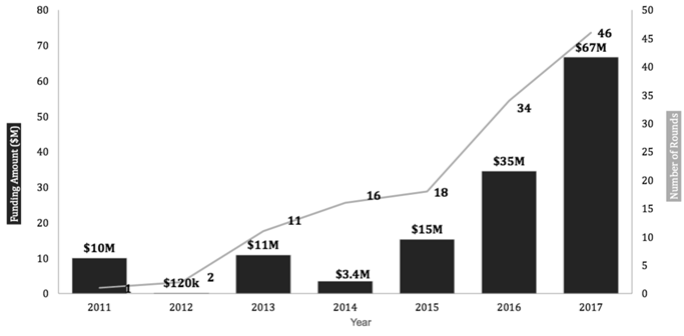


Figure 3.7: Investments in AI startups

Although India has been a laggard in AI space, the data shows that the total number of startups has been growing in number year by year. The corresponding investments are also growing. Startups grew in number from 18 in 2015 to 34 in 2016 and then to 46 in 2017, while investment also jumped by 230% from $15 million, to $35 million in 20116 and then by 90% to $67 million

in 2016[17].

However, total investment in AI startups in India between 2011 and 2017 is less than $ 150 million.

These numbers, though is a miniscule compared to the Chinese investment in AI.

Every Company wants to become Intelligent

Peer pressure is also working. Every company, in whichever sector wants to be intelligent and for some good reasons. Companies have realized the value of using intelligent products and services. The life-line of companies depends more and more on invention of new products or services, whereas the opportunity of making new inventions had plateaued with computing. There was an underlying need for something better. AI provided the new technological capability, which made it possible to realize the old dream of humans to confer intelligence to machines to see how they behave and whether the machines could become as good as humans.

There is thus a race in the game of providing intelligence. The giants of the technology industry are all engaged in serious research work with large team of researchers to reinvent their industries and remain the leader in whatever they are doing. Whether it is the tech industry, like 3AFIM, or ABJT or others like J P Morgan Chase and Johnson & Johnson, common element amongst all of them is that they are all inventors and heavy users of AI technologies. Pure investment companies like Berkshire Hathaway also rely heavily on artificial technology to boost their businesses.

China is emerging as a big player in artificial intelligence. The new age companies, ABJT are leaders in their own field and they have expanded their footprints in South East Asia, India

17 India's AI startups are at a tipping point', Ctrlshift.co; April 13, 2018 (https://ctrlshift.co/2018/04/13/indias-ai-startups-are-at-a-tipping-point/)

and other countries in the region. They are trying very hard to enter the US and European markets, but have met with stiff resistance from the likes of Amazon, Google and Facebook.

Sure enough, AI industry is taking shape on a hectic pace. In order to penetrate into the markets, companies are resorting to different kinds of strategies to gain market share. When startups succeed, they get acquired by bigger players with financial muscle. Established players are willing to shell out money for acquiring top talent and maintain their leadership in the market.

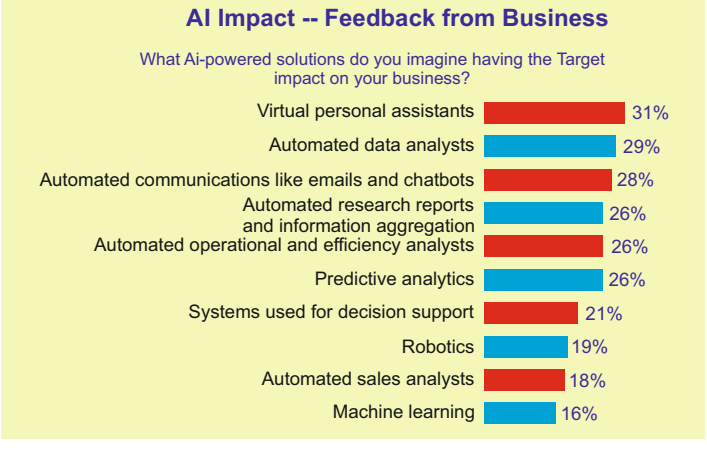


Figure 3.8: Feedback from business on use of AI

Demand for top talent in AI Skills

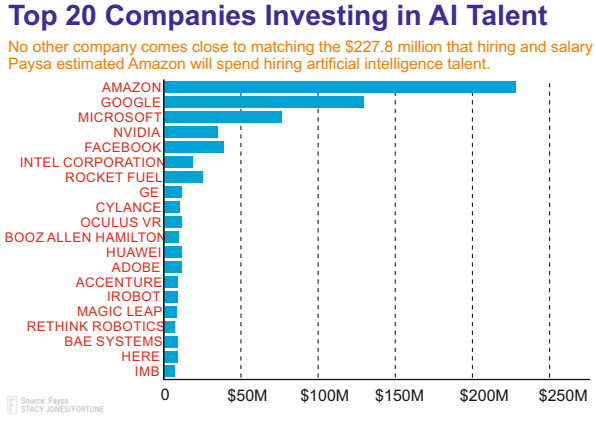
There is a huge demand for AI-skillsets. Demand far outstrips the supply and hence there is a huge shortage of skilled tech professionals in AI, machine learning and deep learning. The total number of qualified professionals is around 300,000 (including students working in the area), whereas more than a million professionals are required.

According to Indeed Research from indeed hiring lab[18], the year-on-year growth in AI-related job postings as a share of the total postings reached 31.6% between January 2017 to January 2018, a rise from 20.1% between January 2016 to January 2017. Jobs in machine learning and computer vision were the highest.

Salaries are also growing to attract the top talent. In the US alone, more than 40,000 professionals are required. In the US, Glassdoor search shows listing of 32,000 jobs. BMW China listing for experts in machine learning shows salaries in the range of $300,000 to $ 625,000. The big tech is poaching on the academia. Fei Fei Li of Stanford University joined Google apparently to 'democratize AI'. The entire faculty team at the Department of Computer Science at Carnegie Melon University quit and joined Google. Now universities are offering dual positions as a faculty to those researchers working at the tech giants.

Top 20 Companies focusing on Investing in AI Talent

Table 3.4: Top 20 companies investing in AI talent



(**Source:** Paysa and Stacy Jones/Fortune)

18 Culbertson Daniel, 'Demand for AI Talent on the Rise', March 01, 2018, https://www.hiringlab.org/2018/03/01/demand-ai-talent-rise/

There is a huge competition among the top ranking digital companies for investment in AI talent. The pack is led by Amazon, followed by Google, Microsoft, Nvidia and Facebook as in the table given below and all of them are shelling out large sums of money to get the right talent.

Business Perception for Job-skilling

More and more business leaders realize the need for skilling their workforce with the knowledge of AI and other advanced technologies. Workers too realize that they need enhanced skilling. According to a survey by Accenture, a consulting firm, 69% of Indian business leaders confirmed that adopting intelligent technologies will be critical to their organization's ability to differentiate in the market. 41% believe intelligent technologies will underpin every innovation they implement in the next three years. 95% of the workers in India also feel that AI will help them do their jobs more efficiently[19]. In the age of AI, a man-machine collaboration is necessary to gain better productivity.

In a global survey of 3000 employees by The Workforce Institute at Kronos Inc., 80% felt AI as an empowering technology for new opportunity but lament on employers' lack of transparency for fear and concern[20]. Expectations from AI among other things are: to simplify the internal processes, improve upon subjective decisions and balance their workload.

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19 'Intelligent blocks of India's future workforce', Report by Accenture, 6th August, 2018

(https://www.accenture.com/in-en/insights/future-workforce/future-workforce-india)

20 'Majority of Employees Worldwide Think Artificial Intelligence Can Make Work Better', February 20, 2016 (https://www.kronos.com/about-us/newsroom/majority-employees-worldwide-think-artificial-intelligence-can-make-work-better)

Publications in AI Research

Another indicator of AI progress is the number of publications in AI. These publications are growing fast, as can be seen from the table containing country-wise publication figures for the year 2011 to 2015. China is ahead of the US, though the quality of papers published has not been judged here.

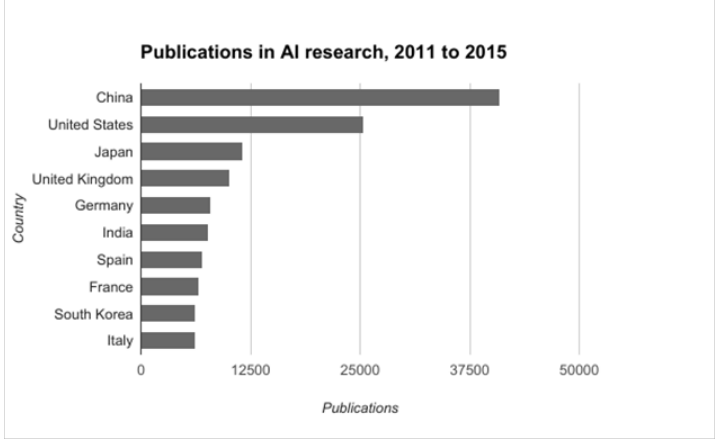

Figure 3.9: Publications in AI Research

Business Feedback on Impact of AI

Feedback from business on 'which AI powered solutions they think would have an impact on their business', received gives a fair indication of which AI product or service is considered to be useful.

31% respondents estimated that Virtual personal assistants will have the largest impact on their business, while 29% spoke in favor of automated data analysis, 28% for automated communications through emails or chat bots and 26% each for automated research reports, automated operational and efficiency analysis and predictive analysts. The responses in respect of the other areas include 21% for systems for decision support, 19% for robotics, 18% for automated sales analysts and

16% for machine learning.

The survey results on various subsets of AI in the development of virtual personal assistants, automated response in communication, generating research reports etc provide key insights into the business functioning. Thus the businesses have become highly aware that AI is strongly influencing their business operations.

Engaging with AI is top priority for the Tech Industry

The big tech, 3AFIM of the US and ABJT of China are moving fast to provide AI platforms in their businesses(discussed in detail in chapter 5). These companies are also creating entirely new lines of businesses as AI offers the largest opportunity to get into such businesses when the technology is young and there is somewhat a level playing field with the established players.

In order to tap new opportunities in AI, Tata Consultancy Services (TCS), one of the largest Indian tech companies in collaboration with Intel has set up a Center for Advanced Computing at Pune to develop solutions in High Performance Computing, data analytics and AI to create industry-solutions in technology, retail, life-sciences, banking and insurance etc. for customers in the US, Asia-Pacific, Europe and China to assist them in research, and in creating innovative solutions in AI and other fields.

As discussed earlier, the non-tech businesses are also going for digital transformation and increasing their budgets.

Conclusion

The lead indicators, financial and non-financial relating to the growth of the AI industry and their future prospects demonstrate unequivocally that AI is going to make a transformative impact on businesses in the coming decade(s). Companies and investors are investing in AI and other technologies expecting better prospects and returns in future.

CHAPTER 4

Data Engine of Artificial Intelligence

Introduction

In the pre-digital age, data collection was small and localized, which had very limited value. The onset of the digital era created the capability to collect data on mammoth scale and with the computing power ever more available for storage, processing and making meaning out of such data for creative and innovative applications, data has become the new oil and the engine of growth of the new economy led by artificial intelligence (AI).

Data could be in the form of text, speech, sound, image or video or in any other form. It is a strategic resource in the development of AI applications. Algorithms for AI require training data. More complex the problem, larger is the data set required to find the right solution. Hence there is the necessity of data collection on a continuous basis to constantly improve the algorithms in order to improve upon the final outcomes.

Companies working in the social media space, e-commerce or through facial recognition technology are collecting ever more data, the pot of new invisible platinum. Just four companies, Google, Amazon, Microsoft and Facebook are estimated to have collected nearly 1.2 million terabytes (one terabyte is 1,000 gigabytes) of data. Size of the data being collected is doubling every two years and by 2020, 45,000 exabytes of data is likely to be in existence. There is an arms-race for collecting more and more data by the new-age digital companies, so that they

develop an unbeatable competitive advantage in their own businesses.

The new 5G, the fifth generation of mobile networks planned to be rolled out in 2019 will further speed up data collection and many more inter-connected devices would generate terra-bytes of data. New services using AI will emerge using those data inputs.

We are living in a world where there is a data explosion as online activities, searches, digitization of records and commercial transactions keep rising at an exponential scale. More and more people transacting online in finance, digital payments, healthcare, e-commerce, and in various other services and businesses also going online in B2B mode through websites, mobile payments, apps or other means mean that ever more data is being generated on daily basis. There has thus arisen a natural requirement for controlling and regulating data to ensure that the transactions are not only smooth but frauds are prevented from happening. Issues of authentication, data-keeping and control, ownership, right to privacy and transparency are arising as a natural corollary to increasing zettabytes of data. The initial days of laissez faire and self-regulation are over.

Before going for data collection or acquisition to develop AI business, one must keep in mind the recent developments pertaining to data, which have acquired a controversial character for various reasons. Data has become synonymous with concerns related to privacy, security and safeguarding the interests of the data subjects. The misuse of data of 87 million Facebook users by Cambridge Analytica in the US presidential elections threw up the bomb lying under the ground. In quick succession came the General Data Protection Regulation (GDPR) of the European Union (effective from 25th May, 2018) which put a whole lot of restrictions on collection, usage and storage of data of the EU citizens by businesses regardless of their location. There are very stiff penalties for violation of the law. To avoid such penalties, AI applications using data need to be designed with compliance of the EU or any other law in

mind.

As if other countries were just waiting for the EU to legislate, suddenly many countries and regions became sensitive to the issue of privacy of data of the users. Congressional committee in the US called the CEOs of the large tech companies to explain why they were so lax and having a free ride on the users' data. The big tech under public scrutiny has started taking action to reverse the situation and comply with the common laws. These events surely call for careful planning for the usage of data in developing AI businesses.

So, how should countries and communities reconcile these forces, which might throw a spanner in the growth opportunities in AI? What precautions the startups and other businesses should take to remain compliant with the laws on privacy etc., so that long-term interests of business do not suffer? Here we discuss various facets of some of these issues.

Safeguards for Making Use of Data

In view of the new regulations and the controversy surrounding usage of data, it is necessary that proper safeguards are undertaken to ensure that companies run smoothly without falling on the wrong side of the fence.

Firstly, data must come from a trusted and reliable source. Data may have sometimes travelled through several stages and finally may have been residing on a particular company's server. In order to ensure that people within the organization do not spend too much time on looking for trusted data and devoting more time on developing and refining applications, there has to be a proper data governance strategy for the organization, which ensures that the right data is discovered and used, while errors are identified, flagged and resolved quickly. It has to be also ensured that data has not been corrupted in any form. Blockchain is one of the options for storage of data, where data is securely stored for future use.

This is important, since lot of money would be spent by the

businesses in processing data for AI solutions, which must not be based on unreliable data. The credibility of experimentation would be at jeopardy, therefore credible and reliable source of data is necessary.

Secondly, data is required to be digitized in proper formats, so that it becomes usable, since capture of data by the traditional organizations may not be done in proper structured formats for direct usage for AI purpose. If agencies like government or the public sector, which are otherwise sitting on piles of data are operating in 'paper and pen' mode, then this exercise becomes important.

Thirdly, data needs to be anonymized or pseudonymized, so that users' privacy rights are properly safeguarded. Anonymization is the process by which data identification tags relating to the individuals, like name, address, pin code etc. are removed from the datasets while retaining the usefulness of data for the desired purpose. Data then becomes neutral and the process is irreversible so that data of individuals cannot be correlated with the data subjects. Pseudonymisation, on the other hand, refers to the process of replacing identifying characteristics of data with a pseudonym so that the resulting data cannot be attributed to a specific data subject, without using additional information. Pseudonymization provides a limited protection as the data subjects can still be identified using indirect means by analyzing underlying data. Encryption (the process of converting data into a code to prevent unauthorized access) and tokenization (a non-mathematical approach to protect data where sensitive data is replaced with non-sensitive substitutes referred to as tokens) are two examples of pseudonymization.

There are concerns that with AI programs, even anonymized data can be re-identified. While technically, the identification may become a reality, this issue can be tackled separately under a legal provision where re-identification is permitted only under certain circumstances.

Fourthly, data must be of good quality and as much in quantity as possible in order to find better AI solutions. The big tech

and other companies are more successful because they have huge datasets available with them. Data in sufficient quantity is required, so that inherent biases based on gender and other factors may not creep in to the algorithms being designed. In order to identify a cat, for example, millions of images are fed into the system. Samples of human voice of an individual in the same language say in English will have to be in large volume so that the voice print based on individual style, annotation can be distinguished based on gender, age or dialect. Search engines in e-commerce constantly track data of consumers to make recommendations to them, store goods according to the demand and track trending. If the organization itself is collecting data, then all precautions need to be taken to ensure that they are properly used and security measures are in place to ensure against any misuse of data.

Fifthly, data needs to be curated, meaning that there must be an appropriate mechanism for managing the data in its entire life-cycle from creation to deletion, when it becomes irrelevant and that data is retrievable for reuse or future research.

Lastly, the data usage must conform to the laws applicable. A mechanism must be put in place where 'data audit' is done at frequent intervals to ensure that all the steps are properly followed to avoid any legal scrutiny and hefty fines that can be imposed by the authorities concerned, for any violations.

Data Security must be robust

While the digital age has enabled collection of huge amount of data, it has also enhanced the security risks associated with such data. Any compromise on data through data-leaks, hacking etc. puts the whole reputation of the organization to risk and sometimes the costs are quite heavy. Users/customers may flee and loyalties do not matter. This is particularly risky where money is involved like with bank accounts.

Cyber-attacks are one of the worst, where years of preparation goe topsy-turvy. Therefore, organizations must use a cyber-security solution and put in place a data security mechanism

with regular data audits. In this book, two of cyber-security startups are discussed and many more exist in the AI space, whose services are available. The organization also has to comply with legal and regulatory requirements for data security, wherever applicable.

Policy Issues on Use of Data

In order to ensure development and growth of the AI industry and usage of data for various purposes by scientists, research institutions, economists, accountants and other experts, we must adopt a balanced approach and find a middle path between the opposing interests of usage of data and individuals' privacy rights. If everybody kept his own land and did not allow any transaction in the same, no road or building could be made. Therefore, availability of data should not become an entry barrier for development of AI business. Here, we are on a safer wicket, since in the usage of data, the property itself is not lost while commercial exploitation of the same results in wealth generation for the society as a whole from which individuals too would benefit.

Data is generated through various sources. It could be personal or related to other activities. Personal data is data points relating to an individual, his health record, financial transactions, or other personal usage. On the other hand, we have data generated from machines, whether from official records, weaponry, and movement of objects or things at the borders. In both cases, there is an issue of privacy but then there are different sets of regulations that may be dealing with privacy of individuals and other systems.

Big Players have big advantage, but why disturb them?

Large companies in their daily business operations can mine data naturally. For example, Walmart, a retailer is collecting data from their 250 million customers buying goods from their

11,000 stores and about a dozen websites. It collects 2.5 petabytes of unstructured data from a million customers every hour. Big data analytics throws up answers to what items customers are buying, how sales are affected by factors like weather etc. An AI-enabled system then processes the big data in real-time to decide on what items to order and keep in stock and place direct orders automatically to the suppliers. Ditto for Amazon and other e-tailors.

There is also an argument that the big tech has been too much maligned for their practice of using private individuals' data. It has been vehemently argued that the individuals must be compensated properly for the usage of their own property. However in a recent survey, it came out that if the big tech companies were to compensate their users for usage of their data, no more than $9 per user would be available for all that data they have shared with the big tech companies.

There is a contra argument that data being collected has no intrinsic value in its raw form. Only when certain processes are applied to the raw data, the processed data can create value for the organizations. Therefore for processing data and converting them into useful formats requires investment of capital into physical and nonphysical assets and unless private entities are allowed to commercially exploit such data they will not be able to recover any cost of investment. Thus, there will be a disincentive for development and growth of AI industry. This argument is also not entirely without any merit and logic.

Making Government Data availability for AI

There are a number of challenges that have emerged in the current scenario. Policymakers are required to lay down a mechanism so that AI industrial growth is not hampered for lack of availability of data. The governments must also ensure that there is a level playing field.

While some private corporations may be sitting on huge piles of data, the government too collects data from many sources, which can be used in an appropriate manner. Governments and

public sector agencies are in charge of property registration, citizens' database, roads and railway networks and many government-run hospitals, transport agencies, electricity grids, logistics networks, compiling vast treasure of data, which can be converted into usable formats and made available to the private players, particularly the startups and SMEs in the AI sector to ensure growth of the industry.

There is a clear logic that in many cases where services are availed free of cost by the private citizens, automatic permission for usage of such data may be allowed without the need for specific consent, since the individual players have already availed the services on free charge basis and that they should not have any objection for usage of such data for commercial purposes. Governments, who spend money on public services, can also earn some money by permitting private businesses to use such data, in an anonymized or pseudonymized form and subject to certain safeguards.

Data ownership versus Control of Data

Ownership of personal data has become a very important subject. GDPR deals with the subject matter quite extensively. Control of data is a well-established legal concept other than ownership of data. Data ownership is a tenuous concept, since the same data may belong to various entities in the transactional process. Data control on the other hand becomes more definite. For example, in the case of financial transactions of individual account holders, the bank owns only so much of data and has control over such data.

Apple allowed users in the EU to download a copy of all their stored data like address book contacts, user preferences etc. from an online portal after GDPR came into effect. This facility has been extended to the users in the US. Apple is having an updated privacy page on its website to let users know what is being stored. Such measures instill a sense of confidence among the users and bring about greater data transparency, which Apple is committed to.

Setting up a Data Authority

Government departments and agencies cannot be individually expected to engage themselves in digitizing data in standard protocols and formats. Not all of them would be fully familiar, nor can they develop policies with regard to the same. Therefore, it has been suggested that a central authority for data should be set up by the government, which will develop policies for digitization of data, frame policies for sharing of such data, fix charges for such usage, if any with proper security features and necessary safeguards. The central authority will be in a much better position to formalize the whole structure and disseminate knowledge to all other sister departments which would be required to follow instructions by the Central data agency. In fact it may also be explored if all public sector data can be stored centrally at one single point and data made available to the private users.

Tim Burners Lee's Project for data Storage and Transaction

Tim Berners-Lee is working on a project 'SOLID', with a view to develop standards and protocols based on the idea of linked data, which would allow individuals to choose, where to keep their personal data and how it should be used.

HAT Project

There is another project HAT, the heart of all things supported by the engineering and physical sciences research Council of UK, which seeks to help users take back control of their personal data by creating decentralized personal databases controlled by individuals. This will allow them to see all of their personal data at one place and see how they are being used and sold or exchanged in return for money. The open banking initiative launched in UK is also trying to demonstrate how individuals can control their own personal financial data. These steps would shift balance of control in the hands of data-subjects.

Conclusion

Data is the most important resource for developing AI applications. While rights of privacy are important and consumers need to be protected against abuse, it has to be nevertheless ensured that data is available to the private industry for usage and development of AI programs. Necessary mechanism has to be developed for sharing of such data within the framework of regulations for privacy and security. One redeeming feature of data is that unlike other forms of physical assets, data can be used many times over and as it gets more and more used, the value of the same keeps on increasing unlike in the case of other physical assets. The cost of duplicating datasets is virtually zero. That should create a sense of confidence while designing an architecture for data sharing.

Annexure to Chapter 4

Salient Features of General Data Protection Regulation (GDPR)

Purpose of the Law

The General Data Protection Regulation (GDPR) is a regulation for data protection and privacy for all individuals within the European Union. The GDPR aims primarily to give control to citizens and residents over their personal data and to simplify the regulatory environment for international business. Its jurisdiction extends to all foreign companies processing data of EU residents wherever located.

Scope

The regulation applies if the data controller or processor or the data subject (person) is based in the EU, or to the organizations based outside the EU but collecting or processing personal data of EU residents. Personal data is defined as below:

> "Personal data is any information relating to an individual, whether it relates to his or her private, professional or public life. It can be anything from a name, a home address, a photo, an email address, bank details, and posts on social networking websites, medical information, or a computer's IP address."

Single set of rules and one-stop shop

A single set of rules applies to all EU member states. Each member state will establish an independent supervisory authority (SA) to hear and investigate complaints, sanction administrative offences, etc. If a business has multiple establishments in the EU, it will have a single SA as its "lead authority", based on the location of its "main establishment".

Data controller should implement measures, which meet the principles of data protection by design and data protection by

default. Privacy by design and by default (Article 25) requires data protection measures to be designed into the development of business processes for products and services. Such measures include pseudonomizing personal data, by the controller. It is the responsibility and the liability of the data controller to implement effective measures and be able to demonstrate the compliance of processing activities even if the processing is carried out by a data processor on behalf of the controller (Recital 74). Data Protection Impact Assessments (Article 35) have to be conducted when specific risks occur to the rights and freedoms of data subjects.

Lawful basis for processing

Data may not be processed unless there is at least one lawful basis to do so

- The data subject has given consent to the processing of personal data
- Processing is necessary for the performance of a contract, where data subject is party
- Processing is necessary for compliance with a legal obligation to which the controller is subject.
- Processing is necessary to protect the vital interests of the data subject or of another natural person.
- Processing is necessary for the performance of a task carried out in the public interest or in the exercise of official authority vested in the controller.
- Processing is necessary for the purposes of the legitimate interests pursued by the controller or by a third party unless interests or fundamental rights and freedoms of the data subject is involved

Consent

Consent must be explicit for data collected and the purposes data is used for (Article 7; and Article 4). Data controllers

must be able to prove "consent" (opt-in) and consent may be withdrawn.

Data protection officer

A person with expert knowledge of data protection law and practices should assist the controller or processor to monitor internal compliance with this regulation.

Pseudonymization

Pseudonymization is recommended to reduce the risks to the concerned data subjects and also to help controllers and processors to meet their data protection obligations. The GDPR encourages the use of pseudonymization to "reduce risks to the data subjects" (Recital 28).

Data breaches

Data controller must notify the supervisory authority without undue delay and within 72 hours after becoming aware of the data breach, unless the breach is unlikely to result in a risk to the rights and freedoms of the individuals (Article 33). Individuals also have to be notified if adverse impact is determined (Article 34). In addition, the data processor will have to notify the controller without undue delay after becoming aware of a personal data breach (Article 33).

However, the notice to data subjects is not required if the data controller has implemented appropriate technical and organizational protection measures that render the personal data unintelligible to any person who is not authorized to access it, such as encryption (Article 34).

Sanctions

The following sanctions can be imposed:

(i) a warning in writing in cases of first and non-intentional noncompliance;

(ii) regular periodic data protection audits;

(iii) fine up to €10 million or up to 2% of the annual worldwide turnover of the preceding financial year in case of an enterprise, whichever is greater (Article 83);

(iv) a fine up to €20 million or up to 4% of the annual worldwide turnover of the preceding financial year in case of an enterprise, whichever is greater (Article 83, para 4);

(v) the basic principles for processing, including conditions for consent, pursuant to Articles 5, 6, 7, and 9;

(vi) the data subjects' rights pursuant to Articles 12 to 22; the transfers of personal data to a recipient in a third country or an international organization (Articles 44 to 49);

(vii) any obligations pursuant to member state law adopted under Chapter IX; and

(viii) noncompliance with an order or a temporary or definitive limitation on processing or the suspension of data flows by the supervisory authority pursuant to Article 58(2) or failure to provide access in violation of Article 58(1)

Right of access

A data controller must provide, upon request, an overview of the categories of data that are being processed, details about processing, and with whom data is shared as well as a copy of the actual data (Article 15). Thus Citizens have the right to access their personal data and information about how this personal data is being processed.

Right to erasure

Data subject has the right to request for erasure of personal data related to them (Article 17) on any ground, including noncompliance with Article 6(1) (lawfulness) that includes a case if the legitimate interests of the controller is overridden by the interests or fundamental rights and freedoms of the data

subject, which require protection of personal data

Data portability

A person is to be able to transfer personal data from one electronic processing system to and into another, without being prevented from doing so by the data controller. Data that has been sufficiently anonymized is excluded.

Records of processing activities

Records of processing activities must be maintained and it includes purposes of the processing, categories involved and envisaged time limits. The records must be made available to the supervisory authority on request (Article 30).

Issues arising out of GDPR

There are many issues arising out of GDPR, including the escalation in cost of compliance, which is estimated to be €200 billion while for the US companies, the estimate is for $41.7 billion. There are other issues as well, but slowly companies are adjusting to the new regime.

Conclusion

GDPR triggered a revolution and became a precursor to many other legislations coming in other parts of the world. Cases of data breaches and compromises appearing at regular intervals have only strengthened the case of regulations.

CHAPTER 5

Big Tech Bets Big on Artificial Intelligence

Introduction

The big technology companies (popularly referred to as the big tech) particularly in social media, search and communications have been the early adopters of artificial intelligence (AI) in providing new products and services to their customers. Companies in e-commerce, retailing, warehousing, logistics, financial payments and automotive sectors are also not very far behind in being the high end adopters of AI to make a big push in their businesses.

The US based Alphabet, Amazon, Apple, Facebook, IBM and Microsoft (together referred to as 3AFIM) have developed large number of AI based applications for their customers. Similarly, the big tech in China, namely Alibaba, Baidu, JD.Com and Tencent (together referred to as ABJT) are deeply engaged in research in artificial intelligence and are also heavy users of the new technology. There are of course a number of companies in other countries as well which are using AI in designing innovative solutions. There is also a tight race among the big players to be the 'AI-first', i.e. to become a global leader in AI.

The big tech companies have not only come out with innovative solutions in their conventional niche areas of services, but they have also travelled much beyond by breaking the traditional boundaries of their businesses to offer AI solutions in areas like healthcare, banking and even in agriculture.

Why Big Tech is betting big on AI

The big tech is doing a host of specific things in AI and there are good reasons why they are betting big on the new technology of AI.

First of all, the big technology companies like 3AFIM and ABJT have huge stakes involved in their businesses. They are all aware of the fact that artificial intelligence provides the next big technological platform that will catapult their businesses in the marketplace to bring in new customers and garner more revenues. They have to not only maintain their position of leadership in the market place but also ensure that they are not disrupted by the next generation invention, which might obliterate their business models and have an impact on the bottom line. There is no guarantee for leadership unless the leader remains on high alert and continues to lead the pack.

Secondly, the big tech companies have the necessary market experience and the leadership position to take big risks which are necessarily involved in developing new products and services which can pass the test of the customers. When a new product or service becomes a hit, the financial gains are surely enticing. That is what keeps the big tech engaged in investing in new research for finding new solutions for their customers. Start-ups especially lack in marketing skills to deepen their customer relationship, even where they find some success out of their product.

Thirdly, the big tech also has the technological depth to understand the solution that could be designed in the shortest possible time and possibly with the most cost-effective method. Thus they can commercialize a nascent product to spin out a commercial success and gain market traction.

Fourthly, the big tech has the deep pockets to burn cash in new research. Investment in any new technology has inherent risks and financial returns may not follow quickly. They may remain invested for much longer without requiring any outside financial assistance.

Fifthly, they have the necessary expertise to make regulatory compliances and are in a better position to handle any adverse situation in the marketplace arising out of various uncertainties. In some cases as we know there are disputes on patenting which is difficult to fight in a court of law. The big tech would have the necessary resources to handle such disputes either in a court of law or in 'an out of court' settlement. Another example is of uncertainty from data protection laws for any dispute arising out of concern on privacy. Handling any such dispute calls for deep resources and a full-fledged team that can settle such contentious issues. The recent example of Facebook facing challenges on data privacy and being called upon to answer before the US congress and the European Union commission is one such case.

Sixthly, application of a new technology poses some serious questions for which political lobbying may be required to ensure that proper national policies are framed which promote new businesses and where question of national competitiveness is involved, a favorable decision is taken by the policy makers. The big tech in the US, for example has successfully been able to raise the pitch that no hurdles are put up by the American administration in promotion of AI businesses, since China has raised the stakes on AI for attaining a super power status by 2030 which allows the Chinese companies to engage in practices that will otherwise be an anathema to the free world.

Lastly, the big tech has the sixth sense to take advantage of any new opportunities in the marketplace arising out of application of the new technology in inventing new products or services.

The big tech is engaged in several strategies for being a leader in their own areas and some of these are:

i. Engaging in high end research work to come out with products and services that will catch the attention of the customers

ii. Hiring top talent in AI for carrying out high end research work.

iii. Keeping an eye on start-up activity, particularly in a start-up that may disrupt the big tech's business technologically. Who knows when another Google will emerge to disrupt the business of Yahoo, which was the leading search engine at one point of time?

iv. Can target a startup, which add value to their business, for acquisition.

It may also be fairly stated that while the big tech has certain advantages, it has on the other hand, certain disadvantages because of their sheer size and other limitations. A young start-up can always innovate and come out with a niche product that can challenge the dominance of the established player. Not all big companies have a startup culture ingrained in them.

What the US big tech companies are doing to Promote AI

Before we look at the specifics of what the US big tech is doing in the area of artificial intelligence, we give a comparison chart of those companies.

Table 5.1: Comparison of the US Big Tech Companies

Company's Name	Global Ranking 2017	Market Cap[1] (billion)	Revenues ($ billion)	Profits/ Losses (billion)	Assets (billion)
Alphabet	52	720	110	9.7	232
Amazon	18	797	178	3	131
Apple	11	800	230	48	375
Facebook	274	395	40.7	15.9	84.5
IBM	92	108	79.2	5.75	125.4
Microsoft	71	805	90	21.2	241

(**Source:** Fortune, August, 2018)

1 Market Capitalization is as on 7th December, 2018

R&D Spend by the US based big tech companies

The US is the Mecca of innovation in new technologies and hence US based digital companies have huge advantage. The US big tech has been investing heavily in R&D. an illustrative figure[2] is given below.

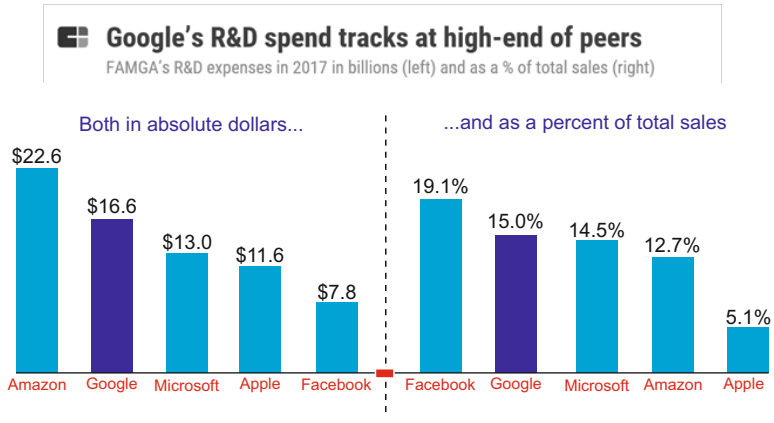

Figure 5.1: R&D spend by Big Tech Companies (Source: CB Insights)

Specifics of what the US Big Tech is doing

The US big tech companies 3AFIM and a few others are doing a number of things in different areas to promote AI to boost their businesses, keep ahead of others and also promote common good. The following details gives a bird's eye view of what the big tech is doing to boost AI technology.

2 Google Strategy Teardown: Google Is Turning Itself Into An AI Company As It Seeks To Win New Markets Like Cloud And Transportation (https://www.cbinsights.com/research/report/google-strategy-teardown/)

1. Alphabet (Google)

In the age of AI, Google has emerged as one of the largest conglomerate and most innovative AI companies in the world. Google's objective is to solve problems with AI for everyone[3]. It declared itself as an AI-first company in 2016. It has re-oriented itself towards becoming the leader in AI research. Google research division has now been re-christened as Google AI and it has been investing very heavily in research and development for the last few years. It has set up research centers at many places and even in Africa, at Accra, Ghana's capital. Google is planting AI and machine learning in everything that it has been doing in the last three years or so. Google's services from Gmail to Google search all use AI in some form. Google X is working on new technologies that would improve the life of humans as a whole. It has several projects like Project Loon for facilitating Internet access to the rural areas. Project Wing is working on autonomous drone delivery service.

Alphabet wants to use AI and machine learning as a unifying platform for all its services both for the consumers and for the enterprises. It is using AI for identification, search results, pricing, autonomous driving vehicles and personal assistant software. Google is fostering a collaborative eco-system with open source AI tools. Now it is entering into hardware devices as well with a lineup of different products like Chromebook Laptops, Google Home smart home device, Pixel line of phones and Home smart speakers, using Google's voice assistant technology.

Google also wants to dominate in many green field areas like e-commerce, logistics, hardware products, content business and even healthcare. On the enterprise side, it also wants to dominate cloud computing and services, where it trails Amazon and Microsoft in the cloud infrastructure services.

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3 Advancing AI for everyone (https://ai.google/)

Google is willing to work with partnerships, make strategic investments and acquire any hot startup with the right fit. It has a number of subsidiaries working in different areas. Prominent among these are: Chronicle in security solutions for cloud business and Verily and Calico working in healthcare solutions.

Google Brain

Google Brain has produced an open source TensorFlow that builds an externally-facing product. When Brain first started, the first research projects were engineering-heavy, but now, Brain focusses on long-term AI research in every AI subfield imaginable, similar to FAIR and Deepmind.

Google Assistant

A digital assistant, which offers a voice-based interactive platform is becoming the source of new competitive advantage of any digital company. Customers would be slowly migrating from mobile platform to the digital assistants in the future, so the importance of focusing on digital assistants.

Google assistant is a flagship program and has lot many features. It has been designed by using the DeepMind's WaveNet technology and speaks like a natural person by using natural language processing technology[4]. It can do many things, like searching internet, scheduling an appointment etc. Assistant is becoming visually more assistive with new experiences for Smart Displays and phones. One can get a quick snapshot of the day with suggestions based on location, time of the day, and recent interactions, on the mobile phone. Google Assistant can also navigate in Google Maps, so that information can be obtained while driving. Google Assistant has now progressed

4 Novet Jordan, Google is finding ways to make money from Alphabet's DeepMind A.I. technology, March 31, 2018, CNBC (https://www.cnbc.com/2018/03/31/how-google-makes-money-from-alphabets-deepmind-ai-research-group.html)

to become Google Duplex[5], which can be used for talking on smartphone. The technology is directed towards completing specific tasks through conversation. This will raise personal efficiency and generate value for small businesses.

Then there is Google Investment Program that helps startups to develop applications on working with its virtual assistant. It is working with appliance makers in the US to bring voice assistants to dishwashers, refrigerators and security systems.

Smart City Project

In partnership with Waterfront Toronto, Sidewalk Labs, an 'urban innovation' subsidiary of Alphabet is working on a smart city project for Quayside, a flood prone land, where overall management and service provisions will run on the back of technology with sensors monitoring everything. Analysis of vast amount of data will make Quayside livable, efficient and sustainable. Data would be shared with the residents.

The cities of the future will have a thermal energy grid, modular buildings the use of which could be changed easily; garbage would be pushed out through underground tunnels; there will be adaptive traffic lights; and robots would be delivering packages against orders. Private cars are banned and only self-driving shuttles will operate[6].

There are a number of challenges including working within the existing regulations. However, the success of this project holds the future in building smart cities.

Smart Maps

Google Maps has become much more intelligent now since it

5 Leviathan Yaniv, Google Duplex: An AI System for Accomplishing Real-World Tasks Over the Phone, Google AI Blog, May 8, 2018 (https://ai.googleblog.com/2018/05/duplex-ai-system-for-natural-conversation.html)

6 'Streets ahead', The Economist, May 18, 2018 (page 55)

can divulge lot more information such as whether the business you want to visit is open or not, how busy is the street and whether parking can be found easily.

G Mail, Smart Compose and Google services getting Smarter with AI

Google wants to use predictive suggestions in all its consumer services. Recently, re-designed Gmail has 'Smart Compose' where, machine learning will understand the context and start typing known stuff on its own, leaving the users to type and compose more important stuff. Similarly, it is making google pictures on your phone smarter with 'suggested actions' with facilities like sending pictures of a person clicked say at a wedding party directly to him/her. It can automatically edit a photo by improving upon the background of the picture, make it brighter etc.

AI Ad-tools

Google has introduced several AI ad tools which helps automate, fine tune and develop effective, targeted advertisement campaigns. Machine learning is used to mix, match and optimize content for carrying, say, 'brand lift' on YouTube. This tool can be used with any other form of marketing campaign from bidding to dynamic headlines. Marketers have the option to choose from fifteen headlines and four description lines and Google will do the rest to work out the best combination.

AI in Healthcare

Google has two healthcare subsidiaries, Verily and Calico, dedicated to working for healthcare AI solutions. The third one is Gradient Ventures, a dedicated fund for AI development. It has invested in a Canada based Benchsci, a startup using AI to accelerate biomedical discoveries.

Specific AI applications include development of a neural net that can detect signs of diabetic retinopathy using medical images of the eye. Further same images are used by processing through

deep learning to predict a patient's risk of a heart attack with a high degree of accuracy. Google's AI and neural networks can sift through large volumes of untapped data, notes buried in PDFs or just scribbled on old charts and can predict accurately whether the patient would need to be readmitted and in that case how long he would require to stay. Google's Medical Brain is working on AI tools that will predict symptoms and disease with a very high level of accuracy. These tools could be used by the doctors with a profound impact on health outcomes. In future, such tools could be licensed to clinics and sold through cloud as 'diagnostics-as-a-service'.

DeepVariant is part of the objective of applying Google's computing infrastructure and machine learning technologies to healthcare and better understand the genome and to provide deep learning-based genomics tools to the community.

Google's DeepVariant won the highest accuracy rate in FDA's precision FDA Truth Challenge in 2016. It has now made AI tool for precision medicine open source and made DeepVariant, available through Google Cloud.

UK's National Health Service is using DeepMind's platform to detect health risks from data collected through a mobile app. It is also doing analysis of medical imaging to detect cancerous tissues.

AI in Agriculture

Google is also dribbling in improving farming by improving crop yield through application of AI. Google's research lab called X is studying how to apply AI to agriculture. Use of machine learning for example, is thought of to scare away locusts to save the crops. Similarly, drones and robots could be used for saving crops from pests etc.[7].

7 Vanian Jonathan, Alphabet Research Arm X Wants to Apply Artificial Intelligence to Farming, Fortune,March 27, 2018 (http://fortune.com/2018/03/27/alphabet-google-ai-farmers/)

Saving Marine Life

Google is using AI to protect vulnerable marine life through specialized applications of machine learning, geo-mapping and cloud computing in some of the world's most delicate eco-system. It uses public broadcast Automatic Identification System for shipping to identify illegal fishing activity in protected areas[8].

Savings on Energy

Machine learning and image recognition algorithms are being used under Project Sunroof, launched in 2015, to train Google's systems for analyzing satellite data and identify areas where solar panels could be installed for maximum capture of sunlight. It is also using machine learning in its 'Nest smart' thermostat products to save on energy consumption by household devices by predicting when and how home owners want their homes to be heated.

Acquisition of Deepmind

Google acquired DeepMind in 2014 and has made a commercial success out of their AI technologies, particularly in the area of neural networks. DeepMind has been producing excellent publications on a myriad of topics such as Deep Reinforcement Learning, Bayesian Neural Nets, Robotics, transfer learning, and relationship between ecology and intelligence. They produced Alpha Go, one of the top ranking AI programs.

Alphabet has taken advantage of the technology of DeepMind to come out with various products like Google Assistant, in

8 Marr Bernard, 'The Amazing Ways Google Uses Artificial Intelligence And Satellite Data To Prevent Illegal Fishing', Fortune, April 9, 2018 (https://www.forbes.com/sites/bernardmarr/2018/04/09/the-amazing-ways-google-uses-artificial-intelligence-and-satellite-data-to-prevent-illegal-fishing/#7a6fab5d1c14)

making personalized app recommendations to the users from their Google Play Store and even in saving money in cooling Google's data centers. DeepMind's code has been used in commercialization of Google Cloud Text-to-Speech application programming interface (API) whereby users have to pay $16 for every million characters of text for conversion to speech.

Chip Design

Google has also designed its own AI server chips, which are used for machine learning for better efficiency and for saving power. Those servers are also available on rent to their customers for cloud computing.

Investments and Acquisitions

Google has acquired more than 220 companies overall and 14 companies in AI. Besides GV and Capital G, investment arms of Alphabet, Google has two separate dedicated funds for AI: Gradient Ventures and Google Assistant Investment Program to make investments in AI related work and startups. In 2018, it acquired India based startup Halli Labs, which specializes in machine learning and deep learning and invested in Dunzo, a personal concierge and delivery service. It invested in GO-JEK, a ride haling service in Indonesia, which also delivers food. It also acquired AIMatter, working on computer vision to process images using neural networks. Earlier it had acquired Banter (working on natural language processing for enterprise cloud services), Moodstops, Api.ai, Darkblue Labs, Vision Factory, Granata, Timeful, Jetpac, Emu, DNNresearch, CleverSense and others between 2012-17.

Google is investing $550 million in Chinese e-commerce company, JD.com and by leveraging the strength of the two partners, JD.com will expand their retail services around the world and create personalized retailing in Southeast Asia, the US and Europe.

Footprint in other Countries

Google is expanding its business in India and countries in South East Asia. It is entering into the Chinese market by complying with the local regulations as Chinese market is too big to be missed out completely.

Conclusion

Google is truly emerging as the top notch AI player. It wants to be a leader in the AI business both for consumers and enterprises and is expanding its operations in large number of verticals. It might become a conglomerate like GE of 2000, when it ruled the manufacturing. Google wants to develop AI in ethical ways.

2. Amazon

Amazon's story is truly amazing. Originally starting with selling books online, this e-commerce player has entered into large number of other businesses and has transformed itself completely with the latest advances in AI, machine learning and deep learning. AI and machine learning has made dramatic changes in product search rankings, product recommendations, demand forecasting, merchandising placements, detecting counterfeit goods, detecting fraud. Amazon's recommendation engine running on AI generates 35% of the company's revenues[9]. Based on browsing history, personal preferences and items frequently bought by customers, Amazon can recommend specific items to the customers, Investment in AI based technologies in smart logistics and recommendation engines are the prime drivers of e-commerce and fetch good returns.

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9 Sennar Kumba, Artificial Intelligence in eCommerce – Comparing the Top 5 Largest Firms, February 1, 2018 (https://www.techemergence.com/artificial-intelligence-in-ecommerce-amazon-alibaba-jd-com/)

Voice based Echo & Alexa

Amazon worked on a voice based home appliance which developed into Echo. It acquired many companies that together created Echo. Once Echo was developed as a far-field speech recognition device, in 2014 it led to development of Alexa, a voice activated service. Amazon's intelligent voice assistant Alexa uses neural networks for natural language processing to analyze the human voice and render an appropriate response to serve the users. Alexa has been integrated with Amazon Music, Prime Video, and personalized product recommendations from an Amazon account.

Alexa for Third Party Developers

Alexa is used by third party developers to create their own voice technology mini-applications to run on Echo to perform certain tasks. These vendors use Alexa skills that add value to the customer's life. Liberty Mutual is providing auto insurance information and Capital One allows customers to make a payment through their Amazon device.

Amazon Web Services

With the development of speech, Amazon brought that to non-Alexa products like Fire TV, voice shopping, Dash wand for Amazon fresh and ultimately, Amazon Web Services (AWS). Customers can use AWS's machine learning tools which can be used for developing different types of solutions like visual serach or to set up a private catalog or to estimate housing prices. It offers personalized AI solutions to large as well as small businesses. NASA is one of the important customers.

Machine Learning in Autonomous Driving

AWS machine learning is being used by several autonomous driving startups to improve products via millions of miles of simulated road testing. In 2016, AWS released new machine-

learning services which has text-to-speech component called Polly and a natural language processing engine called Lex. Customers can now build their own mini Alexas.

AWS and the new machine-learning services are hugely successful. They generate a good stream of revenues for Amazon. Customers like Infor have used AWS's Lex technology to create business applications for their own corporate customers to automate various processes, analyze performance, and interact with data all through a conversational interface.

Amazon Go

Amazon has opened Amazon Go, an AI-powered supermarket in Seattle, which uses deep learning. It runs a cashier-less convenience store which monitors the products leaving the shelves and identifies the customer who buys it. Plans are afoot to expand Amazon Go to 3000 stores.

Use of Robots

Amazon is also using robots in warehousing for optimizing the warehouse spaces, packing and delivery. Automation is playing a key role in warehousing operations, since Amazon acquired Kiva Systems for $775 million (now Amazon Robotics). This robotic arm automates picking and packing. 'Click to ship' time has reduced from 60-70 minutes to just 15 minutes and inventory capacity utilization increased by nearly 50%, with operating cost coming down by 20%.

Amazon employs nearly 100,000 robots for warehouse management. Company's Lab126 hardware division has a home robot, Vesta, which would be like a mobile Alexa, navigating around the house like a self-driving car.

Drone Delivery

The future plans of Amazon include using AI for home delivery of orders. Amazon's Prime Air delivery drones are at experimental stage for delivery of packets to the customers

through drones. Regulatory challenges currently limit such usage, but talks are on with the regulators.

AI in Healthcare

Amazon is also planning to use AI in developing healthcare applications in partnership with JP Morgan chase and Berkshire Hathaway.

Flywheel Model for Knowledge Sharing[10]

There are so many parts of Amazon's business that these can be compared with a flywheel, where the knowledge innovation through machine learning in one part of business can be transferred to any other part of business or across several businesses. Amazon also offers its machine learning platform as a paid service to outsiders, which creates yet more data for use in developing AI services.

Amazon's achievement lies in creating an organization which works seamlessly across different divisions to catapult the engine of innovation. Teams in different divisions work co-operatively to transfer knowledge to create better experience. AI and machine learning has now become the bedrock of innovation. It has also created a good infrastructure for internal training of its employees in machine learning to build its future.

3. Apple

Apple has come out with innovative products like iMac, iPod and iTunes, iPhone, the App Store, and its many mobile apps. Its products are a perfect melding of top-notch hardware and software designed to get the best out of the technology. Apple

10 Morgan Blake, How Amazon Has Reorganized Around Artificial Intelligence And Machine Learning, July 16,2018 (https://www.forbes.com/sites/blakemorgan/ 2018/07/16/how-amazon-has-re-organized-around-artificial-intelligence-and-machine-learning/#447671b47361)

became the world's most valued company when its valuation crossed a trillion dollar mark on 3rd of August, 2018, a day after announing its first quarterly results announced in August, 2018.

New Bionic Chip for AI and ML

Apple has showcased a new system-on-chip, A12 Bionic, which is the first commercial 7 nanometer processor with 6.9 billion transistors. This will enhance computing power into the hands of users for ML and AI features on its devices. It will speed up applications such as FaceID and can recognize people's hair and glasses, thereby speeding up image processing. Third-party app developers can access it through Apple's Core ML software.

AI-enabled features on Phone

Apple is using computer vision for authentication in unlocking phones through facial recognition technology and use of customers' thumbs impression. In the race to garner more and more share of advertisements, it wants to capture customers' reactions to those advertisements.

Apple is focussing on developing a host of AI based solutions to bring AI to its phones. It is using Siri, with a series of enhancements to make Apple's iPhones with iOS12 operating software, a personalized device. This AI iPhone can tell location of the user, and catch what the user is doing and what further he would like to know being there.

Siri's new enhanced features include suggestions to call your friend on his birthday or telling someone through text that you are running late for a meeting and a lot more. These suggestions will improve over a period of time as per usages.

Apple is also using AI to build other features on iPhone, in iOS 12. A new "For You" tab in the Photo app will prompt users to share photos taken with other people, with the help of facial recognition and machine learning. Those other people can in turn share their own photos with the user. The tab will also pull out the best photos and feature them, and prompt users to try

different lighting and photo effects. A smart search feature will make suggestions to the user to pull up photos from specific places or events.

Apple in Healthcare

Apple started healthcare vertical in 2014, when it introduced Health App and Healthkit. In 2015, it introduced ResearchKit and Apple Smartwatch, which tracks health of the bearer giving continuous update on pulse rate, heartbeat, barometric altimeter and other health parametsrs. It can navigate GPS, one can listen to music and seamlessly downloand any app without touching the phone. A newer version of Apple Watch was announced in September 2018. Earlier, in 2016, it acquired Gliimpse, a startup that built personal health records. Health app captures huge clinically relevant data from users that can be used for finding various solutions. Apple realizes that watches could give it a big push in integrating AI health solution for capturing a pie of global health industry of $7 trillion.

Collaboration with Developer Community

Apple is working on a strategy to create an eco-system of innovation from the developer community on an outsourced basis. Its effort is to bring more app developers to use AI tools for recognizing objects before iPhone's camera, for example. Apple has announced an easy to use "Create ML" tool which is built on top of its own Swift Programing Language on which now machine learning models could be further built with their latest operating systems. For example, an image-recognition algorithm can be trained to distinguish different flavors of ice cream. Create ML could teach software to do sentimental analysis to capture customers' reactions or predict the quality of wine from characteristics such as acidity and sugar content.

CreateML Apps for Apple only

Apple wants to promote the app developer community for

developing applications for iOS12. The limitation is that CreateML apps will work only on Apple's devices and not on cloud based resources. Privacy conscious users will be more comfortable since their data never leaves the device. But competing with TensorFlow, an open source AI framework from Google is tough. Google's ML Kit works both on Android and iOS, which can operate from the device or the cloud.

Business Applications in AI

Apple is also deveoping large suite of AI applications for businesses for seamless working on iPhones, iPads and Mac. Apple in 2017 added a neural engine to the iPhone processor to power machine learning software.

Acquistion of Startups

Apple has acquired thirteen AI companies since 2012. Biggest acquisition was of Siri in 2010, which is the AI assistant for Apple. It bought **Emotient**, an AI startup. It also acquired UK-based AI company Vocal IQ to help develop its voice enabled Siri further and use Vocal IQ's speech AI software. Vocal IQ had earlier developed voice-controlled technology for General Motors.

It bought Pop Up Archive which has developed tools to search and organize audio files and is using machine learning to convert speech to text and crowdsourcing the task of fixing transcription errors. In 2017, it acquired Lattice (for $200 million) which can convert unstructured data into structured data using AI. It acquired Realface, an Israili startup (for $2 million) for user authentication, German SensoMotoric Instruments which makes eye-tracking technology useful for augmented and virtual reality and French Regaind for computer vision technology, which can search and sort photos through machine learning.

Conclusion

Apple has realized that the future lies in the new technology of AI. Even though Apple lauched Siri well ahead of the AI industry developments, it somehow grew slowly. It is now working with different stakeholders to get past the competition and stay ahead in the race.

4. Facebook

Facebook, a social media outfit with a monthly active user base of over 2.2 billion has very ambitious plans for the advancement in machine intelligence to provide better technologies for communication. While their long-term objective of understanding intelligence and building intelligent machines are bold, in the near term their objective is to understand and develop systems with human-level intelligence and get machines to the level of human level thinking in terms of seeing, hearing, language and cognition by 2025.

R&D in AI

Facebook researchers and engineers are focusing on building systems that will get the global communities together[11]. It has several dedicated AI research labs in different cities in the US, Canada and France. Researchers are concentrating on AI to derive knowledge from data, algorithms, software and hardware infrastructure and applications to solve problems[12]. By using AI to produce detailed maps, Facebook is trying to get data on population density and internet access to help those

11 Faceebook AI researchers advance the field of machine intelligence, May 4, 2018 (https://research.fb.com/videos/facebook-ai-researchers-advance-the-field-of-machine-intelligence/)

12 Advancing the field of machine intelligence(https://research.fb.com/category/facebook-ai-research/)

communities without internet access[13]. It's a team effort by involving the entire research community through publications of what Facebook does and by sharing open source software and collaborations with the academia.

Different AI Applications

The ultimate goal is to automatically and intelligently enhance people's experiences across Facebook products. Facebook has the AI technology for facial detection, object detection, depth map inference, simultaneous localization and mapping and image captioning. It wants to apply computer vision to identify all the objects around us like tables, chairs, cats and dogs and also extract sentiments, meanings and perceptions from those pictures to make humans interact with emotions. Through visual sensors derived from digital images and videos, information can be extracted about our environment to automate tasks that people automatically do today visually.

By using neural networks, a Facebook app can generate a description for every photograph, which will help even the visually challenged see photos. AI tools can produce detailed maps with information on population density and the access to internet across the globe. Facebook intends to bring internet to the people deprived of access.

Data Ownership and Legal Compliances

Facebook has the advantage of owning some of the largest set of data for developing applications (though there are now legal and regulatory limitations in using such data). AI now powers its news feed algorithm and facial recognition technology; it screens fake news and powers its chat bots and Virtual Assistant technology. In view of sharp criticism faced by Facebook

13 Mercer Christina, Tech giants investing in artificial intelligence February 8, 2018 (https://www.techworld.com/picture-gallery/data/tech-giants-investing-in-artificial-intelligence-3629737/)

recently, it has deployed more than 20,000 safety and security personnel to detect inappropriate content. It is also developing tools to help in such detection. Large number of spam, fake accounts, fake advertisement, malicious link, inappropriate videos, and hate speeches had been identified and removed from their link[14]. It has plans to use AI to deliver personalized services to each user.

Future Projects

Facebook is working on next level of AI to go into reasoning and consciousness to reach the frontiers of human intelligence.

5. IBM

IBM wants to re-capture the leadership position in technology business that it had lost out in the mid-1990s.

IBM's Watson

IBM is now famous with Watson, which is a multi-channel platform for achieving different things in different areas from marketing to legal and more. It has developed AI-enabled business solutions. Watson Customer Engagement (WCE) software for enterprises leverages AI and cloud to help marketing companies for digital transformation by tailoring the content, identifying message sentiment and personalizing customer experience in real time with a view to contextualize their marketing communication to build relationships with the customers across all channels to boost market growth. From the data, it collates actionable insights for delivering what customers want. It optimizes costs across the entire marketing value chain.

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14 Lev-Ram, Michal, Facebook's Fix-it Team, *Fortune*, June 1, 2018, (Page 38).

Another of IBM products is IBM Watson Studio[15] which drives innovation by accelerating the machine and deep learning workflows of a business and provides tools for working with data to build and train models at scale. Businesses can customize their models and deploy them with APIs with Watson Machine Learning or CoreML. There are other solutions with embedded AI services, including Watson Visual Recognition and Natural Language Classifier. There are solutions for building an open source, intuitive visual modeling and an interactive dashboard.

Watson for Healthcare

IBM Watson has been focusing on AI healthcare since 2015, when it acquired Phytel and Explorys and has added Watson for Genomics and Watson for Oncology to the supercomputer's portfolio. IBM's Watson Oncology is in development at Memorial Sloan Kettering Cancer Center and Cleveland Clinic. IBM has entered into a collaboration agreement with US Department of Veteran Affairs (VA) to provide access to precision treatment using Watson for Genomics platform to 10,000 cancer patients. Doctors have developed personalized therapies targeting breast, bowel, lung and prostate cancer.

IBM is also working with CVS Health on AI applications in chronic disease treatment and with Johnson Johnson on analysis of scientific papers to find new connections for drug development.

Watson is capable of answering questions posed in natural language. It has taught computers how to understand photos, videos, text and speech better. Earlier, in 2011, Watson won the US quiz show Jeopardy, beating a human at the other end.

Sporting Challenge

In the last World Cup, Fox Sports partnered with IBM for use of

15 IBMWatson Studio (https://www.ibm.com/cloud/watson-studio)

Watson for analyzing matches from the previous tournaments from 1958 onwards for users to select shots by any player, team or game or any combination thereof and create their own personalized experiences for sharing on Facebook or Twitter. Watson excelled at the use of AI, data analytics and experience design[16].

Collaboration with Nvidia

IBM has teamed up with graphics processor Nvidia, which has helped develop Watson's response rate by 1.7 times. It is also developing a teaching assistant app that will plan lessons based on approved material.

Conclusion

IBM is making deep expansion in AI. Its Watson platform is a popular comprehensive suit for development of many AI programs.

6. Microsoft

With its philosophy of 'AI for All', Microsoft has set one of the highest objectives for use of AI by democratizing its usage and making it accessible to every person and organization for improving lives, transforming businesses and solving some of the biggest problems of our society. Technology is central to all areas of the Microsoft business and Satya Nadella, the CEO has openly stated that Microsoft "will infuse everything with AI".

AI in different applications

Microsoft and their partners have developed solutions in agriculture, healthcare, education, manufacturing, financial

16 Wilson Matthew, In the news: IBM, FOX Sports and the FIFA World Cup, July 18, 2018 (https://www.ibm.com/blogs/cloud-computing/2018/07/18/news-ibm-fox-sports-fifa-world-cup/)

services and e-commerce. Microsoft wants to deploy AI in detecting deadly diseases; increasing the crop yield for farmers; reducing accident risk and in predicting consumer behavior. In their Indian operations, in association with Forus Health, it is using AI capabilities to detect diabetes, glaucoma, retinopathy and macular degeneration.

Microsoft is using AI in human language technology, assistive robotics and developing machines that can read medical images. It is also using AI in cloud-based tools for genomics and precision medicine.

Since 2012, the company has applied for nearly 1000 patents related to AI and machine learning in diverse areas like financial services, security, healthcare etc.

Project Oxford

Microsoft launched Project Oxford, which aims to understand its users with face, emotion and speech application program interfaces (APIs). Skype owned by Microsoft offers real-time AI language translation. This translation system will recognise user's speech and convert it into translated text as they speak.

FPGA and Project Brainwave, the Cloud based Services

Without entering into chip designing, Microsoft wants to run AI projects atop chips called FPGAs, whose designs can be easily re-programmed to support new forms of software. Microsoft is offering a new cloud service for image-recognition project, named as Project Brainwave. It can process images very fast and relatively at a small cost.

Nestle for example, is making use of such a service for healthcare to analyze the severity of acne, from pictures submitted by patients. Software can process images and recommend the most appropriate treatment for the patient and also monitor for its effectiveness. Jabil, an electronics manufacturer having more than 90 facilities worldwide will deploy software to check images of circuit boards flagged as defective by factory

equipment. Because it can process images quickly, at a lower cost than the graphic chips commonly used in machine learning projects, it has turned out to be highly effective.

Project Brainwave can process a single image in just 1.8 milliseconds and cost of processing a million images is just 21 cents by using a standard image recognition model, Microsoft's technology however competes against the rival's offers from Google's TPUs, and graphics chips from Nvidia.

Another challenge of Microsoft's Brainwave is whether its cloud service can adapt a customer's software to FPGAs, since initially it can run only one kind of computer-vision model.

AI used with Windows and Office Products

Microsoft has re-organized the company to take full advantage of AI and bring the new technology closer to its core Windows and Office products for convenience and faster implementation. Every application from photo to skype to Office 365 would be infused with intelligence. Similarly, Microsoft's virtual personal assistant, Cortana would be deployed in human and computer interaction. More than 500 million machines have got access to Cortana. All developers would have the same access to cognitive capabilities like machine analytics, vision and speech as in Microsoft apps.

AI in Healthcare

Microsoft has entered into partnership with Oregon Health & Science University's Knight Cancer Institute, to predict the most effective cancer drug treatment options for patients. Other projects include medical image analysis of tumor progression and the development of programmable cells. It released new products including HealthVault Insights, Microsoft Genomics, a chatbot and Project InnerEye for radiotherapy.

Venture Funding

Microsoft launched a new fund for AI startups in December,

2016 which invests in AI startups working on inclusive growth and creating a positive impact on society[17]. It also focuses on investing in machine learning, big data, the cloud, security and SaaS particularly in startups with a focus on inclusive growth and positive impact on society. Microsoft Ventures has invested in Element AI, a Montreal-based startup, Agolo, which uses AI to create summaries of information, in real-time, and invested in Bonsai, which enables the automated management of machine learning algorithms.

R&D Center for AI

Microsoft AI and Research Group was set up in 2016 to build on the company's focus on AI. This group employs more than 5000 scientists, engineers and other experts for research in AI product engineering and New Experiences and Technologies (NExT) for developing new capabilities for the customers across agents, apps, services and infrastructure. Microsoft also wants to develop the world's most powerful AI Supercomputer and connect it to Azure for making everything available to everyone.

Conclusion

Microsoft has realized that AI is the key to their future. Focussiong on social goals is an important objective so that the benefit of AI technology percolates to the masses.

7. NVIDIA

Hardware-maker that powers the AI Industry

Nvidia is the hardware maker that has been driving AI, machine learning and deep learning capabilities through inventing GPUs of higher capacity and higher speed and which can store

17 Mercer Christina, Tech giants investing in artificial intelligence Microsoft, February 8, 2018 (https://www.techworld.com/picture-gallery/data/tech-giants-investing-in-artificial-intelligence-3629737/)

more data in smaller sizes.

Nvidia first invented the GPUs in1999, which are the new computer brains for virtual reality, high performance computing, and artificial intelligence. Whereas CPUs performance is now growing by just 10% a year, GPUs performance is growing by 150% a year and is set to grow 1000 times by 2025[18]. These GPUs are powering the world's fastest supercomputers and data centers in the US, Europe and Japan.

GPUs became Popular in Gaming

Nvidia GPUs first became popular with the gaming industry. NVIDIA GeForce is its largest platform and GeForce GTX GPUs and the GeForce Experience application transform everyday PCs into powerful gaming machines. The software, GameWorks allows developers to make games photorealistic and immersive.

Open Source Enhancements

Nvidia has optimized Deep learning framework for NVIDIA CUDA and CuDNN technologies. It has the most powerful GPU, Kubernetes integration and accelerated inference capabilities. NVIDIA has been promoting the open-source community to support the Kubernetes ecosystem.

TensorRT 4 Speeds up Image reading

Nvidia's TensorRT 4[19], the latest version of its deep-learning inferencing software optimizes performance and reduces the cost of operationalizing deep learning models in applications

18 The time for GPU computing has come (https://www.nvidia.com/en-us/about-nvidia/ai-computing/)

19 Henschen Doug, NVidia accelerates artificial intelligence, analytics with an ecosystem approach by April 09, 2018 (https://www.zdnet.com/article/nvidia-accelerates-artificial-intelligence-analytics-with-an-ecosystem-approach/)

for natural language processing, speech and image recognition and recommender systems. The performance of Google's TensorFlow-based image recognition system without TensorRT and the same being integrated with TensorRT in terms of speed of image reading goes up from 300 images per second to 2,600 images per second.

Collaboration with Medical Equipment Manufacturers

Nvidia is also collaborating with medical device makers to enhance their medical imaging capabilities. With Project Clara, NVIDIA and its partners are modernizing the old medical imaging equipments to the AI technology for better performance of various devices for X-Ray, CT Scan, Ultrasound or Mamography[20]. This platform leverages the GPU based cloud system to enhance image quality.

Partnership with ARM

NVIDIA and ARM have entered into a partnership to bring deep learning to mobile, consumer electronics and Internet of Things (IoT) devices. With ARM being a strong player in consumer electronics and mobile device market, developers will be able to quickly build applications that take advantage of the Nvidia's embedded AI capabilities. NVIDIA and ARM will integrate the open-source NVIDIA Deep Learning Accelerator (NVDLA) architecture into ARM's Project Trillium platform for machine learning to enable IoT and mobile devices to gain inference capabilities.

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20 Janakiram MSV, NVIDIA Pushes Its GPU Technology To The Front And Center Of Artificial Intelligence, April 2, 2018 (https://www.forbes.com/sites/janakirammsv/2018/04/02/nvidia-pushes-its-gpu-technology-to-the-front-and-center-of-artificial-intelligence/#664e0e5132ab)

AI Health care

Nvidia in association with Nuance is working on AI powered healthcare solutions. NVIDIA's deep learning platform and Nuance's PowerScribe radiology reporting and PowerShare image exchange network together have worked on an AI Marketplace for Diagnostic Imaging providing new tools for analyzing X-rays and other images used in radiology. AI developers can share models they have been trained via Nuance's PowerShare network and other medical professionals can subscribe. AI algorithm can then be applied in relevant circumstances.

Conclusion

Nvidia has revolutionized the AI industry through innovation in hardware that made it possible for the lead players to create new products and services in AI. The continuous innovation that Nvidia is engaged in, keeps raising the level of products and services.

8. eBay

EBay, one of the earliest pioneers in e-commerce is using AI to maintain consumer interest and a competitive edge. It is using machine learning as an integral part of its business strategy. AI in the retail industry is being employed in processing customer service inquires, product packaging delivery and internal operations. It is used for matching of products, price prediction and item categorization as well as for attributing extraction, generating the proper names of browse nodes, filtering product reviews etc. Machine learning helps to optimize the relevance of shoppers' search and navigation experiences.

eBay's chatbot, *Shopbot* introduced in October 2016 can be accessed through the Facebook messenger platform. The bot, an AI assistant can communicate through text, voice or by using pictures taken with the smartphone of images related to a particular product and helps users find products of interest.

eBay acquired Salespredict and Expertmaker which are using AI platforms. AI combines intelligence about individuals, behaviors, trends, and context. Expertmaker has created an advanced AI platform for optimization and automation. Its technology is used to help improve shipping and delivery times, trust, pricing, and more.

eBay is using AI effectively in its own domain.

Rise of China's Big Tech in AI

China has been the breeding ground for AI technology and AI businesses. With a digital-savvy population of 1.4 billion, consumers are demanding ever more powerful digital services than before. The local e-commerce market alone is expected to rise to $1.7 trillion by 2020. That is a big opportunity for the new age companies in China taking to AI to generate higher traffic and higher revenues.

Chinese tech firms have grown as conglomerates, focusing on many things at a time from e-commerce, search engines, cloud based services, mobility,e-payments, smart city solutions, autonomous driving, conversational AI, predictive healthcare and many more to digital payments and cloud computing. They had to set up infrastructure for their expansion as the state dominated economy was so inefficient earlier. Further, Internet sector in China is very lightly regulated. That leaves the local firms to acquire dominance that would immediately alert the regulators in other liberal markets.

Chinese Companies have a great Success Strategy

Not long ago, China's big internet companies were dismissed by the investors in the silicon valley as marginal players. However, the Chinese big tech, namely Alibaba, Baidu, JD.com and Tencent (ABJT) have come a long way and are now betting big with huge investments in research, developing partnerships and setting up offices abroad both for research and marketing, giving a run for their money to the US big tech. They are finding

innovative solutions to common problems in many areas and reaching out to the masses. Before going further, a broad overview of the big tech (ABJT) is given below.

The great thing about the Chinese tech is that while the country has virtually closed its doors to their foreign rivals for operating in China, it has taken full advantage of the liberalism of the West. For example, it has allowed its own companies to be listed simultaneously on bourses at New York, to attain better valuations so that these companies can get advanatge of higher valuations.

Table 5.2: Comparison of Chinese Big Tech Companies

Company's Name	Global Ranking	Market Cap[21] (billion)	Revenues ($ billion)	Profits/ Losses (million)	Assets (billion)	Remarks
Alibaba (Group Holding)	300	393.7	38	9,673.1	114	
Baidu	-	62.6	15			
JD.com	181	30.3	54	(22.5)	28.3	
Tencent Holdings	331	377.8	35	19,580.6	85	

While Baidu, Alibaba and Tencent, collectively referred to as BAT have become the market leaders in China, they also have huge global ambitions. Strategy involves around recruitment of top talent in AI, particularly the US trained scientists, acquiring AI startups in the US for technical capability and IP and forming global alliances for expansion. Between 2014-18, BAT made investments in AI industries in e-commerce, healthcare, enterprise AI, industrials and advanced materials, cyber security, personal assistants, news, media and advertisements, fintech and hardware for AI. Chinese startups are fetching huge funding, next only to the US.

21 Market Capitalization is as on 7th December, 2018

The Chinese big tech, particularly BAT are themselves fighting a tough war at home and abroad, but sometimes they end up co-operating too. All three, for example have invested in Didi Chuxing, the ride-hailing firm.

Chinese companies engaged in developing AI solutions have hired a number of US based scientists of Chinese origin, who have been instrumental in developing AI products and solutions for their new employers in China. Andrew Ng, a celebrated AI expert first worked at the Google Brain project, where a top notch work in computer vision in 2012 for identifying images of cats from YouTube videos was done.

Later in 2014, Baidu recruited Andrew Ng, who is credited to have developed Baidu's AI research in autonomous driving and conversational AI platform over the next three years, before he quit. Baidu in its 2017 financial report made a special mention of aggressive acquisition of AI talent for developing Chinese language processing, deep learning and autonomous driving.

BAT has also invested in equity deals in more than 40 AI startups engaged in development of software and chips since 2014.

AI Products developed by Alibaba and JD.com in retail, by Baidu in autonomous vehicles and voice assistants have great similarity with AI products developed by the US giants (3AFIM). Thus BAT is giving tough competition to their US counterparts.

The Chinese AI companies are also focussing on investing in startups globally but with greater attention to those in the Asian economies, where they expect to become the leader by expanding overseas. BAT have invested huge amounts in startups in not just China, but also in the US, Israel, canada and other countries. The following figures indicate their investments between 2014 till April, 2018[22].

22 Rise of China's Big Tech in AI: What Baidu, Alibaba, And Tencent Are Working On", (https://www.cbinsights.com/research/china-baidu-alibaba-tencent-artificial-intelligence-dominance/)

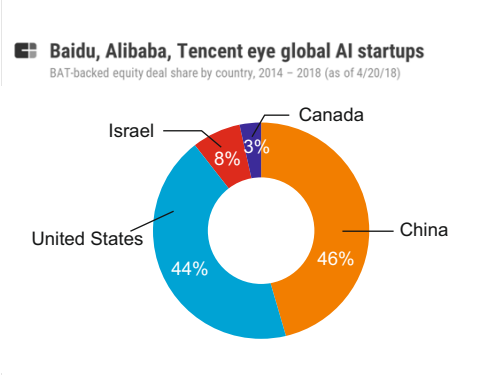

Figure 5.2: Chinese Companies share of investment in Startups

Source: CB Insights ("Rise of China's Big Tech in AI: What Baidu, Alibaba, And Tencent Are Working On")

Role of the Chinese Government

Chinese government is promoting usage of AI on a larger scale to realize the larger objective of gaining the top spot and becoming a superpower in AI. It has divided the timeline into three segments for achieving certain specific targets.

In order to promote AI businesses, China has some control over its national champions. Alibaba is making a great push in smart cities, while Tencent is focussing on computer vision for medical diagnostics. Baidu is specializing in autonomous driving and iFlyTek in voice intelligence. Chinese government has announced that China's open AI platforms will rely on Alibaba for smart cities, Tencent for AI in healthcare, imaging and diagnostics and Baidu for autonomous vehicles.

China also allows unfettered access to data collected by various entities in developing AI solutions. The privacy and personal rights over the data of the subjects is virtually non-existent in China. Thus there is an unprecedented advantage in usage of data for training AI algorithms by their national champions, ABJT, which have huge advantages over their peers in the US.

The Chinese strategy on AI has forced other countries to think

differently and safeguard their own turfs. The US has now put up a great barrier on acquisitions of tech startups or on M&A activity involving high technology and security of the country. Now every acquisition is being closely scrutinized on case by case basis.

Here is the detailed list of AI progress made by the Chinese big tech, ABJT.

9. Alibaba

Alibaba, started in 1998 in Hangzhou and has now become a global conglomerate providing multiple services in e-commerce, payments and in cloud. It is handling more transactions than what eBay and Amazon handle together each year. Their two shopping malls, Tmall and Taobao serve more than one billion customers. Jack Ma (who announced retirement in a year's time) has vowed to serve 2 billion customers globally within two decades.

Alibaba has become a global leader in e-commerce. China alone accounts for nearly 50% of global e-commerce sales, more than the combined sales of the US, Japan and Germany. In order to give an AI push in running its e-commerce business, it hired an ex-Amazon scientist Ren Xiofeng, who was running Amazon Go, to lead its AI push. It has put Tmall Genie, a voice activated assistant like Amazon Echo at a low cost to perform tasks, such as controlling smart-home devices or checking weather. Users can shop and pay through Tmall Genie which is a form of authentication signature. Now Alibaba has tied up with Marriott Hotel chain which will use more than 100,000 smart speaker units to provide concierge services.

Alibaba is using AI in their e-commerce business as also in social media services for making recommendations, targeted

advertisement and forecasting demand[23]. It has developed facial recognition technology for authentication and is running an AI chatbot, Dian Xiaomi, which understands customers' emotions and handles over 3.5 million interactions a day.

Alibaba is using AI powered Tmall Smart selection and makes recommendations to customers for purchase and then alerts the retailers for such purchases. Alibaba generated sales of $ 25 billion on Chinese New Year day of 2018 (which is more than the value of goods sold in 2017 and three times the value of sales in the US on 'thanks giving day' spread over three days).

Alibaba is also using AI in logistics and its online payment system through Ant financial. It is using 250 robots in their warehouses to pack goods and have been using drones to deliver packets. By using Cainaio, a logistics affiliate of Alibaba for mapping the best delivery routes, Alibaba is saving in the number of vehicles being used and distances travelled for delivery.

Alibaba has set up kiosks at Shanghai sub-way station where tickets to the travelers are issued on speech and facial recognition technology running through AI cloud.

City Brain Project

Alibaba is running City Brain Project for managing city traffic by making data about everyone and every vehicle in the city in a cloud based system. It analyzes such data collected through video, image, and speech recognition and then applies machine learning to provide insights for city administrators to improve operational efficiencies and monitor security risks. The experiment has been successful in Hangzhou city, where traffic congestion could be reduced by 15-20%. It is working with Macau government to build smart cities and smart tourism

23 Knight Will, Intelligent Machines: 'Inside the Chinese lab that plans to rewire the world with AI', March 7, 2018 (https://www.technologyreview.com/s/610219/inside-the-chinese-lab-that-plans-to-rewire-the-world-with-ai/)

initiatives. Next experiment is in Malaysia to support smart city project for digital transformation.

Investments in R&D

Alibaba is investing big in research and development in AI. It has launched a $15 billion R&D initiative focused on AI, quantum computing and other key technologies. It has set up seven research labs which focus on AI, machine learning, network security, natural language processing and many more areas. Alibaba wants to become a global leader in cloud based system running on AI, so that AI could be taken to the masses and anyone with a computer and broadband connection can start a business in AI on his own.

It has also set up a not-for-profit organization in association with SenseTime, a startup and Hong Kong Science and Technology Parks Association for setting up an AI lab for advancing the frontiers of AI and helping startups building and commercializing their products.

Alibaba has set up DAMO Academy[24] ('discover, adventure, momentum and outlook'), a research institute for researching on fundamental technologies. DAMO refers to Dharma, a legendary Indian monk who traveled to China in 5th century and spread Buddhism.

Investing in Acquisitions

Alibaba has made smart investments in Israel, one of the leading technology hubs. It acquired Visualead for computer vision technology and engineering team it had. It also made investments in Nexar (running AI-based vehicle to vehicle

24 Marr Bernard, The Amazing Ways Chinese Tech Giant Alibaba Uses Artificial Intelligence And Machine Learning, July 23, 2018 (https://www.forbes.com/sites/bernardmarr/2018/07/23/the-amazing-ways-chinese-tech-giant-alibaba-uses-artificial-intelligence-and-machine-learning/#4fdecbee117a)

network technology), Twiggle, (an e-commerce search engine) and ThetaRay (in cybersecurity). It has investments in local online payment firms through Ant Financial in Singapore, Thailand, the Philippines and South Korea.

Alibaba Competing Nationally and Internationally

Alibaba is setting its footprint in India and other parts of Asia on a grand scale with smart investments in startups, AI technology and products. It is competing aggressively with Tencent at home and Amazon and other in the international markets.

It took the initiative of persuading G20 to start "electronic world trade platform" for facilitating small businesses for cross-border trading. It launched a 'digital free trade zone' in Malaysia. This public private partnership would simplify logistics and payments to help small merchants.

Conclusion

Alibaba promoted e-commerce in B2B segment, when there were only a few players in that business. Rising from a humble background, Jack Ma has been a true entrepreneur, who has raised the bar, in everything he has done. He pushed his internet based businesses into AI as he saw a big opportunity with the new technology. He has invented many things and is working towards the objective of enriching lives of the common people through application of technology.

10. Baidu

Founded by Robin Li and Eric Xu in 1999, Baidu, the most popular Chinese search engine is using AI in providing various digital products and services to its users. China's online user base of over 750 million people provides a great advantage to Baidu, which gets the training data for free for developing AI services for targeted advertising and product recommendations

etc.[25]. Employee's authentication at Baidu's office at Beijing's Haidian district through facial recognition technology has been in place for some time now replacing identification badges. Employees can use that identification for restaurant services.

Baidu has developed DuerOS, a voice assistant, which is richer in dialogue than its competitors like Alexa, in the same league. DuerOS is being used by large number of appliance makers for TVs, refrigerators etc. DuerOS's limitation of training in Chinese language was overcome when Baidu acquired a Japanese startup Simeji, an input method editor company which has access to Japanese language and user's conversation. This enabled Baidu to launch "Aladdin", a 3-in-1 smart speaker, smart lamp, and projector for the Japanese market. Baidu has also come out with a smart screen called Little Fish VSI. It has also designed a smart speaker Raven H, with hardware design outsourced to a Swedish company, Teenage Engineering. It had acquired Raven Tech, a voice assistant startup earlier.

Baidu has the ambition to expand its markets to the global stage in countries like India and Brazil, which have similar marker characteristics like China's.

It has acquired a patent titled "human-computer interactive method based on artificial intelligence and terminal device" which combines voice recognition and facial recognition into a consumer-robot like device.

R&D in Autonomous Driving technology

Baidu is researching in autonomous driving technology. With Apollo program, an open-source AI based driver-less platform, it has reached out to car makers for providing the brain of the car for free in exchange for data which can be used for AI

25 Hemple, Jesse, Inside Baidu's bid to lead the AI revolution, December 6, 2017 (https://www.wired.com/story/inside-baidu-artificial-intelligence/)

development. The Apollo platform[26] consists of core software, a number of cloud services, and self-driving vehicle hardware such as GPS, cameras, lidar, and radar. If it is successful, Baidu could catch up with Alphabet's Waymo, being developed since 2009. More than 75 companies including Ford and Nvidia have signed on Apollo platform. If Apollo gets going, Baidu will earn revenues from advertisements. It is hoped that Baidu's partners will mass produce semi-autonomous vehicles in 2019, which will have many self-driving features.

By 2021, autonomous cars may go in full production, subject to the regulators permitting it. Baidu has also invested in iDriver+Technology.

R&D for advancement of AI

Baidu is focusing on fundamental research in AI with the objective of 'All in AI' and hiring top talents from around the world, especially from the campuses of the American universities, like Stanford and MIT. Baidu has set up research centers with facilities at Beijing, Seattle, and at Silicon Valley for dedicated research on AI which will power businesses with cloud and IoT. It had hired Lu Qi, an ex- Microsoft top talent for strategizing its AI businesses, who later quit. SVAIL and Baidu Institute of Deep Learning are doing well in research, and it is working on home assistants, aid for the blind and self-driving cars. Baidu wants to focus on autonomous vehicles and voice assistants, and for this purpose it restructured the company by selling off its food delivery business Waimi to its competitor Ele.me controlled by Alibaba, It also sold off IQiyi, a video streaming service.

26 Rise Of China's Big Tech In AI: What Baidu, Alibaba, And Tencent Are Working On , April 26, 2018 (https://www.cbinsights.com/research/china-baidu-alibaba-tencent-artificial-intelligence-dominance/)

AI in Health care

Baidu is using deep learning and computer vision for detection of tumors or cancerous cells for early detection and treatment of cancer. It made investments in Atomwise, a startup using deep learning for drug discovery and Engine Bioscience, another healthcare AI startup.

AI based Mobile Platform

Since navigating the web is happening more through the apps rather than through the web, the company's focus has shifted to AI based mobile platform. They have partnered with Huawei for developing an open mobile AI platform for developing AI-powered smartphones. Baidu has also tied up with Qualcomm to optimize its DuerOS for IoT devices and smartphones using Qualcomm's Snapdragon Mobile Platform.

Cloud services

Baidu also wants to gain a competitive edge in developing intelligent cloud services for the corporates. With more than100,000 paid corporate-users, Baidu cloud currently focuses on applications in finance, media, IoT and marketing.

Investment in Startups

Since 2014, Baidu has been investing in AI startups in news & media, advertising, healthcare and AI chips. It invested in five startups in the US including one in Lightelligence engaged in making hardware chips. Baidu provides search engine service and Internet-related services including a video platform and earns through targeted advertising and transaction services.

Conclusion

Baidu believes that in the age of AI, it will infuse everything and every system—from medicine to cars and entertainment with intelligence. It is investing in different technologies to

become a global leader in AI.

11. JD.com

JD.com (Jingdong), a Chinese tech company is engaged in e-commerce and retailing and has interests in warehousing, logistics and couriers. It has huge ambitions on AI, big data and robotics to ultimately make their operations human-less. It wants to leverage technology as the bedrock for being the best retailer in the world by providing the best shopping experience to the customers.

GSCI, R&D Center

JD.com has set up a Global Supply Chain Innovation Centre (GSCI) as a research center that will collaborate amongst universities, private companies and industry experts to develop the future technology related to supply chains. GSIC will research in the area of big data, machine learning, computer vision and other AI technologies to anticipate consumer's needs better and achieve better efficiency.

JD.com is collaborating with Siasun Robot & Automation Co Ltd for using robotics and automation technology to improve warehouse operations, improve the speed and efficiency of product sorting and delivery in warehouses, thereby cutting costs and ultimately increasing revenues.

Retailing and Warehousing

It is collaborating with Fung Retailing, to use their global retail experience and is investing in AI research centers for developing a rich customer shopping experience that manages everything from product to warehousing, pricing and payment processing.

It has also invested in AI Catapult[27] which is developing retailing solutions in AI and blockchain technology. With investments in Zebra Technologies and Digital China, JD.com wants to improve upon logistics management, mobile computing and computer vision.

It wants to set up an unmanned warehouse where AI and robots will be doing the jobs related to packet sorting, categorization and packaging for delivery. It has also set up seven logistics centers for operating more than 400 warehouses throughout China.

Drone delivery

JD.com has also been using drones for delivery and researching on developing drones that will carry more tonnage of cargo. It has spent more than a year building a drone-delivery network with 40 drones covering nearly 100 villages. Orders placed through the app are delivered the same day through the 'postman' of the village appointed by the company to receive packages from the autonomous drones guided remotely. This is a boon to serve the rural markets growing at 35% a year in e-commerce. It is also cheaper to deliver packages through drones in far-flung areas, though overall cost factors have to be worked out.

LingLong DingDong Speaker

JD.com is having its own home speaker, LingLong DingDong, which responds to natural language commands in Mandarin and Cantonese and performs the same functions as Amazon's Echo.

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27 Marr Bernard, How Chinese Retailer JD.com Uses AI, Big Data & Robotics To Take On Amazon', August 3, 2018 Marr (https://www.forbes.com/sites/bernardmarr/2018/08/03/the-amazing-ways-retailer-jd-com-uses-ai-big-data-robotics-to-become-the-global-e-commerce-leader/#3196b52d7a1a)

Conclusion

With entry in several key areas of growth, JD.com is a company to watch. It may emerge as a serious rival to Alibaba and Tencent in the future.

12. Tencent

Tencent specializes in online gaming and social media, but otherwise has a large area of operations in video streaming, mapping, mobile payments, digital assistants, entertainment, sports, movies cloud storage, and artificial intelligence. Pony Ma, its chairman wants to preside over the global tech revolution of the future by focusing on AI, machine learning, computer vision, natural language processing and speech recognition for developing applications in AI[28]. Tencent is now betting big on AI and that its objective of 'Make AI everywhere'[29] shows its commitment to embracing the new technology. "AI in all we do" is what was referred to in the Q4 results of 2016 and Tencent is betting on AI as the core technology for all its products.

WeChat, the Prime Mover

With over a billion users, Tencent has established a huge network through WeChat. It has exploited the penchant of the digitally savvy Chinese people for messaging, money transfer, photo sharing, accessing online content and services like shopping, booking flights and simply chat. WeChat's platform is used for messaging and payments. WeChat has thus developed huge resources of data for training AI algorithms. Even hospitals are accepting payments through WeChat, which is also using voice

28 Marr Bernard, Artificial Intelligence In China: The Amazing Ways Tencent Is Driving It's Adoption, June 04, 2018 (https://www.forbes.com/sites/bernardmarr/2018/06/04/artificial-intelligence-ai-in-china-the-amazing-ways-tencent-is-driving-its-adoption/#e645512479ac)

29 Tencent AI Lab (https://ai.tencent.com/ailab/index.html)

recognition technology. Tencent has developed a speaker Ting Ting, which can access WeChat applications and services like sending voice message.

WeChat made up 34% of China's total mobile-data traffic in 2017. It alone has helped Tencent to have large data sets, which it is using for training algorithms. WeChat users have access to a virtual healthcare assistant through Babylon Health, a joint venture of Tencent.

Investing in R&D and Startups

Tencent is investing in technology and startups to build the world's largest AI research team for the future. As part of its vision of 'Make AI Everywhere', it established an AI lab at Shenzhen. It has established one of the largest AI labs at Seattle and is using AI in messaging payments, video, mail and/or social media platform. Its AI platform provides many ways of testing real-world AI like virtual assistants and voice to text.

It has also invested in UBTech, a humanoid robot which showcased a Walker, a robot that can climb down stairs. It invested in Element AI, a Canadian startup led by the renowned AI scientist Yoshua Bengio. It is part of a consortium that spent $8.6 billion to acquire Finland's Supercell, a deal which pushed Tencent as the biggest purveyor of online games. It has invested in Hike Messenger, an Indian messaging app and America's Snapchat.

Leadership in Facial Recognition Technology

Tencent is the leader in facial recognition technology. It is working with two banks China Unicom and Webank for facial identification. Some of the Chinese provinces want to use facial technology for issuing electronic ID cards replacing the physical cards.

Further, it has opened up its AI images platform to all, offering basic image and facial recognition capabilities for free. Users can access Tencent's Youtu platform, via WeChat's mini-programs,

which are apps operating in the WeChat ecosystem. Youtu can recognize faces or text. A mini-program can read texts from name cards, business licenses, identity cards or credit cards. It can also synthesize sound with female and male voices with various speeds. Its facial recognition technology can recognize key parameters such as sex, age, emotions of a person and can tell simple indicators such as what a person is wearing. It can recognize the type and brand of a vehicle, detect pornography and violent images. Youtu's technologies are used by Tencent's various businesses like its online bank WeBank and messaging app QQ.

Tencent services are used by Shenzhen Police, Nanjing Police, Chengdu State Administration of Taxation, Citic Bank and China Unicom.

AI expansion in Healthcare

Tencent has huge interests in health care. It has connected large number of medical institutions and is providing facility of online registration of patients. It developed Miying healthcare, an AI platform which helps in reading CT scans and in the diagnosis of four different types of cancers and in managing healthcare records. Miyung's solution will be extended to other areas. It has invested in some pharmaceutical projects. Tencent is also working on personalized medicine through investment in iCarbonX, which aims to develop a digital representation of individuals for this purpose. It invested in Atomwise a Californian startup for drug discovery, and Massachusetts based Xtalpi, which shows global ambitions of expansion into pharma AI.

Autonomous Vehicle technology

Tencent has invested $1.8 billion in Tesla, which is betting on autonomous vehicle technology. It has also invested in an autonomous driving startup NIO, which obtained a government license to test drive its autonomous vehicles on public roads.

Chinese government efforts to control on-line video

Tencent has had some problem with the Chinese government regulators over video content. Ministry of Education has recognized the growing problem of myopia among the Chinese youth because of constant video watching, so it wants to control the number of games that can be released[30]. That is a trouble spot for online gaming companies like Tencent.

Conclusion

Tencent has been a leader in several domains and is an inventor and heavy user of AI content and technology. It has several flagship products which are very popular with the users. It has been investing in R&D, startups and expanding in different areas to corner share of the market. Its leadership position is next only to Alibaba. They are competing aggressively against each other and encroaching upon each other's territory.

Summary of what 3AFIM and ABJT are doing collectively

3AFIM of the US and ABJT of China, the tech-savvy big tech giants have made the AI race competitive and quite interesting. They have many things in common like they are investing heavily in R&D, setting up research centers in different parts of the globe and all are gobbling up startups with a technology they can integrate with or expand their services.

The American tech giants, 3AFIM are being challenged globally by ABJT who have their government on their back to support their expansion in the market and advantages of a big but closed marketplace with huge number of internet-savvy population.

30 Huang Eustance, Tencent's stock falls more than 5% after Chinese ministry proposes increased regulation' August 31, 2018 (https://www.cnbc.com/2018/08/31/tencent-hit-by-new-chinese-proposed-restrictions-on-online-video-games.html)

Additionally, ABJT are also collecting huge amount of data without any restrictions from their businesses in social media, e-commerce, on-line search, gaming, e-payments, and all other services, which further helps them grow in AI. 3AFIM no doubt also have huge data bank available from their businesses, but they face scrutiny from various authorities and have to comply with a number of legal requirements.

They are all focused on global growth and global strategies, with acquiring the best talent. They are trying out in different businesses, be it in technology services, voice assistants, smart cities, health or agriculture or in some unconventional areas. They are developing a market place for providing AI services to the customers in the most convenient ways and serving enterprise customers through cloud services to bring down cost.

All these companies are aggressively looking for the best talent and filing patents to safeguard their intellectual property. They are creating infrastructure, promoting supply chain technology to bring in more partners to create a bigger market for their products and services.

Concluding Remarks

While the big tech has been facing criticism for an unfair competition they create in the market place, we must surely recognize their contributions in promoting the new AI technology not just in the US or China but elsewhere too. They surely have an advantage in adopting any new technology and making a success out of it.

Therefore, the big tech is better placed to engage in creating a favorable business climate for development and promotion of AI. Even the smaller companies may benefit out of some of their efforts.

CHAPTER 6

AI Startups that Transformed Businesses

Introduction

The world over, Startups have ignited an animal-spirit like enthusiasm among entrepreneurs and especially among the youth, keen to experiment upon new ideas. They are using AI, machine learning, deep neural network, computer vision and other new technologies to develop new products or services or to make improvements in the existing ones.

There is also a race among nations to support and develop an eco-system of startups that take advantage of the new technologies to drive the new-age economy, which promises large benefits in terms of new employment and rise in productivity that could lead to another economic boom raising life-standards of the people. China wanting to be the next superpower is encouraging their home grown entrepreneurs to beat the US, where largest number of startups in the new technology has come up.

Apart from the silicon valley of the US, the Mecca of innovation, there are other city-centers, like London, Tel Aviv, Shanghai, Bengaluru, Paris, and some other cities in Europe which have played a lead role in the new-age boom.

Startups in different Industries

CB Insights, a research firm published the list of 100 most promising AI startups. These are working in different areas of finance, healthcare, cyber security, social media etc. Here, we discuss about a dozen startups which appear in the list of the top hundred startups published by the research firm,

CB Insights[1]. A few are from outside the list also. They have applied innovative technologies to do something different and are disruptors in their own industries. They provide better value to the customers, gaining market traction and have also attracted huge investments through venture funding.

1. Affirm (Financial Loans), USA

Founded in 2013 by Max Levchin, former co-founder of PayPal, Affirm is a fintech AI start up with a mission to reinvent the industry which has hardly changed since 1970s. It wants to deliver honest financial products to improve lives. It has disrupted the traditional model of financing of personal loans and offers easy and flexible payment plans without any hidden charges for financing to customers making purchases from retail stores, with whom it has a tie up for purchase-finance[2]. Affirm uses AI to perform better risk assessment than what the conventional credit score based system can do. It is using machine learning to extend credit particularly to those who get excluded in the conventional model, make a fair assessment of risk with the borrower's ability and intent to pay, which reduces chances of default and fraud and uses machine learning for assessing price risk for the customers at the point of sale[3].

It offers multiple payment options to the customers in a transparent manner and reminds them about any payments pending. Customers can open an account with few personal details and get an instant loan on purchases from stores. It runs an app service with iPhone or android. It is all about convenience and customers exercising their own personal

1 A ranking of the 100 most promising private artificial intelligence companies in the world. CB Insights; (cbinsights.com/research-ai-100)

2 Nielsen Maria Thing, Affirm - Revolutionizing the Loan Industry Through the Use of AI, October 19, 2017 (http://www.icdk.us/blog/affirm-revolutionizing-the-loan-industry-through-the-use-of-ai)

3 Affirm: Delivering honest financial Products at https://www.affirm.com/business/company/

choices for payments. It has partnered with Eventbrite and Expedia to offer loans on events and travel.

Benefits of using technology in loan approval process is in terms of higher amount (by 125%) of loan approval than the industry average, more transparent dealings with customers with no hidden fees or charges and higher turnover of merchants' sales and finally getting repeat customers.

Affirm has the ambition to become as big as PayPal though it has faced criticism over lending for purchases of luxury goods, which it has justified.

2. AlphaSense (Intelligent Search Engine), USA

Alpha Sense is a search engine running on AI, advanced linguistic search and natural language processing algorithms to search for information at one location, from thousands of documents and sources like company's own reports, transcripts, broker's reports, news reports, trade journals etc. It intelligently indexes every line of text and takes to the right keywords at superfast speeds. Its 'smart synonyms' expand the keyword searches to include synonyms. It collates information and hidden insights tailored for a particular purpose for knowledge professionals and experts in investment banking or research, corporate strategy, M&A, private equity etc. for smarter decision making[4].

The users can get the information very quickly. On account of its specialization, the search engine performs better than Google to get the information required.

3. Byte-dance, (Social Media), China

Founded by Yaiming Zhang in 2012, Bytedance provides a

4 Your Brain, Our AI: Find what others miss with AI powered business insights at https://www.alpha-sense.com/

platform for content discovery and creation[5]. It uses machine learning and mobile technology to inform, entertain and inspire people across language, culture and geography. Users don't need to provide any explicit input. Its platform automatically learns the user's preferences with every tap, swipe made and time spent on various product offerings. It does sentimental analysis knowing users' likes, dislikes, favorites etc. and is able to create personalized high-quality content. With AI and machine learning tools, it has been able to refine its products through continuous feeding of data into the system.

Bytedance is one of the fastest rising Chinese startup in social media using AI to create mobile entertainment apps made available through Tiktok and Douyin (which Bytedance bought in November, 2017). On Douyin, a user can upload a click or a 15-second video. Douyin claims to have a user base of 300 million in China, more than that of Kuaishou, another short video app in which Tencent has a stake. Chinese people are spending now more time on watching short videos than messaging and hence the battle of the titans. Tiktok, an international version of Douyin became the most popular downloaded iPhone app, excluding games. It is doing well in Indonesia and Thailand. Tiktok has now merged with Musical.ly[6].

Bytedance also bought Toutiao, which is a news aggregator of all newsfeed from Chinese media and where Y Combinator, a Silicon Valley investor has acquired a stake. It is taking Toutiao global in English-language news reader apps[7]. It also bought News Republic (a global news aggregator) from Cheetah Mobile. Toutiao and Douyin together are giving a tough fight to WeChat of Tencent. Two other video apps, Xigua and Huashan

5 We are building the future of content discovery and creation at https://bytedance.com/

6 Russel John, Fast-growing Chinese media startup ByteDance is raising $2.5B-$3B morehttps://techcrunch.com/2018/08/08/bytedance-is-raising-2-5b-3b/

7 The Economist July 14, 2018 (Page 55-56)

owned by Bytedance have turned the competition interesting.

With Bytedance bying out Flipagram (a short video platform) and Musical.ly (a short video with music platform), it has aggressive plans to focus on growing its presence in China and the rest of Asia. In the U.S. market, it claims to have some 60 million users.

Bytedance and its affiliates hold several patents in big data analysis, data storage and compression, audio and video processing and natural language processing. In the last round of funding, its valuation grew upto $ 75 billion, more than the market valuation of Didi Chuxing or Uber.

It had to face a serious challenge when the Chinese censorship authorities shut down Taotiao temporarily and removed from the app store on account of circulation of some inappropriate content.

4. CrowdStrike (Cyber Security), USA

Co-founded by George Kurtz (current CEO), CrowdStrike[8] provides a cloud based AI powered cyber security platform specializing in threat intelligence and end point protection that gives instant visibility across the organization. It unifies various solutions for next generation anti-virus, end point detection and response and a 24x7 managed hunting service.

AI can be used in development of malware by the hackers, some of whom may be state sponsored or criminal cyber-gangs. If the miscreants develop mutating malware that changes the structure to avoid detection, then that could cause even greater damage to the internet businesses.

CrowdStrike runs Falcon platform, which uses sophisticated signature-less AI and Indicator of Attack (IOA) based threat prevention to stop all kinds of threat to provide protection to customers against advanced cyber-attacks. CrowdStrike threat

8 https://www.crowdstrike.com/about-us/

graph analyzes more than 50 billion events per day from millions of sensors deployed across the globe in over 160 countries. It detects signs of an impending attack and kills that threat before it strikes. It has been able to detect some high-profile data leaks like the Russian interference in the US elections in 2016 and North Korea's hacking of Sony Pictures in 2014. It is capable of providing security solutions around cloud based offerings, now a popular platform for providing AI services.

5. Darktrace (Cyber Security), UK

Darktrace[9] applies AI and machine learning and delivers AI-powered autonomous response across email, cloud, and network traffic, taking action to contain in-progress threats within seconds. By enforcing the normal 'pattern of life' for a given user or device, the system works by interrupting malicious activity only and giving the security team time to catch up.

It detects real time threat and makes an automatic response to prevent any cyber-attack. It works on the self-learning human immune system, creating a unique cyber defense network for the enterprise. Just as human immune system continually adapts to new forms of threats, such as viral DNA, which constantly mutates, Darktrace also works on the same principle and learns a unique 'pattern of life' ('self') for every device and user on a network and correlates such insights to spot threats that would otherwise go unnoticed. Its cyber defense mechanism does not require any previous experience of a threat or pattern of activity in order to understand that it could be potentially threatening. It works without prior knowledge or signatures, detecting and fighting back against subtle, stealthy attacks inside the network, in real time.

With over 7,000 deployments across 105 countries worldwide, Darktrace's cyber AI is being harnessed to transform even the most complex and vulnerable organization into a resilient,

9 https://www.darktrace.com/en/technology/

self-defending digital business, neutralizing advanced attacks before they escalate into a crisis.

Its AI platform uses unsupervised machine learning to analyze network data at scale, and makes billions of probability-based calculations based on the evidence that it encounters. Without relying on past threats, it independently analyses data and detects patterns.

Darktrace's world-leading cyber AI is the best proven, most scalable and most accurate artificial intelligence platform used today in the enterprise. It counts CIA, MI5, NSA and GCHQ among its clients.

6. Flatiron Health (Cancer Research), USA

Founded in 2012 by Nat Turner and Zach Weinberg, this AI start up is working in oncology, an area of cancer research, where it connects large number of partners from the academia, health clinics, hospitals and patients to find a solution to one of the most vexed problems of mankind. It has data base of millions of cancer patients, which can accelerate research for better decision making on new medicines and interventions for cancer cure[10]. OncoCloud is being used for services in community oncology. Research institutions have access to data they can work with for better patient care. Earlier it had acquired Altos Solutions, an electronic health record (EHR) company which expanded its reach to large number of oncologists, using Altos's cloud based platform.

Flatiron Health has now been acquired by *Roche* for $2.1 billion.

7. GrayOrange (Robotics), Singapore/India

Founded in 2011 by Samay Kohli and Akash Gupta, GrayOrange is a startup working in design, manufacturing and deployment of advanced intelligent robotics systems for supply chain

10 www.flatiron.com;

automation in warehousing serving up orders in e-commerce etc[11]. Conventional warehouses are still running with pallets and racks, which offers a huge opportunity for automation.

GrayOrange has Butler, an autonomous mobile robot (in two models, M and XL) which is deployed by companies operating in e-commerce, logistics, FMCG, consumer electronics and fashion industry. Butler can be used for inventory storage, replenishment, and order-picking at the fulfillment centers. It works on multi-deep storage technology for smart space allocation for increasing space density. A Japanese home furnishing chain with more than 400 distribution centers is using Butler, which expedites the process of order fulfillment by queuing up items for picking. With the use of AI, Butler arranges the racks with popular items nearer to the picking area, increasing efficiency. Butler automatically does ABC analysis in real time for placement of racks, according to seasonal demand of various items.

The other robot, PickPal does order processing, consolidation and preparing orders in warehouses. High speed LinearSorters are being deployed by e-commerce and third party logistics companies to sort out large volume of parcels. LinearSorter was recently installed at an international fashion company providing fashion clothing and accessories for women, teenagers and children across India. Sorter will also handle segregation of return inventory. It deploys advanced software and has a flexible platform that can be customized for individual requirements. Their solutions are flexible, scalable, convenient and highly efficient. Robots can be moved around and deployed on any floor in any manner.

Robots offer several advantages in logistics, warehouse management and order-fulfillment as they reduce complexity and increase efficiency and productivity of operations leading to reduced cost. Businesses become more agile focusing their

11 https://www.greyorange.com/

attention on growth.

GrayOrange received a funding of $140 million from Silicon Valley investor Peter Thiel's Mithril Capital. It is the single largest round of investment raised by an industrial automation firm. It had raised $35 million in the previous round. Headquartered at Singapore, it operates in the US, Germany, Hong Kong, Japan and UAE besides its operations in India. It has a R&D center at Gurgaon (India) and recently opened another one at Boston in the US. It counts several branded customers, important among them being DTDC, Ekart, Flipkart, Jabong, Ninja Van, Myntra, Mahindra and Kerry Logistics.

8. InsideSales.com (Sales Acceleration), USA

Founded in 2004, InsideSales.com is using a powerful AI engine, Neuralytics, which feeds on trillions of data points on B2B transactions for sales acceleration. It uses AI tools that unlock the potential of sales team by focusing on more prospective customers, who are likely to convert into a sales opportunity[12]. The company has several products like Predictive Playbooks, PowerDialer, Pipeline and Predictive cloud which help target the right leads, contacts and accounts and make better sales decisions to prioritize and manage leads for personalized sales engagement with the clients. Its AI platform uses customer's data and then combines that with the collective intelligence of billions of sales interactions to guide in closing more orders.

Its AI powered sales acceleration provides deeper insights with predictive analytics at every stage to the sales representatives to enhance their productivity and efficiency. It captures information on clients more precisely to engage with them in the most efficient and effective way at the right time with the right medium. Its CRM tools automatically capture all sales activities and records updates with a hassle-free operation. Ultimately businesses can make better forecast and close more

12 https://uk.insidesales.com/

deals with greater consistency that generates more revenues with higher employee satisfaction.

It has received an investment of $264 million including some from Microsoft, which is in partnership to provide predictive analytics to its Dynamics CRM customers.

9. Mobileye, (ADAS) Israel

An Israeli technology company has developed vision-based advanced driver assistance systems (ADAS) which provides warnings for collision prevention and mitigation. Its revolutionary autonomous driving technology has completely changed the way people drive their cars and now it controls nearly 90% of market. World's leading manufacturers rely on Mobileye technology for making their vehicles safer to drive. Mobileye is based on the concept of reinforcement learning, whereby machines learn on their own by repeated exposure to videos. Thus the machine develops the capability to solve problems which it has not encountered before.

In August 2014, Mobileye caught the attention of the markets in one of the largest Israeli IPO ever. In August 2017, Intel acquired Mobileye for a valuation of $15.38 billion, the biggest ever acquisition of an Israeli high-tech company.

10. ORCAM (Computer Vision), Israel

Founded in 2010 by Prof. Amnon Shashua and Mr. Ziv Aviram, OrCam has a mission to harness the power of AI for the visually impaired and to help those having reading difficulties. Its wearable platform improves the lives of those needy individuals and gives them freedom and independence. It has created AI-equipped technology and computer vision algorithms that lets visually-impaired hear printed text and differentiate between products. OrCam MyEye device was initially launched in 2015 and the next generation MyEye 2.0 was launched in 2017. This tiny wearable device costing $3500 has a camera, a speaker and a cable, which are all connected to a smartphone-like bigger

device. The device can be clipped to the eye glasses and can read text, identify faces and products[13]. If the database has the face of an identifiable person, it can tell their name also. The device can also translate the document in another language.

11. SenseTime, (Identification), China

Founded by Bing Xu and Xiaogang Wang in 2014, SenseTime is one of the most valued startups (at $4.5 billion) that is innovatively using the power of AI, deep learning and computer vision for facial identification, intelligent video analytics, besides object, image and text recognition, medical image analysis, video analysis, autonomous driving and remote sensing etc[14]. It claims an error rate of 1 in 100,000 in reading faces[15] and it has licensed its facial recognition technology to others for use in making payments, security verification for reading bank cards, etc. It is also using the power of mobile internet and providing a host of other services like online entertainment. It has entered into several lines of businesses such as finance, retail, smart city project, education, real estate etc.

Having won several awards for innovative use of AI and published large number of scientific papers, its mission is to lead AI innovation to power the future and it believes that computer vision and deep learning is going to establish a new relationship between human beings and the world at large. With more than 300 clients, it has established partnerships with several leading players like Nvidia, Qualcomm, Alibaba, iFLYTEK, Honda, Wanda, Huawei, OPPO, Weibo and set up a research laboratory at MIT in the US. It has also developed robust technological infrastructure with a deep learning platform and supercomputing centers.

Other than offices in Chinese cities of Beijing and Shanghai,

13 https://www.orcam.com/en/

14 https://www.sensetime.com;

15 SenseTime, https://www.crunchbase.com/organization/sensetime

it has opened centers at Tokyo and Singapore. The following achievements of SenseTime are quite noteworthy and deserve special highlight:

- Partnership with Honda for developing autonomous driving technology and R&D for smart AI cars to co-create L4 autonomous driving solution suitable for passenger cars
- Partnership with OPPO and Vivo for using facial identification technology for mobile internet
- Partnership agreement with Shanghai Municipal government to establish a R&D center, smart car project, smart chip project, and smart education project for promoting AI solutions
- Investment from Qualcomm for use of AI algorithms with chips
- Partnership with Huawei in project SenseAtlas, to develop an intelligent city project and applying facial recognition technology
- Partnership with Huawei to develop a cloud based whole network video cloud solutions with the idea of promoting development of city visual systems
- Partnership with Tianhai Investment for advancement of AI in aviation, education, tourism, finance, logistics, retail, real estate, and healthcare

This startup has made waves in its own domain and has been ranked only next to Google in many of the sub-sets of AI. With a deep vision, it is going to become another leader in AI space.

Another startup Megvii is also working in the area of facial recognition technology, where Alibaba is a major investor. Megvii's technology will be used in running human-less stores.

12. UBTECH (Robotics), China

Founded in 2012 by Zhao Jian, Shenzhen based Ubtech Robotics is a global AI and humanoid robot company, whose aim is to

bring robots in every home and create an intelligent way of life with intelligent robots, becoming as good as a family member. Company's Alpha 1S model of robot holds a Guinness World Record for 'most robots dancing simultaneously'[16]. It has designed several types of robots for a variety of applications. UBTECH robodog *Jimu* comes in a kit form where one can either make any predesigned type of robot like Grabberbot or Digbot, Astrobot, Rover or Astron or can make any other type based on a set of instructions on the app. Children can make BuzzBot or MuttBot, two different types of robots.

Then there is *Cruzr*, an intelligent, customized, cloud based humanoid service robot for various home or commercial applications. It has flexible arms with a very high face detection ratio of 98%. It runs in an open source that allows third party resources for emotion detection and identification of features such as gender, age, ethnicity recognition etc. It can do many things and can engage even in video conferencing. *Cruzr* can be customized based on one's own requirements.

Lynx, a voice-activated and video-enabled companion is a smart and highly advanced home robot that can be integrated with Amazon's Alexa and check weather conditions, traffic conditions etc. Sensors fitted on the robot lets sense a human touch and can detect changes in light and motion.

Stormtrooper, a Star Wars First Order, which sells on Amazon for $300 is a robot that works with augmented reality and takes orders through voice command and has patrolling-capability to keep an area safe from intruders. Like a Lego pack, it also sells a kit, BuilderBots Kits to the children to build robots.

Tenecnt is one of the major investors in the company. It is putting in heavy investment in R&D, plans for a cloud service, a robot operating system (ROSA) and upgrade in robots for home and

16 Peng Tony, UBTECH Robotics Gets US$820 Million Funding; Becomes the World's Most Valuable AI Startup, May 3, 2018 (https://medium.com/syncedreview/ubtech-robotics-gets-us-820-million-funding-becomes-the-worlds-most-valuable-ai-startup-c25cd357e87e)

commercial applications. Future plans include implementing a service robot, *Home AI*, low-cost service humanoid robot by 2020 and integrating hardware, software and cloud services to launch a full-fledged solution for the service robot industry.

13. Zoox (Autonomous Vehicle technology), USA

Founded in 2014 by Jesse Levinson and Tim Kentley-clay, Zoox is discovering the potential of AI with advanced mobility for high-quality urban living experience[17]. It wants to run its own fleet of self-driving cars. They are designing bi-directional electric self-driving cars from the ground up, rather than retrofitting existing cars with software and sensors. There is a piece of software that makes it possible to configure the sensors while driving, using objects in the real world to provide feedback. The level of accuracy is pretty high to 2 millimeters and 1/100th of a degree. The design of the vehicle is identical in the front and rear, with each tyre having its own motor to allow rotary movement in narrow spaces. Its cameras and sensors are seamlessly integrated. LEDs in the front and rear send signals to other vehicles that it encountered an obstacle, its directional sound system would alert a pedestrian. Computer vision technology provides complete information about people and objects in the surroundings. Cars will have luxurious interiors.

Prototypes of VH1 and VH2 to VH6 are already being worked upon for testing.

The company is valued at $3.4 billion. The other big players in this segment are: Cruise Automation, Wymo, Uber and Lyft.

17 Vance Ashlee, $800 Million Says a Self-Driving Car Looks Like This, July, 2018 (https://www.bloomberg.com/news/features/2018-07-17/robot-taxi-startup-zoox-has-800-million-and-a-wild-pitch)

14. Zymergen (Biotech), USA

Founded in 2013, biotech startup Zymergen[18], is using AI, robotics and machine learning to augment the role of humans in scientific experiments for discovery of synthetic molecules. It is working with several of Fortune 500 companies to deliver genetically engineered new microbes. It also has orders from DARPA to make synthetic organisms. The global market for microbes is nearing $300 billion, with healthcare as the largest consumer (60%), followed by energy (25%) and manufacturing (15%). So, any disruption to the conventional ways could produce big results.

Fermentation of sugars into alcohol with the help of yeast laid the foundation of biotechnology industry. Strains of microbes have been used in the past to turn grape juice and wood pulp into useful chemicals through the process of industrial fermentation. This process has also been used to invent beer, cheese and chocolates. Today, Protein Engineering, a branch of biotechnology that falls under synthetic biology is trying to make wide range of products by designing unique molecules. Industrial microbes can be tuned up that could produce ingredients for biofuels, plastics or drugs. AI, machine learning and robotics is now being used to design billions of cells to discover the right molecule. Robots tinker with microbe's genome to engineer a version that makes its products more efficiently.

Zymergen uses gene editing technology to change the way micro-organisms behave. Automation at Zymergen is used at every stage from robots pipetting to computer controlled process of fluid flows and flasks heated and cooled with machines.

There are of course some limits to such experimentation, as

18 Bringing Zymergen to Scale: Enabling Engineering Biology with AI & Robotics, October 11, 2016 (https://medium.com/@dcvc/bringing-zymergen-to-scale-enabling-engineering-biology-with-ai-robotics-d998a2b0cc1)

microbes that are sent to the labs are already engineered a lot and finding somewhat better microbes is not easy. There are also limits on AI to interpret data and doing design experiments. Machine learning is not up to the mark in RNA design problems compared to what scientists can achieve on their own.

Conclusion

Startups discussed in this chapter are some of the world's leading young companies, which have demonstrated their success with artificial intelligence and other associated technologies in their industrial segment. They have applied new models and new ways of doing things, generally superior in performance, which bring a host of benefits to the customers. They have not only improved upon the existing, but have also created entirely new industries with new industrial structures that will go a long way in solving problems of human beings and establish trust and faith in the new technologies.

CHAPTER 7

AI Startups in Finance

Introduction

Financial sector has been in the forefront of the computing revolution, when everything moved from paper to bits and bytes over the last three decades. Banking and non-banking financial institutions continue to implement large scale technological solutions, where 'going digital' and delivery of everything through mobile and apps have become the key strategy. Even the government regulators are going digital to supervise and monitor the performance of this sector.

Fintech, other than the high tech, telecom, and automotive sectors, is now one of the high-end adopters of the new technology of AI, machine learning, deep learning, neural networks and other technologies like natural language processing and block chain. AI can process big financial data and delivers a number of benefits such as better management of loans and bad debts portfolio, personalized services to the customers and managing their wealth. AI also provides tools for the regulators to improve upon their supervisory control over the individual players.

Based upon a feedback from IT decision makers, Cyber Media Research with Nasscom in India has prepared a report on the need for AI based solutions for banking and Financial Services (BFSI) sector[1]. The report predicts a strong need for AI in four

1 74% OF TOP INDIAN IT DECISION MAKERS SEE STRONG ROLE FOR AI IN BFSI: NASSCOM-CMR REPORT PUBLISHED ON JULY, 2016 (http://cmrindia.com/74-of-top-indian-it-decision-makers-see-strong-role-for-ai-in-bfsi-nasscom-cmr-report/)

major business areas: personal customer support, automation of back-end business operations, tracking consumer behavior for offering customized products, and finally monitoring processes and data for regulatory compliance, risk management and anti-money laundering.

Here in this chapter, specific applications of AI involving banking and non-banking businesses are discussed. Whereas the leading banking organizations like Goldman Sachs, BNP Paribas, American Express and Deutsche Bank have invested huge resources and are betting big on AI, a huge swathe of startups have also taken up the lead in disrupting the whole eco system of fintech by dis-aggregating the financial services industry and providing niche services that add value to the conventional service delivery platforms.

Startups have divided the fintech industry in several verticals and some of the new categories of business are: Disbursal of loans (commercial and personal), credit scoring, fraud detection, market research, sentiment analysis, debt collection, trading in shares and other financial instruments, predictive analysis, investment, regulatory compliance, AI assistants, bots and financial reporting etc.

New Technology Trends in AI for Fintech

The technology trends driving change in the AI-enabled fintech industry are:

(i) **Open data** - legally compliant and authorized datasets of the customers would ensure that better apps, models and services are developed for the customers

(ii) **Open source platforms** - high end computational tasks can be performed by start-ups wanting to develop AI-based solutions. For example, Google's Tensorflow, an open source AI program is used for developing various types of AI solutions

(iii) **Collaboration** - between banks and start-ups with AI based solutions to improve their performance

(iv) **Integration of workflow**- AI-based solutions for data analytics, research and faster and better communication can be integrated with the users to achieve higher efficiency of operations

(v) **Data security for securing customers' data** - data within the organizations can be secured from hackers and fraudsters. AI and block chain together provide better security solutions. Start-ups have developed AI solutions for fraud detection at the early stage or any time before completion of the suspicious transaction

(vi) **Marketing of products –** in the conventional system, converting the lead into actual sales is low. AI tools quicken that process of enquiries into higher sales through rapid response

(vii) **Decision-making process** - AI driven solutions ensure that decision-making process becomes faster and better to save on time and resources

(viii) **Redressal of customers' grievances –** AI and analytics help banks to aggregate complaints from various channels like Facebook, Twitter, emails, SMS etc and classify them properly for redressal.

(ix) **Chat bots** - AI-based personal assistant bots are simplifying the banking services to customers and save on time and enhance operational efficiency.

Key Fintech verticals and Startups

As stated above, AI based solutions have been developed by startups in different areas like asset management, loans, debt collection, predictive analysis, etc. Scope of their activities and startups working in fourteen verticals are highlighted below.

Table 7.1: Key Areas of Fintech and AI Startups

Sr No	Finance Vertical	AI Solution	Startups
1	Asset Management	Management of various types of assets and wealth	Alpaca, Alpine Data Labs, Domeyard, ForwardLane, Fount, SigOpt, Pit.ai
2	Loans	Faster loan approval by automating financial decisions using machine learning in the assessment of credit worthiness for sanction of a loan	Affirm, Argon Credit,Avant Creamfinance, MoneyLion Penny App
3	Trading	Developing new trading strategies	Aidiya, Alpaca, Clone Algo, Eye Capital
4	Debt Collection	Improving debt collection through personalized planning and communication	CollectAI, TrueAccord
5	Predictive	Making predictions by using machine learning	H2O.ai, Kensho Technologies, Analysis Skytree, SmartZip Analytics, Trifacta
6	Risk Management	Risk management of capital and other portfolio	Eye Capital, Upstart, Zest Finance
7	Fraud Detection	Fraud detection in advance by use of machine learning in developing a model to stop fraudsters in completing a transaction to bring down	DataRobot, Fraugster, FeedZai, Sift Science,

		fraud rate on prepaid cards	
8	Investment	Investment in bonds and other instruments by way of crunching market data	Numerai, Sentient Technologies
9	Sentiment Score	Sifting through large number of analysts' reports on companies to award an aggregate sentimate score	Alphasense, Dataminr, FeedStock, iSentium, Orbital Insight, Signal Media
10	Regulatory compliances	Compliances including regulatory compliances	ComplyAdvantage, Digital Reasoning Systems, Trifacta
11	Credit scoring	Automated credit scoring and underwriting for taking credit decisions	Affirm, Aire, Avant, CreditVidya, Float, Habito, James, Naborly, Upstart, WeCash, ZestFinance
12	Insurance	Selling insurance policies and in managing claims of machine learning	Lemonade, Cape Analytics, Cyence, Captricity, Risk Genius, Shift Technology, Understory, Zendrive
13	Chatbots	Chatbots improve customer experience and bring down cost	Active.ai, Braina AI assistant, Digit, Kasisto, Morph.ai, Niki.ai
14	Market Research	Market research for promotion of business, customer feedback etc.	AlphaSense

Returns on Investments in AI

AI-based solution through adoption of the new technology is likely to give good returns. Expected ROI varies from region

to region, but globally the average is 20%. Asia has the highest returns with an average return of 25% with India in the lead where expected return is the highest @29%.

AI-based Startups in Fintech

Globally, there are a large number of AI startups in various verticals of the fintech industry. Some details of the startups, which have developed specific solutions in fintech, are:

1. Active.ai (Conversational banking), Singapore

Active.ai[2], a Fintech AI startup delivers context driven conversational banking services and brings automation and insightful customer engagement to the banking and financial services institutions (BFSI). Through predictive capability, it handles customers' queries and helps customers have natural dialogue over mobile, messaging, voice chat or IoT devices. Its Morfeus conversational middleware integrates with the APIs of the banks or the financial systems. It deploys Triniti Enterprise Solution, a conversational AI engine for retail banking in loans, deposits, payments etc. Its Omni Connector platform uses AI and NLP to provide services across various distribution channels.

It specializes in several languages including English, Spanish, Thai, Malay, Mandarin and Bahasa to interact with the customers. It has offices in Singapore, India, USA, and Australia. It counts among others Axis Bank, CIMBBANK and HDFC Securities as its clients.

At the 2018 The TechXR8 Asia Awards function, Active.ai was recognized as the best AI startup and also for being a deep learning innovator.

2 https://active.ai/

2. Feedzai (Payments), USA

Founded by data scientists and aerospace engineers, Feedzai has built the next generation platform for fraud management and runs 'Any Data, Any Payment' module for security of payments in commercial transactions, whether through mobile, or on-line payment or in person. It provides an end to end intelligent solution using machine learning to detect unusual patterns of transactions in real time to assess risk factors to prevent fraud[3]. It understands behavior patterns and takes a 360 degree view of the customer from every data source and diagnoses new patterns of frauds by gaining insights with intuitive reports. Retail banks, acquirers and merchants can use its solution that effectively manages payments and stops fraud. It can also be used for Anti-money laundering operations by BFSI.

It launched a new product, Auto Machine Learning (AutoML) which uses an advanced type of semantic based automatic feature engineering and machine learning, which is 50 times faster in fighting fraud.

3. Intelligent Voice (Speech transcription tools), UK

Intelligent Voice[4] provides speech transcription tools to the large banks to monitor trader's phone calls in real time (or post-call) for signs of any wrongdoing, such as insider trading. It captures key words and phrases from live telephone calls or e-mails or IM and converts them into text at superfast speed to analyze and to decipher any anomalous behavior. It has a cloud based solution also.

It has offices in London, New York and San Francisco.

4. Kabbage (Rating people to lend money), USA

Kabbage, a small business on-line lender combines machine

3 https://feedzai.com/

4 https://www.intelligentvoice.com/

learning algorithms, data from public profiles on the Internet and other factors to rate people and then loan them money for their small businesses. When an organization signs with Kabbage, it also permits usage of third party data, say from PayPal or Facebook[5]. It can recognize the need for a loan and makes an approval at a super-fast speed, generally in ten minutes, thus promoting small borrowers.

The company says it has served over 100,000 small businesses through its platform, extending more than $3 billion loan in the US and has been on the list of America's fastest growing 500-companies for the last three years. It acquired Orchard Platform Markets, a New York based startup, a provider of lending data and services.

5. Kinetica (Risk Exposure), USA

Kinetica[6] uses GPU database, real time location visualization and AI to provide an insight for the extreme data economy, as it likes to call. The idea arose from the need for US military to track national security threats in real time. It takes data from unpredictable sources and delivers super-fast insights. It deploys GPUs for parallel computing by replacing costly data warehouses. Geospatial visualization and streaming data analysis are the other advantages. An AI database, a subset of general database can explore and analyze fast moving data within milliseconds and provide businesses to take appropriate decisions. It provides solutions to finance, telecom, retail, healthcare and logistics etc.

6. Kreditech (Loan Disbursal), Germany

Founded in 2012 and being one of the largest AI startups,

5 AI Doesn't Impress Kabbage COO Kathryn Petralia. Here's The Tech Trend That Does. June 21, 2018 (.https://www.cbinsights.com/research/kabbage-kathryn-petralia-future-fintech/)

6 https://www.kinetica.com/

German online lender, Kreditech has built a suite of credit and banking products for consumers with little or no credit history. It analyzes big data with more than 20,000 data points collected from various sources like on-line behavior, social networking sites and GPS etc. to rate the credit score of the individual customer in just one minute. Applicant is required to share his browsing history to gain access to online shopping habits. Kreditech then maps applicant's behavior through algorithm to determine if the applicant qualifies for a loan. Kreditech has big objectives to provide access to those who find it otherwise difficult to get a loan, and provide a tailored product for the customer, who has the financial freedom to choose an option that suits them best.

It operates in several countries such as Poland, Russia, Spain, India and Czech Republic[7].

7. Lemonade (Insurance), USA

Lemonade[8], a certified B-Corp, rated A-Exceptional Corporation is in the business of insurance for home stuff and it bypasses the traditional brokers and uses machine learning both in selling insurance policies and in managing claims. It charges a flat fee and operates on an app with an AI chatbot, Maya, to work out the best plan for the customer and process the claim instantly. It has catchy slogans like 'Zero deductibles, zero rate hikes and zero worries'.

8. Monzo (Banking), UK

Monzo[9] wants to build a bank with everyone for everyone. It works on an app that has a card which can be used for spending,

7 Cheung K C 'The World's 10 Largest Artificial Intelligence Startups' June 7, 2018 (https://algorithmxlab.com/blog/2018/06/07/the-worlds-10-largest-artificial-intelligence-startups/)

8 https://www.lemonade.com/

9 https://monzo.com/

transfer of money and many other uses. Customers have the choice of changing their bank. A customer can set limits on spending, for example on groceries and can see an overview of his account.

Using machine learning, it has also developed a model to deal with data theft and stop fraudsters in completing a transaction to bring down fraud rate on the pre-paid cards (fraud rate reduced from 0.85% in June 2016 to 0.1% in Jan 2017).

9. Ping-An (Sentiment Analysis), China

With a market cap of $164.34 billion[10], Ping An Insurance is one of the largest insurance companies grossing revenues of over $90 billion. It has been a great adopter of technology moving from mobile apps to AI and blockchain in finance, insurance and asset management. For example, in assessment of damage to a car in an accident, the customer can use the app and take photos and send. Then it is used with millions of other photos in the database to assess the damage.

Ping An[11] Technology is a wholly-owned company of Ping An that invests in technology startups. It invested in Lufax, peer-to-peer lender. OneConnect, a business app connects over 2400 banks and non-financial institutions for lending. It processes the loan application through unique voice print technology and micro-expressions. The latter records tiniest movements of eye muscles and area around the lips within milliseconds. These are used in loan interviews through a mobile app for credit assessment. Online application for loan through an App is assessed through a Q&A on income and repayment plan through video by monitoring 50 facial expressions to gauge the level of honesty and determine scrutiny.

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10 https://ycharts.com/companies/PIAIF/market_cap (as on 12th October, 2018)

11 Huang Eustance, AI is absolutely critical for us,' Ping An Technology CEO, April 13, 2018 (https://www.cnbc.com/2018/04/13/ai-is-absolutely-critical-for-us-ping-an-technology-ceo.html)

It wants to expand in several other areas like medical diagnostics using computer vision.

10. Shift Technology (Insurance), France

Shift Technology[12] is reinventing insurance claims industry. As insurance claims processing is being automated with AI enabled settlement claims, there is a corresponding increase in fraud. Shift offers Force, an AI product that automates the processing of insurance claims and detects abnormal behavior indicative of fraud. It provides advanced detection methods through AI which is unique to a client environment.

11. Sift Science (Fraud Detection), USA

Sift Science Digital Trust Platform provides AI and machine learning based solution for fraud prevention and risk management for online businesses through insights from global network of data[13]. Clients' sites are monitored in real-time to detect any abnormal behavior patterns. It alerts the customers or merchants before any fraudulent orders are booked. It also provides a solution for payment fraud, account abuse, content abuse and promo abuse.

Global fraud in eCommerce has been increasing every year. As per 2017 Global Fraud Index, $57.9 billion were lost in such frauds across eight industries.

12. Upstart (Lending), USA

Upstart[14] is an AI based lending platform that does pricing for credit and automates the borrowing process. Application for loan is made through mobile and customers can see what they qualify for, to take a loan. Its underwriting engine assesses the

12 https://www.shift-technology.com/

13 https://siftscience.com/

14 https://www.upstart.com/

risk of the borrower through machine learning. Verification about applicants' credentials including their identity and income etc. is also done automatically. Customers have the option to specify the loan amount, term and rate of interest. Then Upstart will arrange a loan from a bank. It offers its service through SaaS model to banks, credit unions and others and its platform can be customized as per users' requirements.

13. Zest Finance (Credit Analysis and Loans), USA

Zest Finance[15] is using Zest Automated Machine Learning (ZAML) platform for an automated credit scoring and running an underwriting tool for taking credit decisions. It wants to re-invent the underwriting industry that had evolved in 1950s when William Fair and Earl Issac used logistic regression. It uses now a Google-like math and tons of data to transform the industry for taking a decision in seconds so that people without credit history and who otherwise deserve credit are not turned away. It provides an end-to-end underwriting solution that uses thousands of data points (most use just fifty or so) with speed and accuracy to perform. ZAML provides a solution that cuts losses for the insurers.

It is partnering with both Baidu and JD.com in China, who have invested in Zest Finance. Its ability to process complex data for credit decisions is handy for both the companies as not much of data is otherwise available in China for credit history or credit score.

Detailed study of a few AI Startups in Finance

A detailed study of the few of the start-ups, discussed below could be useful in developing an in-depth understanding of how AI startups are working in the fintech sector.

15 https://www.zestfinance.com/zaml

14. Cape Analytics (Insurance), USA

Cape Analytics[16] is engaged in providing insurance by using machine learning, computer vision and data sciences without inspecting individual houses for insurance purposes. It is working with national reinsurer XL Catlin and the Florida-based Security First Insurance for providing information about ROOFTOPS of the houses customers buy. It gets data from a number of sources, including drone data and satellite imagery from companies like DigitalGlobe and through aerial imagery taken from airplanes. It has a partnership with Google to utilize the images that it takes with its Earth observations. The company then feeds those images into its machine learning algorithms to develop information about particular homes. To process all that information and develop its algorithms, company employs a team of people to handle computer vision, machine learning and data science in order to get the data that insurance companies are looking for. This entails training its algorithms to identify things like the condition and type of roof a home has, what the building footprint is, and whether the home has a new addition, pool, solar panels, or other new construction.

15. China Construction Bank (Banking Services), China

This bank is a futuristic model of bank running with Robots[17] and not tellers. It is the first unmanned bank, which is fully automated. It is using AI in an innovative manner to go almost human-less in its operations. As soon as the customer enters the bank, it can access the banking services in a virtual reality room through facial recognition technology to recognize the customer. It has talking robots and touchscreen facility for conducting banking transactions like account opening, money

16 https://capeanalytics.com/

17 https://www.bankingtech.com/2018/04/china-construction-bank-opens-robot-run-branch/

transfers and selling foreign exchange.

Only one manager is sitting in the corner to take care of any customer requirements and to interact with the customer physically.

16. Eye Capital (Security Trading), Argentina

Eye Capital[18], specializes in trading of securities, which otherwise involves huge risks. It employs tools with the application of natural language processing (NLP) and the firm's algorithms read and interpret financial news in real time. Financial trading requires very accurate and very cautious people and systems. Risk in trading, particularly in automated trading can be reduced by using risk parameters with trained AI algorithm models, which ultimately has the potential to generate portfolios with big returns and minimal risk.

The code of one of Eye Capital's algorithms focuses on designing the step by step process of how to approach the mass of text that the algorithms deals with and may have 3000 lines, but the logic that applies to the buying or selling of an instrument is coded between 100 and 150 lines, and the rest of the coding lines are used to control and reduce risk. Algorithms are also tested in rigorous simulation environments in real-time sync with the markets, which helps to detect any type of failure. They have produced three tools – two financial sentiment lexicons, one in Spanish and one in English, and the Financial Market Drivers Lexicon.

17. Kasisto (Conversational AI Platform), USA

Kasisto[19] enables companies to acquire, engage, support, and transact with their customers via human-like, intelligent conversations, anytime, anywhere. Its conversational AI

18 https://thestack.com/big-data/2018/05/23/meet-the-startup-that-could-put-an-end-to-human-traders/

19 https://kasisto.com/

platform, KAI, powers omni-channel bots and virtual assistants with deep domain expertise across mobile apps, web, messaging platforms, wearables, and IoT devices. With contextual and personalized conversations, they fulfill requests, solve problems, and predict needs and help companies support and market their products and services. Built with the deepest AI portfolio in the industry, KAI is an agile platform with self-service tools to customize and continually improve consumer experiences and seamlessly add new features. Customers include DBS Bank, Master card, Standard Chartered, TD Bank, and Wells Fargo, among others and KAI enables them to:

- Offer entirely new and differentiated experiences to their consumers, designed with the most intuitive user interface: natural human language
- Reduce customer care costs by deflecting call center calls and triaging inquiries
- Increase lifetime value of customers with contextual and relevant offers for financial products and services
- Engage customers and promote brand loyalty with proactive financial well-being features
- Meet customers in their preferred channel – mobile, web, messaging or home devices

18. Kensho Technologies (Analytics), USA

Kensho Technologies[20] (since acquired by S&P global) is a developer of analytics software, machine learning, and artificial intelligence (AI) solutions, and data visualization systems for banks and investment institutions. Its intuitive platforms, sophisticated algorithms, and machine learning capabilities have established a wide following throughout the Wall Street and the technology world. Its goal is to deploy scalable machine learning and analytics systems across public and commercial

20 https://www.kensho.com/

institutions in the world to solve some of the hardest analytical problems. S&P says the acquisition will enhance its ability to deliver essential, actionable insights that will transform the user experience for its clients, and accelerate efforts to improve efficiency and effectiveness of its core internal operations.

Fortune has named Kensho as one of the five hottest companies in fintech, while it also appears in the list of AI 100.

19. TrueAccord (Loan Recovery), USA

TrueAccord[21] is focused on strategic growth initiatives, ongoing product development and innovation of its customer-focused platform, providing audit and compliance functionality, continued expansion into vertical markets, client acquisition, retention and hiring.

It is using machine learning to streamline debt collection, making it more manageable for the people in debt and increasing recovery rates for the financial institutions. Its platform is a decision engine that analyzes consumer behavior and determines when and how they should be contacted about their debt, as well as the best payment options to offer. The company communicates via email, text messaging update on mobile and use of social media. Using algorithms the company also optimizes number of times it reaches out to a customer. A customer in financial distress gets a personalized payment plan, can negotiate a reduction in their debt burden or report bankruptcy, making it customer-focused. They are using a unique digital approach to redefining the debt collection industry receiving higher customer engagement and satisfaction. Recovery rates have also shot up.

There is a huge demand from the market with growth in its customer base by 2.5x with more than 1.8 million customers on its platform since inception. Personal debt in the US alone exceeds $4 trillion.

21 https://www.trueaccord.com/

20. Vymo (Improving Agent's performance for Debt Collection), India

Vymo[22] is engaged in developing an AI-based solution for loan recovery. It has developed an AI-enabled enterprise assistant which automatically detects activities of agents which are engaged in debt recovery. It suggests next best actions, optimized for best outcomes.

For one of the large banks, Vymo has been able to improve the 'time to win' by over 10x. Calls and meetings with agents are automatically detected through integration with the native phone dialer and geo location. So, managers can instead focus on how to optimize the agents' efforts. It reduces stress. With one of its recent customers, Vymo was able to demonstrate a 35 per cent increase in average meetings completed per day by agents. It learns from the behavior of most successful agents. Their activities are correlated to outcomes to understand 'good behavior' that is conveyed to all agents. For instance, day, time and location of successful collection activities are mapped against customer profile types to nudge the 'best time of day' for outreach. Also, agents are nudged to make unscheduled pick-ups in their location to identify the intent of customers whose payment commitment is doubtful.

With increased efficiency, banks do not have to resort to dubious tactics and risk their brand capital.

Overall, Vymo has improved the debt recovery rate by using agent's time more productively.

Benefits of AI in Financial sector

There are huge advantages of AI in fintech applications. It has

22 Kurian Vinson, Fintech start-ups turn to AI products for accelerated growth, June 12, 2018, The Hindu Business Line (https://www.thehindubusinessline.com/info-tech/fintech-start-ups-turn-to-ai-products-for-accelerated-growth/article24143073.ece)

created new opportunities for the entrepreneurs as well as the established players, like banks etc. There are now new tools that assist in faster loan approval, recovery of loans, fraud detection and prevention, trading of securities etc. as highlighted in the study of startups, earlier. New models in banking are emerging, where the cost of banking would be vastly reduced.

Regulatory limitations of AI based solutions

The fintech sector is heavily regulated as there are various government agencies like the central bank, security regulator and the competition commission who exercise direct or indirect control over the industry. So, any innovative solution must be developed keeping in mind the regulatory requirements and compliances and disclosures to be made. Further, the sector as a whole deals with sensitive data of customers, which has to be protected at all cost. Cloud-based solutions therefore may pose their own problems. After GDPR came into effect in May, 2018, the requirements are growing tougher and hence the need for the organizations to safeguard their operations. Organizations also have financial constraints, since budgets are limited and changeover to a new technological solution is a time taking exercise, so decision makers are cautious.

Conclusion

AI startups are invigorating the markets with innovative solutions in various segments adding value to the industry. Some have tied up with big players to deliver high-tech services. The fintech industry is technologically moving up the value ladder fast and is set to change radically over the next decade.

CHAPTER 8

AI Startups in Healthcare

How AI is being applied in Healthcare

Artificial intelligence is disrupting the healthcare sector in numerous ways to provide better health care facilities. Big data and predictive analysis are transforming the old models.

AI has impacted all the stakeholders in the healthcare industry, namely the doctors, hospitals, insurance companies, and of course the patients. Usage of AI, for example in the US is very high, as 86% of hospitals, healthcare companies, technology vendors and the life-sciences companies are using Intelligence and AI. With applications across imaging and diagnostics, virtual assistants, remote monitoring, in-hospital care etc. the AI healthcare has seen a record number of new companies entering this segment. Sensing a big opportunity with AI technology, the big tech companies like Google and Apple are also entering healthcare.

AI is used across the board by several specialities. For example, AI, machine learning and computer vision is being used in early detection of cancer, incidence of which is rising globally. In India alone, the number of cases has doubled from 550,000 to 1.06 million between 1990 and 2016, i.e., within a gap of 26 years. Mortality rate among cancer patients in India is high because of lack of facilities for early detection. By the time, patients report, the disease is at an advanced stage. That problem can be solved with the use of AI for early detection and precious lives could be saved. In a study by Holger Haenssle of University of Heidelberg, it was found that the AI skin-cancer detection system beat the dermatologists in accuracy in detecting skin cancers by 95% to 86.6%. It also misdiagnosed fewer benign

moles.

In an accidental case, a patient may need brain surgery if there is a blood clot (because of which nearly 2 million cells die every minute). Viz.ai, an AI company uses machine learning to analyze scans of patient's brain taken at the time of admission to tell which patient would need urgent attention first against those who may still wait. By identifying urgent cases and alerting on-call specialists who see the scans taken, urgent cases could be taken up for surgery to save life.

In eye care, ophthalmologists use AI to read images. DeepMind has an AI that screens retinal scans for glaucoma, diabetic retinopathy and age-related macular degeneration. Deep learning is being used to verify disease diagnosis, improve surgical outcomes and improve the accuracy and reproducibility of ophthalmic diagnoses, personalized medicine and future prognosis. Deep learning models can read a Humphrey visual field and predict how quickly they will go blind or read an OCT and predict who will develop wet macular degeneration. US FDA has approved use of machine learning algorithms for the purpose of automated diabetic retinopathy grading[1].

AI is being used in cardiology function and in detecting disease of brain. A study was conducted at the Icahn School of Medicine at Mount Sinai[2] and published in the journal *Nature Medicine*. The study reports that AI can diagnose a stroke, hemorrhage and hydrocephalus through brain CT scan in just 1.2 seconds. More than 37,000 head CT scans were screened for data points

1 Healeo Occular Surgery News, June 10, 2018 (https://www.healio.com/ophthalmology/technology/news/print/ocular-surgery-news/%7B373d8cf8-f72b-43fe-b362-29ba35c416ba%7D/ai-applications-in-ophthalmology-achieve-human-expert-level-performance?utm_source=TrendMD&utm_medium=cpc&utm_campaign=Healio__TrendMD_1)

2 Artificial Intelligence Platform Screens for Acute Neurological Illnesses at Mount Sinai, Press Release, August 13, 2018 (https://www.mountsinai.org/about/newsroom/2018/artificial-intelligence-platform-screens-for-acute-neurological-illnesses-at-mount-sinai)

to train a deep neural network to identify whether an image contained critical or non-critical findings. The platform was then tested in a randomized controlled trial in a simulated clinical environment where it triaged head CT scans based on severity. A comparison was drawn for the time taken by the computer algorithm and the radiologist to notice a disease. Computer algorithm turned out to be over 150 times faster than for physician to read the image.

AI is being used to interpret echocardiograms, where certain changes can be detected which otherwise is missed by the doctors, 20% of the time. Ultromics, a London based firm is entering the market. In a study at Stanford University, Andrew Ng found that AI helps in better detection of arrhythmias, particularly arterial fibrillation which increases the risk of heart failure and strokes. A collaboration with ECG device makers is planned. Apple watches could also capture important health indicators like heart-rate data.

Deep neural network on smart watches are used to detect atrial fibrillation in patients. Data relating to heart beat and step count are collected through a mobile app (Cardiogram) and network has been trained on heart rate measurement.

AI in drug discovery could provide a better return to pharma industry, which is struggling with low returns on investments in research. As per 2017 report by Deloitte[3], the 12 largest bio-pharma companies got a measly return of 3.2%, out of their drug research wings, whereas that figure was 10.10% in 2010. It now costs nearly $2 billion to bring a drug to the market. AI can help in analyzing large data sets from health records, clinical trials, genetic profiling and various other studies to bring down the cost and time. It can help researchers find patterns and trends faster. Some are already tying up with healthcare startups to

3 A new future for R&D? Measuring the return from pharmaceutical innovation 2017 (https://www2.deloitte.com/global/en/pages/life-sciences-and-healthcare/articles/measuring-return-from-pharmaceutical-innovation.html)

achieve their goals. Some are using Bayesian approach rather than a neural network.

AI is being used in many other ways like for better hospital management and for a better IVF treatment plan for women. Here are different areas of application of AI.

(i) Better Management of Hospital facilities

- Improving internal operations, reduced need for lab test, enhanced patient experience
- Using doctors' and nurses' time more effectively for patient care

(ii) Diagnostics and treatment plan

- Diagnostics for analyzing tests, X-Rays, CT scans etc. by cardiology and radiology departments
- Early diagnosis based on genomics-- body scans can be taken and then AI can diagnose cancer and vascular diseases early based on their genetics
- Personalized treatment plan for the customer say for IVF treatment
- Healthcare System Analysis-- in Netherlands, 97% of healthcare invoices are digital. AI can be used to sift through the data to highlight mistakes in treatments, workflow inefficiencies, and avoid unnecessary patient hospitalizations

(iii) Collection of patients' information

- Better patient registration system for life-cycle management of patient care
- Digital automation and data Management of Patients' records through electronic health record (HER) system
- Robots may be collecting data, re-formatting them for storing them for access

- Digital nursing facilities takes care of constant care of patients at home

(iv) Devices and Apps

- App based management where users can describe their complaints and based on users' history and record of database, personalized treatment plan is recommended and use of medication monitored to ensure patients take proper medicines. Critical patients can be monitored closely. Apps also provide general information and advice
- Health Monitoring through Wearables
- Use of Chatbots—routine complaints like sore throat could be addressed through proper training of chatbots, saving on expert's time and resources.

(v) Drug Discovery

- Fast tracking development and testing of new drugs
- Precision Medicine-- Genetics and genomics look for mutations and links to disease from the information in DNA
- Improving ability to understand diseases and predict diseases

(vi) New Age Solutions

- Research in anti-ageing
- Developing remedies for cancer etc.

Use of Blockchain and IoT in Healthcare

Blockchain is useful in managing pharma and medical device supply chain, patient's safety, patient recruitment for clinical trials, security and interoperability of IoT and medical device data and privacy protections for precision medicine. The drug supply chain can be compromised by infiltration of fake,

falsified and substandard medicines. But blockchain enables provenance of supply chain data across multiple partners and ensures integrity. Clinical trial recruitment can be costly and time-consuming. But blockchain can more easily enable patient matching and monitoring (by matching with electronic health records) and can validate data, incentivize participation and allow for e-consent.

Medical device IoT security is of critical concern, but blockchain can help by allowing contracts for maintenance and ensuring tamper-proof device log-ins.

AI Startups in Healthcare

There are a number of AI startups, each with their unique solution to improve healthcare industry. Some of them are discussed here.

1. AiCure

With the use of AI on smartphones, which can be downloaded as an app, AiCure[4] has the objective of connecting the patients for better treatment and healthcare. The platform can be customized according to the disease type. It specializes in medication adherence by the patients to ensure that they take medication as prescribed. Patients benefit from higher efficiencies. By using SaaS platform AiCure uses image and facial recognition algorithms to confirm medication ingestion. The system also detects fraud and duplicate enrolment.

AiCure platform is also transforming clinical research and the pharma companies gain from patients' high quality data created for further research.

4 https://aicure.com/

2. Babylon, UK

Babylon[5] is a smartphone based A.I. Clinical assistant for doctors. It is using AI to replicate a doctor's brain with lots of data and inferences. Tencent's WeChat and Samsung's Galaxy make of smartphones have made this service available to their users, who can get an access to a doctor's service. Patients can also use the service to find out more about their symptoms and get advice from the chatbot.

National Health Scheme (NHS) of UK has been working with Babylon app, where it connects patients through a video service for an appointment with a doctor. Service is available on subscription basis. Google's Deepmind has invested in the startup.

3. Bay Labs, USA

Bay Labs[6] uses deep learning in cardiovascular imaging, which might be otherwise difficult to interpret, for diagnosis and management of heart disease. It uses algorithms and past data from a vast video library to interpret echocardiograms properly by the professionals from various disciplines like AI, cardiology, visual neurosciences and physics.

It is working with many medical institutions like NewYork Presbyterian Hospital, Minneapolis Heart Institute and Duke University School of Medicine. It complies with the national standards for data anonymization under the Health Insurance Portability and Accountability Act (HIPAA).

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5 Olson Parmy, This Startup Wants To Replace Your Doctor With A Chatbot, Forbes Digital Cover, June 29, 2018 (https://www.forbes.com/sites/forbesdigitalcovers/2018/06/29/this-startup-wants-to-replace-your-doctor-with-a-chatbot/)

6 https://baylabs.io/

4. Benevolent AI

It is data and technology driven startup[7] for drug discovery at the early or late-stage clinical development. Its AI platform selects the mechanism to modulate the best targets. It selects the right patients who would respond to the treatment process and then captures information on their response to the treatment administered. It employs computational and experimental tools on mined and inferred data for faster drug discovery saving on time and cost.

5. Insilico Medicine

Insilico[8] mission is for developing new age solutions for the benefit of mankind as a whole. It is working for extending human longevity by using knowledge from different disciplines like genomics, AI, deep learning and reinforcement learning.

It provides solutions for drug discovery, bio markers, personalized healthcare and finding anti-ageing interventions. It is conducting trials for various diseases like oncology, metabolic diseases, fibrosis/Senofibrosis, senoscense, dermatological conditions, neurodegenerative disorders and others. It is also providing services like advanced deep learning solutions, custom bio marker discovery, customs drug discovery engine and new tools for ageing research to academia, pharma companies, cosmetic and nutrition companies. It has entered into a partnership with GlaxoSmithKlein to speed up the drug discovery process.

It is currently working on four different units: *Pharma.ai* for applying deep learning to transform pharma industry; *Young.ai*, which is working on predictors of a person's age; *Chemistry.ai* for experimentation on molecules and *Embroyonic.ai* to identify the embryonic score of a sample.

7 https://benevolent.ai/

8 http://insilico.com/

It has won several top ranking awards from Nvidia, CB Insights, Frost & Suliwan Best Practices Award 2018.

6. Olive, USA

Olive[9] focuses on healthcare identity management solutions as it automates repetitive, high volume tasks like filling out forms, transferring data through the use of robotic process automation (RPA). The AI technology is interoperable with existing computer systems for healthcare providers. It has 'Queue', a new version of patient registration system, which provides patients to safely log in to healthcare, giving providers the ability to deliver a more personable level of care and returning control of patient identities back to them. One of its main functions is navigating EHRs, as it can transfer patient's data, audit data retrieval, process medical bills, automate insurance data, process claims, enter eligibility checks, and report analytics. It is using machine learning to make contextual decisions based on training of historical datasets. It also uses computer vision to read documents and images.

7. Paige.AI, USA

Paige.AI[10] or Pathology AI Guidance Engine has a mission to revolutionize clinical diagnosis and treatment of cancer through building clinical-grade AI. With machine learning systems, objective is to transform pathology from a largely qualitative to a more quantitative discipline, and move it into the digital era. Computational pathology solution eliminates the need for an in-depth review for pathological review. Its 'AI Module' application suite has a dedicated physical slide viewer that can be used with any microscope.

Currently, Paige.AI is concentrating on training algorithms for detection, quantification of tumor percentage and survival

9 https://oliveai.com/

10 https://paige.ai/

analysis for breast, lung and prostate cancer. It is using a very robust hardware system, AIRI, which has GPU capacity of 10 petaflops, which helps train models on an unprecedented scale. Paige.AI has implemented slide viewer, whose function includes being microscope vendor agnostic, device independent, and the fastest viewer in the field. It also provides clinical decision support for pathologists, clinicians and researchers, which saves on time and resources, enhances accuracy of diagnosis and increases patient's confidence in treatment procedure.

Paige.AI signed a licensing agreement with Memorial Sloan Kettering Cancer Center for providing exclusive access to MSK's intellectual property in computational pathology, including access to MSK's 25 million pathology slides[11].

8. Prognos, USA

Prognos[12] is a startup with a mission to improve health by predicting disease the earliest by using AI to analyze clinical lab and diagnostics results and make predictions about an individual's risk for disease, from identifying those at early high risk, to newly diagnosed patients, to those not responding to care. It has 500 clinical algorithms to enable earlier patient identification for enhanced treatment decision-making, risk management and quality improvement. It has entered into a partnership with clinical labs and diagnostics companies while its clients include health plans and Life Sciences companies. It tracks 180 million people in over 50 diseases like asthma and lung cancer. The Prognos registry includes more than 15 billion medical records.

11 Cheung K C, Machine Learning Helping Paige.AI and other Startups in Diagnosing Cancer', May 16, 2018 (https://algorithmxlab.com/blog/2018/05/16/training-could-help-paige-ai-and-other-startups-in-diagnosing-cancer/)

12 http://www.prognos.ai/

9. Qventus, USA

Qventus[13], is using AI system based real-time decision management platform that helps solve operational challenges in internal hospital operations and patient-care management. It allows teams handle any situation and take the best course of action. Results can be seen in improved efficiency, reduced need for lab tests, reduced need for stay in hospitals, better patient experience and clinician satisfaction.

10. Univfy, USA

Univfy[14] is using AI and most advanced predictive analytics for personalized IVF treatment to help women conceive a baby through In-Vitro Fertilization by offering more accurate predictions about their chances for success. The startup applies machine learning to provide personalized reports using the patient's own health data and the individual provider's past outcome data. Over 50% of patients have higher probability of IVF success than estimates based on traditional age-based analysis. By using this service, women can have more confidence and personalized IVF treatment plan at a lower cost for a higher success of having a baby.

11. VoxelCloud, China

VoxelCloud[15] has a mission to provide high quality medical care without any geographical or economic barriers. In China, doctors are over-worked, so there is a need to simplify their jobs. VoxCloud offers automated medical image analysis algorithm for treatment of lung cancer, cardiovascular and retinal diseases based on big data, AI, deep learning and computer vision. Doctors can make better decisions based on

13 https://www.qventus.com/

14 https://www.univfy.com/info/about.jsp

15 http://www.voxelcloud.io/en/index.html

better interpretation of medical images.

It provides services through cloud based systems and has offices in Shanghai, Suzhou and an R&D lab in Phoenix (US). It wants to invite third party developers to further develop their own applications. Tencent is one of the investors in this venture.

Advantages of AI in healthcare

There are a number of advantages of application of AI. There is going to be less of human error in diagnostics. AI-system also increases speed of detection. Saving in money and time would result from automation. Personalized medicines for patients having different risks can be possible with the use of AI. Health records can be reliably kept for decades and can be used for the whole life of the patient. Nursing can be vastly improved. Doctor-assisted robotic surgery can make surgeries safer.

Limitations

Healthcare has limitations of creating electronic health records. Data is fragmented and not stored currently in usable formats. So, there is a gap in delivery. There is also the question of security of patients' data. New regulations will need to be enacted to protect patients, providers, and their data. Healthcare organizations will need to earmark special budgets and recruit expert staff with strong data science skills to monitor and develop AI in the healthcare setting. Machine and human experts need to work together for more accurate and better outcomes.

Conclusion

AI is revolutionizing the healthcare sector. There is a 360-degree change with different stakeholders like pharma companies, academia and research institutions, the governments and the common citizens participating in the new technology. Venture funding too is available to entrepreneurs, who want to apply the technology in an innovative manner. The industry is set to

change in a radical way in the next decade.

But then there are limitations of automation and AI. A machine-human interface would always exceed the performance of AI-enabled machines. Human touch and judgment cannot be entirely replaced. After all, radiologists will have to decide which scans to take, they will discuss with the patient the treatment plan and examine him again when required. There are surely human elements of everything automatic. Healthcare will receive a boost with AI, but humans will be irreplaceable.

CHAPTER 9

AI Startups in Human Resources

How AI Changes the recruitment process

Artificial Intelligence is omnipresent and is also the new disruptor in the HR industry. It is reshaping the future of work by changing the conventional ways of managing human resources by the corporates[1]. The same technological subsets of machine learning, deep learning, computer vision, natural language processing, data analytics and AI personal assistants are also being used for revamping the conventional business processes of human resource management. A popular assistant AI-bot using natural language processing could be deployed for engaging with and recruiting people and scheduling meetings etc. The process brings down the time to recruit, increases numbers to be hired and saves on overhead costs for recruitment. Virtual assistants are being used as the first tool of interaction with the candidate to know more about him, leading to a transformational change.

The conventional way of recruitment works through Applicant Tracking Systems (ATS), online assessments and professional networking sites. Applications are invited, screened and then a few selected candidates are interviewed and then finally verification on the referrals may be completed before final selection. This whole process could take months. The system is not functioning well, since both parties -recruiters and applicants are dissatisfied. 75% of applicants who apply do not hear anything from the employers and 60% of recruiters

1 'Managing human resources is about to become easier', The Economist, 31st May, 2018

complain about not getting the skill sets they are looking for.

There are a multitude of things that AI is doing in reforming human resource practices within the organization. The new wave of AI-tech HR solutions are creating new platforms to automate screening large number of applications through multiple data points, recognizing certain patterns in applications, interacting with the candidates through multiple channels, like SMS, e-mail, Facebook Messenger and video answers and then making the selection of the right candidate. Sentimental analysis could be done through textual material or through video answers for assessing the candidate on his personal attributes, depending upon the nature of position to be filled-in. It can predict employees likely to leave and strategies to retain them or shift workers to some other task more suitable for the candidate's skill-sets. AI can also predict jobs that are likely to vanish and alert those engaged in such jobs with the objective of re-skilling them for another role.

AI in training

Training is an important aspect of HR management, where organizations are providing a platform to the employees to upgrade their skills to become job-ready or enhance their skill sets. Microsoft Professional Program in AI, for example, runs a series of online courses featuring hands-on labs and free expert instructors for learning in AI and other technologies. This can bridge the skill gap in this field.

What Startups are doing in Human Resource Management

Startups in HR management have invigorated the entire industry by modernizing the whole process of recruitment. New practices have emerged which offer several advantages over the legacy systems. Details of some of the startups discussed here would show how different AI tools in human resources management are being deployed to confer those advantages keeping different stakeholders more satisfied.

1. Belong, India

Belong[2] uses AI, machine learning, data science and predictive analysis to recruit top talent. Its curation engine curates talent data from ninety different professional networks, social sites and niche platforms like GitHub, Muckrack and ResearchGate. Its adaptive search engine picks up candidates similar to those successful candidates selected earlier. One of its products, Belong Picks analyzes present or past employees' data to pick the best talent for the current job. It is candidate focused and engages in personalized recruitment, and targets even passive job seekers while matching candidate's information with job profiles. It removes biases for political affiliations, gender or religious views.

It has a big client list in Amazon, Flipkart, ABB, Cisco, Airtel, Ola, Uber, Myntra, and Bigbasket.

2. Hire Abby, USA

By using advanced messaging capabilities, Hire Abby[3] identifies, screens and engages in AI powered conversation with the candidate on 24x7 basis. It puts the right questions to assess the candidate's intelligence and skills[4] and also identifies their personality traits and motivational drive for the job. By combining feedback from conversation, with the data points from the resumes and more than 200 public sources, it can identify the most suitable candidate for the job. Keywords and filters are replaced with machine learning and it keeps a tab on pay and skills to provide a feedback to the companies recruiting. Simultaneously, it also improves candidate's experience with the recruitment process by automated follow-ups and lets them

2 https://belong.co/

3 https://www.hireabby.ai/

4 Hinman Jay, '8 HR TECH COMPANIES USING AI TO ENABLE THE FUTURE OF WORK', BLOG ON ASCENDIFY (https://blog.ascendify.com/8-hr-tech-companies-using-ai-to-enable-the-future-of-work)

know about the hiring status.

3. HiredScore, USA

HiredScore uses big data and predictive analysis to select the right candidate more quickly and at a lesser cost[5]. It conducts a data driven application analysis in real time, where the right candidates can be identified for recruitment, as soon as they apply. It screens a large number of applications through deep data insights and AI from hundreds of online and offline sources including social media beyond just the resumes for selecting potential-wise candidates. Company's proprietary technology integrates with other major HR systems.

Johnson & Johnson and Accenture are some of their premium clients.

4. HireVue, USA

HireVue[6] uses video of candidates answering questions to judge their verbal skills, intonation and gestures for suitability for a particular assignment. Through AI tools, it has created a custom built predictor for selecting the right candidate with the right skill sets. AI awards each video a score based on more than 200,000 data points, which can also be customized for each client. Machine learning keeps refining accuracy over time. This is helpful for the candidates from different cultures and/or first language. System is candidate-friendly and also lets the candidates know why they were not hired and directs them for other jobs, when it opens up.

It counts big names like Singapore Airlines, Unilever, Vodafone and Mercedes-Benz among its top clients. Hilton and Accenture who are using their system found hiring time reduced from 42 to 5 days.

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5 https://www.hiredscore.com/

6 https://www.hirevue.com/

5. Ideal, Canada

The recruitment automation software platform using AI does automatic and accurate screening of large number of resumes in real time instantly, which is useful in the next step of contacting the candidates. All of candidate data sources can then be connected together to select the best candidate for a particular job profile. It analyzes resumes, performance data of candidates and their conversations through chatbots to enhance the quality of the hire, reduces the turnover by selecting the right candidate and removes bias[7]. It also finds internal candidates suitable for a different role within the organization and all this is done very efficiently.

6. IBM Watson, USA

IBM Watson[8] is an AI-enabled recruitment and cognitive talent management platform which on the basis of predictive analysis selects the best suited candidate without any bias. It increases efficiency in recruitment process. IBM's Watson can find out how difficult it is to fill certain positions requiring certain specialist skill-sets. It provides real time workforce insights based on employee's sentimental analysis and provides an advance warning if a candidate needs a better conversation with the organization to stay in his job. Watson also provides market perceptions and finds out the typical reasons for quitting a job. Watson Talent, running on AI is another tool that attracts best talent, selects the best candidate and offers a solution to retain them within the organization. Pair Watson Talent Frameworks, another tool assists candidates write more effective job postings that can match industry's requirements in terms of key responsibilities and industry-specific skills. IBM Watson Candidate Assistant is another AI tool that engages

7 https://ideal.com/

8 https://www.ibm.com/talent-management/hr-solutions/recruiting-software

with candidates to have a personalized discussion for positions that fits them best.

7. Leena AI, India

Starting with ChatterOn which allowed people to build their own chatbots, Leena AI[9] is a provider of AI powered virtual assistant for the workplace for better HR management. It answers the employee's queries, instantly. It can be integrated with Workplace of Facebook, Skype or Slack. It offers about a dozen modules in HR and processes thousands of conversations with the employees which are fed into a neural network. It resolves HR queries faster and improves employee experience. It can schedule a meeting between an employee and his manager and uses the data for better talent management. It is available to all the employees through multiple channel. AI engine allows personal interaction. It conducts surveys to assess the organizational rating and collect information on the impact of any policy changes and actionable points to improve performance. It has future plans to use the technology in other areas like finance, procurement, sales and IT.

8. Pymetrics, USA

By applying cutting edge AI and neuroscience games, Pymetrics[10] matches talent to opportunity without any bias. It conducts games at an early stage of recruitment which ignores factors like gender, race or level of education. Machine learning analyses 80 traits and ranks candidates against top performers and predicts their suitability for a role. A rejected candidate gets an opportunity in some other role across different clients using Pymetrics.

Major clients include Unilever, Accenture, Nielsen, LinkedIn and Tesla.

9 https://www.leena.ai/

10 https://www.pymetrics.com/employers/

9. Restless Bandit, USA

Restless Bandit[11] uses AI, machine learning and data sciences to algorithmically source candidates from a large pool of database by going through their resumes and finding the candidates for open roles within just a few seconds. Its Talent Rediscovery product tool looks at thousands of data points to automatically find, connect and retarget the most qualified candidates including passive candidates from within the organization. Resume Refresh tool updates employee's profile to get their best for another position arising within the organization.

10. Textio, USA

Textio[12] is using language based AI, data and 'augmented writing platform' to improve job listings through finding meaningful patterns in language. It predicts power of words used for response of the people and accordingly plans impactful, bias-free and gender neutral writing through e mail, texting, writing and talking. It uses predictive analysis from global hiring data and their hiring outcomes to find patterns in language used that lead to successful outcomes. It removes jargons like 'synergy', 'managing', which attracts more candidates especially from minorities and women group. Results can be seen in hiring at a faster pace.

11. TwineLabs, USA

Its software and analytics based on machine learning techniques algorithmically suggests employees for new roles within the organization. Its SaaS model is subscription based. Internal mobility policy can save a lot for the company and enhance employee's satisfaction level and improve performance.

11 https://www.restlessbandit.com/

12 https://textio.com/

12. Vettd, USA

Vettd employs deep neural network and AI based solutions that has transformed the hiring process for open positions, promotions within the organization or talent re-organization[13]. Its service allows managers to upload their expertise into their own AI service and then supports recruiters or interviewers for talent evaluation. Sharing of expert knowledge is achieved within the company's 'library of Intelligent Data Science' agents that reside within Live data Observatory (LDO) built upon real time cloud architecture. LDO transforms dormant data into useful data assets that creates new AI service opportunity. Their idea is to create a business that can grow and scale in the cloud environment.

13. Workey, USA

Workey now known as Gloat, uses AI tool to identify candidates' profiles in an anonymous way with those required by the recruiters[14]. So, it does matching candidates with company's talent hunt, even when candidates are not seeking job changes actively. Applicants remain anonymous to begin with to avoid any bias, but they are free to take a call when the right opportunity comes. The platform offers an employee to compare his career history with millions of others to find another career opportunity and discover his own worth,

Advantages of AI in HR

According to a survey by Deloitte, 33% of employees expect their jobs will become augmented by AI in the near future.

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13 Artificial intelligence startup Vettd launches the first AI powered HR deep neural network platform, closes Series A round, TechStartups Team, April 10, 2018 (https://techstartups.com/2018/04/10/artificial-intelligence-startup-vettd-launches-the-first-ai-powered-hr-deep-neural-network-platform-closes-series-a-round/)

14 https://www.gloat.com/

IBM in a survey found that 46% of HR professionals believe that AI is transforming their talent acquisition capability and 49% believe it is bound to transform their payroll and benefits administration.

There are several advantages of the AI enabled selection process. First of all, voluminous resumes can be scanned quickly by the AI systems, which reduces the time for hiring the right candidate. The AI enabled screening process and recorded interviews are taking over mundane tasks of recruitment and the time taken in face-to-face interviews is vastly reduced. Algorithms will ensure that candidates' facial expressions in the recorded interviews are properly evaluated so as to judge their psychological personality. Technology is scalable where large number of applications can be screened, processed and based on client's requirements, candidates selected through several stages.

Secondly, AI-based tools also make an assessment of risk to the existing employees' positions depending upon the nature of their skill sets they possess and those jobs likely to be disrupted in the next few years. AI system also provides alternative employment to the existing employees and fits them into a new role, if the nature of the job changes within the company. By providing internal mobility from one assignment to the next, the employee can still be retained. The turnover particularly in critical skills thus can be reduced. The system allows assessment of critical skill sets, so that employees prone to quitting can be offered a pay hike for retention. Job Buddy of Accenture tells employees how automation will impact their jobs and suggests to them the training programs for developing the right skills for the future.

AI tools also ensure that any existing biases in hiring are eliminated to the extent possible. Women, sections of minority, the disadvantaged or differently abled could be employed in greater numbers. Thus companies can develop a diversified workforce to meet certain social objectives. For this, proper algorithms are developed and constantly monitored to ensure

that the selection process is free from any bias.

Lastly, new HR industries will emerge that will deploy the new tools, techniques and processes that will make the whole process of recruitment and HR management faster, cheaper and more transparent and effective, with better matching of employers' and employees' expectations and finally in reduced turnover.

With technological disruption, the number of recruiting agencies and HR firms may drastically reduce as lots of manual jobs get automated.

Limitations of AI in HR

Though the use of AI has changed the practices in HR management, there are certain safeguards that must be built into the system. While the AI powered tools are heavily relying upon machine learning methods, one must be conscious of the fact that training data through machine learning is also likely to perpetuate the biases that was part of the previous hiring system. So, constant efforts must be made to ensure that the system is transparent.

Conclusion

AI, machine learning and big data analytics are transforming the recruitment landscape in the cognitive era. The conventional ways of employee recruitment, retention and promotion has been disrupted. It is now possible to collect information from dozens of sources on large number of data points that would help better manage human resources, key to organizational performance.

CHAPTER 10

AI Startups in Fashion, Law, Agriculture and Other Areas

How AI Changes Fashion, Law and Agriculture et al

Artificial Intelligence and other technologies are also impacting areas other than finance, healthcare and HR management. It is even revolutionizing agriculture where big tech companies are making a big push. AI is also being applied in law, which has remained on the outer edge of any change even in the past. Here are some examples.

AI in Fashion Retailing

Fashion industry is leveraging technology for automation and is using AI in designing clothes to the taste of the customers, re-furbish the entire supply chain, reducing time to market and create savings by cutting costs and reducing wastages and finally boost revenues and profits. AI can automate many manual processes, send personalized advertisements and recommendations to the customers based on their choice, purchase contact and previous decisions.

A Research Brief from CB Insights[1] shows that AI and virtual reality are being leveraged to create better and personalized designs instantly. A typical scenario for quick creation of a

1 Research Brief on Merchandising, How Tech Is Reshaping The Industry, February 27, 2018 ((https://www.cbinsights.com/research/fashion-tech-future-trends/?utm_source=CB+Insights+Newsletter&utm_campaign=f1d6a4e635-ThursNL_10_04_2018&utm_medium=email&utm_term=0_9dc0513989-f1d6a4e635-91029453)

dress would be as follows:

i. Sheila wants a dress for a party
ii. she feeds in her measurements and style preferences
iii. AI synthesizes her preferences and big data signals, trending styles, past e-commerce learnings and digital behavior
iv. Sheila uses an Augmented Reality fitting room to try-out different options and select the one she likes
v. A 3D platform renders dress tailored to Sheila's measurements
vi. Robots prepare the dress
vii. Sheila attends the party

AI learns an individual's style and creates customized computer-generated images of new items that fit that style. Digital content allows brands to capture the broader fashion trends, which could be used in planning for future designs or even an entire label.

Here, we discuss what some of the startups are doing in retail.

1. Myntra (Online-fashion Retailer), India

Myntra, an online fashion retailer (owned by Flipkart) is using AI and Machine Vision in innovative ways for promoting retail fashion business. Based on its success, Myntra wants to become an AI-first fashion technology company.

In an online purchase decision, a customer makes a choice based on the image of the garment on a screen. That image can be broken down to various attributes like color, shape, texture, patterns, falls etc. Machine learning and machine vision algorithms can crawl through archival data to make the optimal combination of all such attributes the customer has liked to make a recommendation for purchase.

In the $2 trillion global fashion retail industry, the cycles are long for order placement, designing, production, and shipping. The

industry works on seasons: spring/winter/summer typically. Wastages are high. At Myntra, the whole cycle of designing to availability of goods in the stores has been cut down to 30-45 days. It has two AI-led fast fashion private label: *Moda Rapido* (entirely designed by AI) and *Here and Now*. The former has seen a growth of 300% in sales with double the margins. AI-led design process monitors what is trending, selling well or going viral and organizes the supply lines to take care of that in smaller cycles and lots to cut on wastages and stock-piling[2].

Myntra has developed an AI platform, *Vorta*, which not only collects data from its own platform but also from numerous other sources like Facebook, Instagram, Pinterest etc. and captures through the AI engine the emerging trends in fashion. It uses deep learning and a neural network to generate designs that comes on top almost indistinguishable from human-generated designs. It also uses machine learning model, the 'traditional curation model' to design something that is likely to become a hit. That style of clothing will go into production.

Myntra wants to leverage *Vorta* for selling to both Indian and global fashion companies on a SaaS model for generating a new revenue stream. The company has tied up with one of the world's leading apparel brands and few of India's top western and ethnic wear brands on the Vorta platform[3]. AI can be deployed in other segments of business like in manufacturing and management of supply chain.

2. Belmiraz (Web Store), France

Social Media has grown into a shopper's paradise and

2 Ananth Venkat, 'Myntra's multimillion-dollar AI bet', The Economic Times Magazine, July 22-28, 2018 (https://prime.economictimes.indiatimes.com/news/65061815/technology-startups/myntras-multimillion-dollar-ai-bet)

3 Stephen Sophia, 'WHAT'S COOKING AT MYNTRA?'AI, FAST FASHION AND… RATATOUILLE!, May 25, 2018 (https://stories.flipkart.com/myntra-rapid-ai-fashion-industry/)

smartphone apps are the new innovation for shoppers. Facebook, Instagram, Pinterest, Snapchat and Salesforce have all realized the value of users on their network, which can be exploited as an opportunity for selling goods.

Sensing such an opportunity, Anissa Kheloufi founded Belmiraz[4], an apparel empire as a web store and boutiques in Casablanca and Paris. Buying and selling by Belmiraz is all through an app. She says that future of retail is in handheld devices and not in e-commerce. Video and Instagram have made all the difference in the shoppers' habits. Macy, J Crew and others like her tag products in Instagram posts and route people to a store, where they could shop[5]. Anissa sells 90% through Instagram.

AI in Product Design

3. 'Billion' (Product Design), India

Flipkart is using AI extensively for customer review analysis (CRA), conversational search, visual similarity, better last-mile delivery, fraud detection, personalization and for better management of warehouses. Its Customer review analysis (CRA) tools go through the website to read, understand and come up with insights about various product categories to design products with a private label. CRA helps to come up with product recommendations at the 'aspect' level (aspect based sentiment analysis), predict demand and go for targeted marketing.

Flipkart designed Power banks with better looks (rose gold with a metallic finish), higher capacity of 15000mAh and fast charging. CRA helped in designing other products like Pans with thicker non-stick coating, Backpacks with more

4 http://belmiraz.tictail.com/

5 How smartphones are reshaping online retail, Bloomberg, June 07, 2018 (https://www.thenational.ae/business/technology/how-smartphones-are-reshaping-online-retail-1.737597)

storage, Baby care products (extra-absorbent Diapers), Irons, Smartphones etc. 'Billion' has twelve categories and Flipkart wants to enter into another forty verticals.

AI and Analytics in Hospitality Industry

Hospitality industry has been on the high end of the technological disruption. Now once again, the conventional form of bookings for airlines, hotels and package tours are set to change with the use of AI, big data and analytics. There has been a three stage transformation- from web site and e mail management to mobile and now to AI, machine learning, facial recognition technology and analytics.

AI is being used to predict travel choices and personalized services, offering complete bookings and managing in-trip and post-trip travelers' needs. Airlines are using AI and chatbots through natural language processing to manage social media inquiries, hotels offering better food menus after analyzing customer reviews.

Facial recognition technology can be used for seamless clearance of passengers through airport, immigration and customs to board the aircraft and later provide services in hotels and restaurants by using blockchain technology. Use of Robotics for baggage handling is further facilitating passengers.

Google Flights is making comparisons to offer cheapest flights. Amadeus has a complex model encompassing customers' purchase behaviors, interests, past travel information, loyalty programs, and likes among others. Using the accumulated data and machine learning, it pairs users with ideal offers based on the identified patterns from a broader community of customers.

Hopper, a startup uses data science to help people book the cheapest flights using applied predictive analytics. Mindtree is using machine learning 'Connected Traveler' to integrate traveler data from various functional applications and creates a 360-degree view of behavior and trends that ultimately helps drive higher conversion and improve loyalty. Leo by SITA Labs

is an autonomous baggage handling robot, which transports baggage at the airport with ease. From collecting luggage from a traveler at the entrance to carrying it to the handling area, Leo can take care of the entire transportation process. It is assisted by Kate, a mobile check-in kiosk. Kate identifies the closest check-in stations and expedites the process. Both are equipped with obstacle avoidance technology.

4. INSTERACT Technologies (Tour and Travel), India

Insteract technologies is using AI, advanced data analytics, machine learning, chatbots and voice interfaces to change the old model in the travel industry. Traditional business is supplier-driven and transaction focused based on lowest cost and static spending caps. It lacks transparency, personalization, quick search and optimization of travel spend. Currently e mail is used to plan, approve and manage, whereas INSTERECT experience improves the content, offers product personalization based on clients' preferences. It uses unique algorithms and data insights, and each option is processed through dozens of parameters that maps the behavior of travelers.

Time to find a plan suited for a customer is just 30 seconds versus 20 minutes in traditional domains and effort is to find the right choice for the customer by finding real-time cost range by data analytics on fares tracked (only seven choices are offered).

Future plans include offerings through enterprise and mobile apps and to expand coverage to accommodation and transfers.

Startups in Agriculture

Agriculture too is being driven by intelligence, automation and autonomy. AI, robots and intelligence machines are providing value input in different areas. Sensor based monitoring systems are providing lot many inputs which can be processed through IoT to make intelligent decisions. Satellite images are being analyzed for general purpose understanding of crop distribution or impact of climate change on agriculture;

monitoring of agricultural fields by drones; assessment of soil conditions or condition of the crops, impact of various types of microbes on plant health and in making predictions based on machine learning, such as seasonal impact or different market scenarios.

In the US, self-driving tractors to plough the farms are also being used. Autonomous vehicles are being deployed to pick strawberries, eliminating the need for imported farm-labor in the US.

Investments by angel investors are being made in general purpose drones and computer vision applications. Deep learning with computer vision technology is being used for monitoring crops in real time.

5. Blue River Technology (Managing Agri-Plants), USA

Using AI and computer vision, Blue River Technology[6] startup manages every plant according to its own requirements for herbicides spray. The use of smart machines eliminates the need for over-spraying, saving in cost and also helps in management of weeds.

6. CropIn (Loans to Farmers), India

This startup helps banks assess credit risk of loans to farmers by using satellite images of the farm and using machine learning algorithm on data input from the farmer as to what crop he cultivated in the last three years, the crop size, yield and the earnings made.

Post grant of the loan, it also monitors what crop farmer has cultivated, crop health and whether he has used the loan for the purpose sanctioned. When the crop comes to the market, the bank can get into recovery mode. The company is providing its services to a financing firm in Africa.

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6 http://www.bluerivertechnology.com/

Startups in Law

Lawyering and consulting in law are set for disruption as there are too many routine tasks like reading voluminous documents which results in wastage of time and drudgery of work. Machine learning techniques can be applied to read large number of documents in a fraction of time otherwise consumed by lawyers, recognizing clauses in a contract and pointing out anomalies, highlighting incomplete or missing clauses like unlimited liability.

Even in court proceedings, AI can be a useful tool, as it can make a summary of the proceedings and cite relevant case laws with relevant paras. There are a number of startups that are working on transforming the legal business. Techemergence[7] lists a total of 35 startups in law. Some companies based on their in-house legal experience have developed AI tools that organize the work faster and in a more convenient way. JP Morgan has developed COIN (short for Contract Intelligence), which culls out 150 attributes from 12,000 commercial credit agreements and contracts in just a few seconds, which may otherwise require 36,000 hours of legal work. Some are using prediction technology to predict the outcomes in court cases. A group of professors from Washington University tested an algorithm in predicting Supreme Court decisions. Algorithm's prediction rate turned out to be 75% correct against experts' accuracy of 59%. This accuracy was reported to be 70.2% for all cases of US Supreme Court reported from 1816 to 2015, in a study conducted by Prof. Daniel Katz of Michigan State University and his two colleagues in 2017.

The following are some of the entities and startups engaged in innovative work in law.

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7 Alan Rayo Edgar, 'AI in Law and Legal Practice – A Comprehensive View of 35 Current Applications', September 19, 2018 (https://www.techemergence.com/ai-in-law-legal-practice-current-applications/)

7. Ross Intelligence, USA

Ross Intelligence[8], a startup uses NLP (natural language program) to help lawyers find relevant cases through the entire body of law and finds a cited answer and topical readings from legislation, case law and secondary sources. The application helps lawyers with knowledge management and keeps them abreast with the latest legislations. To find an answer to a tricky question, the keyword using AI makes a search to get the meaning from the question and look for answers across billions of documents. The system analyzes the meaning and relationships between words to understand the legal concepts they form. The system would show the level of confidence in its answer. This is a kind of application which puts AI outside of the tech industry, who may have missed out on its potential.

It is designed to be intuitive and can be integrated with the workflow easily.

8. Kira Systems, Canada

Kira Systems[9] founded by Noah Waisberg, a former corporate lawyer and Dr. Alexander Hudek, a PhD in Computer Science, is using a patented software tool with 450 built-in models for M&A, due diligence, contract management database population and internal audits etc. The software uses machine learning to review unstructured contracts and related documents. Software is trained on a set of documents to automatically highlight and recognize clauses such 'as change of control' that are important. Searching and analyzing contract text can be deployed for due diligence, lease abstraction, regulatory compliance etc. Kira Quick Study can be trained for any additional models for identifying any other clause.

Machine learning can also help cases for trial, speeds up

8 https://rossintelligence.com/

9 https://www.kirasystems.com/

discovery (exchange of documents) and help in drafting a litigation strategy.

Kira systems has large client base and has received a $50 million funding from Insight Venture Partners.

9. Lex Machina, USA

Lex Machina[10] uses litigation data and court documents from previous cases to obtain insights about judges, lawyers, parties, and the subjects of the cases themselves to make predictions about a particular case such as its time to trial, chances of success and damages it could win.

Their legal analytics tool provides deep insights about the subject matter and is being used by lawyers, law firms, corporations and others for practice areas in patents, trademarks, anti-trust, securities etc.

10. LISA, UK

LISA (Legal Intelligence Support Assistant), named after Steve Job's daughter is using AI tools powered by Neota Logic's AI platform technology and is the world's first robot lawyer (Billy Bot) that helps draw up non-disclosure agreement (NDA). LISA's AI tools are developed with decades of human legal knowledge and experience. It can draft an agreement fair to both the parties to save on time. It is also working on a suite of property contract tools. Billy, a virtual assistant answers basic legal questions for individuals and can direct them to lawyers, if need be.

Its mission is to make legal advice accessible through self-help, on anytime anywhere model with saving in time and make legal services affordable. LISA in 2018 has been named as one of the AI leaders by the national Law Journal.

10 https://lexmachina.com/

11. Pensieve, India

Pensieve has developed AI-driven legal research platform called Mitra[11] which is using AI and natural language processing (NLP) to improve work-efficiency and productivity of law firms. It understands the context and relevance of a search query and then provides the most suited solution. It also uses machine learning to prepare defensible arguments. It has made it into an Axilor Accelerator Program (one of India's largest accelerator program), which helps understand the business priority. Product range can extend from one domain to another catering to technology solutions for problems in areas such as linguistic and text analytics.

Pensieve services are already being used by more than 300 customers.

Startups in Conversational Platform

12. Artificial Solutions[12], Sweden

Led by Alexa and Siri, conversational AI tools are the latest buzzword in the enterprises and are in great demand. Gartner predicts that by 2020, customers will manage 85% of their relationships with an enterprise without interacting with a human.

Artificial Solutions[13] based at Stockholm has developed Teneo, a natural language interaction (NLI) development suite that allows even non-specialists to build multiple channel conversational AI applications that think intelligently like a human being. It can be used across multiple channels, devices or

11 https://mitra.ai/company/about

12 https://www.artificial-solutions.com/

13 Wigger Kayle, 'Artificial Solutions puts customer privacy first with Teneo', a conversational AI platform', SEPTEMBER 10, 2018, (https://venturebeat.com/ 2018/09/10/artificial-solutions-puts-customer-privacy-first-with-teneo-a-conversational-ai-platform/)

languages whether in voice, text, touch or even gesture and thus can be customized as per users' requirements and preferences. It can be deployed in the cloud or on-site and offers increased data reporting, analysis, and anonymizing features. It has four core components: the Teneo Interaction Engine, the algorithmic "brains" of the platform; Teneo Studio, a natural language application creator; Teneo Language Resources, a database of language packs; and Teneo Data, a real-time analytics and reporting tool.

It has auditing tools that lets measure the system's conversational performance. Taneo tool enhances user experience in a wide range of solutions in Smart Websites, Smart Homes, Smart Cars, mobile apps, IoT solutions and Wearables.

The key advantages are: a combined linguistic/statistical model which can be deployed without any training data, and its ability to remember the context of conversations across devices and systems and to view collated analytics data about customer behavior in a single dashboard. It ushers in a new era of conversational CRM, with increased productivity and redefining customer experiences with voice technology.

Teneo is fully compliant with European GDPR as its system works in a way that the information gathered for insight is stored in one place, making it easier to query, interpret and delete. Data is tagged for identification and can be pseudonymized, if necessary.

Artificial Solutions has offices in Sweden, Germany, France, Spain, Italy, Japan and the US and has raised more than $18.7 million.

Benefits of AI

There are clear benefits of use of AI and robotics as time taken to complete tasks is reduced, there is an improved accuracy of processes and outcomes, particularly where information is constantly changing.

Conclusion

AI is being used in its own ways in different industries, be it agriculture, law fashion or retail. New ways of doing things with the use of AI is bringing in benefits to all the stakeholders. Service providers benefit by way of increasing volumes of business and profits, customers benefit on account of cost cutting, convenience and better quality of services, whereas the society benefits in terms of the larger penetration of technology and overall increase in productivity and business opportunity. It is a win-win situation for all.

CHAPTER 11

Ethical, Social and Political Issues in AI

Emergence of artificial intelligence (AI) has raised a host of ethical, social and political questions that need immediate attention of various stakeholders, namely, the government, academia, industry players, citizens and other stakeholders. Policymakers and politicians fear large scale unrest arising out of vanishing jobs as automation and the technology engine is chugging along nicely.

Secondly, an uncontrolled use of AI by nations or some rogue elements may lead to unexpected consequences. There is also the lurking danger of tyranny by the authoritarian governments, which are able to control information and citizens' behavior by use of AI. Stakeholders in different countries are also concerned about certain negative consequences of AI, which may pose a danger to the human society as a whole. AI virtually alters the human society and business, so such sensitive issues need to be discussed at length. Some of these discussed here are:

(i) Ethics of Intelligent Systems
(ii) Job losses
(iii) Human-machine team-up
(iv) Inequality and wealth gap
(v) Bias of algorithms
(vi) Monopoly of the big tech
(vii) Concerns on Privacy
(viii) Fake news and fake videos
(ix) Cyber security and hacking
(x) Over-indulgence on social media and gaming

(xi) AI for public good

(xii) Dangers of autonomy to machines

(xiii) Tyranny of authoritarian governments

Simultaneously, we must know how technology succeeds in the market place, so as to draw a balance between the two competing interests of regulations and promoting the AI businesses.

Ethics of Intelligent systems

When the process of decision-making is handed over to the 'intelligent machines', it would pose several challenges related to privacy, equality, gender discrimination, safety, environmental preservation and promoting human values and aspirations according to certain standards and practices. What happens, for example, when an autonomous vehicle driving on the road behaves in a bizarre fashion? Who should own the responsibility for a fatal error, if committed by a self-driving vehicle? Whether machines could think like humans in social and ethical aspects in such situations or whether machines could be designed that can differentiate between right and wrong. Development of intelligent systems would certainly require a framework for their operations in a safe and secure manner.

Scientists have visualized computers becoming more intelligent than humans at some point of time. As deep neural networks become more intelligent, that could create a virtuous cycle of intelligence explosion or 'singularity', where machines race ahead of humans in intelligence. Whether humans could control their own destiny in the midst of such super-intelligent machines has been a subject of long debate and science-fiction stories.

The question becomes even more important since sometime in the future, General AI machines could be developed that will act and behave like humans. Ray Kurzweil predicts that by 2029, intelligent machines will outsmart humans, though some predict that machines would never match humans in overall

capability. Stephen Hawking warned that 'once humans develop full AI, it will take off on its own and redesign itself at an ever increasing rate'.

While human capabilities are being advanced with the use of AI, it also calls for humanizing the use of technology.

Job Losses- the biggest worry in the rise of AI

The US President John F. Kennedy in 1961 stated that "the major challenge of the 60s is to maintain full employment at a time when automation is replacing men". That challenge has remained the same over the last more than fifty seven years.

When computing revolution picked up pace in the 1980s, there was a fear of large-scale job losses and a computer-phobia was created with the apprehension that humans would become redundant. Yet the history of the last six decades suggests that far more jobs have been created in the computing industry than what has been destroyed to automation or computerization.

Whether AI will cause heavy disruption, in the existing jobs leading to a large-scale unemployment is the biggest worry now facing the policy makers. The answer to this sensitive question is a clear NO. There would in fact be an opposite effect in the medium to long term. AI will create millions of jobs which do not exist today. We are just at the beginning of that curve.

A study from McKinsey global Institute suggests that by 2030, automation may displace between 400-800 million jobs, requiring 375 million people to switch jobs in different categories. Similarly, Brookings institution suggests that some Western democracies may resort to authoritarian policies to deal with civil unrest because of the large scale job losses.

Gartner's 2017 hype cycle for emerging technologies states that globally, artificial intelligence (AI) will push 1.8 million people out of work by 2020. But Gartner has also predicted that AI will create 2.3 million jobs by 2020, producing a net gain of 500,000 new jobs. There are various other reports on the issue. Progressive Policy Institute in their research findings concluded

that from 2007 to 2009, while e-commerce produced 355,000 jobs, 51,000 jobs were lost in the general retail sector, with the net addition of 300,400 jobs.

There is now a huge challenge for the national policy makers to find a solution to the vexed problem of job losses, as technology takes charge of our work places.

The other side of the story is that the data projected for new jobs from application of AI shows that jobs would be plentiful. For example, the number of project managers required for getting organizations digital-ready and reshaping their future businesses is quite huge. Knowledge of big data, AI and digital marketing forms the core of project management. The need to employ people with relevant skills is emerging in IT, manufacturing, healthcare and BFSI. According to Project Management Institute, there is going to be likely demand for 700,000 professionals in this area in the US alone by 2020. India, the second fastest-growing market will need 7 million project managers by 2027. Large number of these jobs are being created thanks to the AI and the digital boom.

Another example is the job creation in 'Unmanned aircraft system (UAS)'. A 2013 study by the Association for Unmanned Vehicle Systems International[1] in the USA shows that more than 70,000 new jobs would be created in the first three years of integration of UAS into the airspace with economic value added for $13.6 billion. Commercial drone industry could add $82 billion and 100,000 new jobs by 2025. So, fear of job losses appear to be unfounded.

Let us examine how technology operates to understand the cycle of 'job destruction and job creation'. Societies and businesses are organized at any point of time broadly on a platform with the dominant technology of the day. So, all the existing jobs are based on the skill sets required to run that

1 Economic Report (https://www.auvsi.org/our-impact/economic-report)

eco-system. But with invention of a disruptive technology, the old system faces a challenge. New entrepreneurs take the lead in transformation and they create the new jobs. Slowly the old players start changing and move to the new technological platform. Some may resist and may perish. Ultimately, some new players and some old players which have transformed themselves may dominate the market place. This whole process of transformation may take anywhere from 5-15 years. The latest example of this kind of transformation is in e-commerce.

The question is how companies can successfully use AI in ways that enables, not replaces, the human workforce, helping to make humans faster, more efficient and more productive. How the new technology can be so helpful like smartphones that seamlessly transformed many things like personal interaction, conducting banking transactions, silently without any noise.

There would be many ways in which our current jobs will undergo re-structuring. Overall, life in the age of AI and robotics is going to be far more fulfilling and satisfying as mundane jobs can be performed by machines and more productive and fulfilling jobs can be performed by humans. Robots at workplace are performing risky jobs reducing risk of exposure to humans. They are working alongside humans as co-workers. Machines do certain tasks more precisely and accurately than humans and hence automation makes things more productive. Applications of AI for improving agriculture, healthcare, understanding the psychology of humans through sentimental analysis, and autonomous technology for smart cities will create huge number of new jobs. Different varieties of jobs will appear for humans to express their creativity and innovativeness.

Each technological change brings with itself a difficult period when jobs evaporate. But, ultimately new jobs emerge to fill the gap. The transitions may be difficult, but they are completed successfully. As for AI, it will create its own jobs, which do not exist today. Governments should focus on retraining and reskilling of the existing workforce so that they can be absorbed

in the new tech sectors.

Technological progress is inevitable and unstoppable. Ultimately, the world will become a better place as workers would be doing more of rewarding jobs, the other mundane and un-interesting work being left to be done by machines and robots.

Billions got Employment thanks to Technological Inventions

The cycle of 'destruction-creation-destruction' of jobs in many technological fields is very well validated from the world population figures from 1500 AD onwards till date as given in the table 11.1. If we look at the figures from 1500 AD onwards, that extra population running into billions was all absorbed in the workforce, thanks to the developments in technology spanning over several centuries in many new industries. Starting with 710 million people in 1700 AD, an extra population of 5.4 billion (approx.) was added in a span of just 300 years. They all got jobs mainly because of three large scale technological disruptions by way of invention of steam, electricity and computing. More than 80% of the jobs we have today did not exist hundred years back. Surely, the profile of the jobs that will emerge in the age of AI will be entirely different from the present ones and will require different skill sets.

Table 11.1: World Population since 1500 to 2100 (projected)[2]

Year	Population (In million)	Year	Population (In million)	Year	Population (In million)	Year	Population (In million)
1500	585	1750	791	1900	1650	2010	6900
1600	660	1800	978	1950	2521	2050	9725
1700	710	1850	1262	2000	6100	2100	11213

2 https://esa.un.org/unpd/wpp/Publications/Files/Key_Findings_WPP_2015.pdf

In the transformation process, industries that come up on the back of the new technology create a whole new eco system, which create the largest number of jobs, on account of expansion of the market size and overall prosperity that the new technology generates. The communication industry is the prime example of technological disruption. Over a period of nearly 170 years since the invention of Telegraph in 1837, the number of jobs that the communication industry created is many times more than what it destroyed. Graham Bell's telephone was invented in 1876, after nearly four decades. 1900s saw further revolution in communication technology and today our world is so different with deep penetration of smartphones and Internet.

Internet of Things (IoT), will connect more than 30 billion devices by 2025. 5G roll out sometime in 2019 will further deepen the communication links as speeds of networks multiply many times over. The whole lifestyle and the way we do business will change dramatically. Many technological changes will evolve in the next decade that will provide millions of jobs around the globe, notwithstanding the fact that some of the existing jobs may vanish. Overall, there will be net creation of jobs in the next generation of communication revolution.

Invention of a new technology does not bring forth an immediate impact though, as it takes years and decades for entrepreneurs to develop solutions that solve life's problems. There are of course entirely new services which create new demand, which the customers cannot foresee in the existing world. AI and other associated technologies like robotics and IoT will take years and decades to mature. Today's products and offerings using AI and robotics will look quite primitive after a decade, as the technology becomes more powerful, the service models change and many more things now on the drawing board mature and become a reality.

It appears that the fear of large scale job losses and consequent unemployment because of AI is over-hyped. There are always some ultra-skeptics, but they would again be proved wrong. In any case, the new technology comes as a wave and humanity

has no choice except to organize their own affairs in the best possible manner to get the most out of the new technology.

Automation may indeed be good

Finally, automation may be good after all. As the population in the developed world keeps shrinking, there is a perennial shortage of workers. In Japan, demographers expect the number of the elderly people above the age of 65 rising a third of the total by 2050. Working-age population has peaked in every country of Europe: Japan and Germany in 1995, France in 2010 and Lithuania in 1990. China has been losing working-age people, since 2015 and the number of people between 15 to 64 years in China is expected to shrink by 19 million between 2020-25 and 68 million in the next decade thereafter.

There is another dimension to availability of workers in the developed world, when economic growth catches up. In the US, unemployment rate fell to 3.8% in May, 2018, the lowest rate since 2000, and in other parts of the developed world like in the EU and Japan, there are more job openings than the people waiting to be employed, so robots can easily shoe-in, so that the economy keeps chugging along. There is a severe shortage in trucking and construction industry, for example. Small businesses are particularly feeling the heat. Worker shortages will also lead to adoption of the latest technologies including AI, which will remove drudgery from work and make society more productive.

Human-Machine Team Up

Since we may be decades away from General AI, a better approach could be to create a human-machine collaboration, where both will apply their advantages in getting a better result. For example, in an experiment on identifying cancerous cells from the images of lymph node cells, while the pathologist had an accuracy rate of 96.6% (error rate of 3.4 %) and the deep learning system had an accuracy rate of 92.2% (error rate of

7.5%), the two when combined, i.e., when pathologists' skills were combined with deep learning, the accuracy rose to 99.5%, thus reducing the error rate to just 0.5%[3].

Similarly, BMW saw big productivity gains when humans and robots started collaborating on the factory floor, whereas Elon Musk in his Tesla plant used only robots and saw the company losing out in the race as it could not manage production lines and has been short of committed targets.

In a research work on 1500 companies compiled in the book Human+Machine (Reimagining work in the age of AI), Paul R Daugherty and H James William have demonstrated that firms achieved the most significant performance improvements when humans and machines worked together enhancing their complementary skills.

There are many other examples where humans could work alongside machines to produce better results. It could also solve the ethical issues of machines acting entirely on their own without any human control, where sometimes results could be wayward and exceptional.

The Inequality arising out of AI

Inequality in various forms has been rising with technology taking command of human lives. In the last three decades, since the rise of computing power and smart phone technology, wealth has been flowing into fewer and fewer hands. The top 1% and particularly the top 0.1% have been the major gainers, while the 50% people at the bottom have not gained much. The gap in skilling is creating a bigger wealth gap. Famous historian Noah Harari notes in his book '21 Lessons for the 21st Century' (Spiegel and Grau), the combination of biotechnology and AI

3 Wang, Dayong, Aditya Khosla, Rishab Gargeya, Humanyun Irshad and Andrew H. Beck, 'Deep Learning for Identifying Metastatic Breast Cancer', submitted on June 18, 2016 (https://arxiv.org/abs/1606.05718))

may enable some people to be digitally enhanced transforming what being human means. So, there would be a big worry in the skill gap between AI haves and have-nots.

With the application of AI, it is feared that the wage gap may further increase as AI requires higher skill sets which fetches better value in the employment market, while low-level jobs may vanish altogether putting lesser skilled workers to a disadvantage. Digital divide has existed for long. In the age of AI, there is also likely to be similar barriers between different classes of people.

In such a scenario, a conscious effort has to be made by the governments, industry and academia to bridge this gap and ensure that the digital-divide does not spread like another AI-divide. There should be an equality of opportunity for all and the issue of AI-literacy for the under-privileged should be specifically addressed. There must be democratization of the AI technology that eliminates barriers among people belonging to different races, communities or any other perceptible differences. People at large must be equal participants of the new wealth generating opportunities. A conscious effort has therefore to be made to ensure that each and every section of society benefits equally from the application of the new technology and a level playing field is created by designing policies in such a manner and putting in investments by the governments to ensure that the theme of 'AI for all' and 'Equal benefit from AI for everyone' actually goes down to the last person. R&D in AI must address this question of developing AI solutions for common good. An appropriate policy for retraining or even lifelong training as an objective by the private sector may be a good investment to meet the demand of a skilled workforce.

The US government report on AI titled as 'Preparing for the future of Artificial Intelligence' prepared by the National science and technology Council issued in October 2016 has laid an emphasis on development of AI to provide an equal opportunity to all. Recognizing that AI will become the future engine of economic growth and be a valuable tool for improving

the world, it has been suggested that the industry, civil society and the government work together to develop the positive aspects of the technology, manage its risks and challenges and ensure that everyone has the opportunity to help in building an AI enhanced society and to participate in its benefits.

In India, Niti Aayog while releasing a policy document on AI, in June, 2018 has suggested a similar policy framework adhering to the theme of 'AI4all' and focusing specifically on healthcare and agriculture to provide benefits to all.

Bias of Algorithms

Kate Crawford, a professor at New York University and a principal researcher at the New York City lab of Microsoft Research studied social implications of AI and writes that sexism, racism and other forms of discrimination are being built into the machine learning algorithms[4].

There has to be transparency, fairness and equal opportunity provided to all. Biases arising out of age, gender, race, color, nationality, creed or sex or any other discriminatory factor must be eliminated from designing algorithms. For example, in the AI enabled process of recruitment for certain jobs, it is possible that designing algorithms based on past data may yield biased results as certain candidates with a pedigree and credentials may have an edge in the automated system for recruitment. Therefore, fairness must be established into the system that will ensure equality of opportunity for candidates from diverse backgrounds particularly those coming from the disadvantaged sections or particular genders.

Similarly, in machine learning, algorithms developed for risk assessment based policing or to expedite hearings in criminal courts for sentencing recommendation by a judge based on risk assessment algorithms, there may be biases against certain

4 VaraVauhini, 'Can this Startup break big tech's hold on AI' Fortune July 01, 2018, Page 40-47

communities or against people living in certain localities of the city. Those biases need to be appropriately removed so that there is no discrimination based on any subjective criteria.

The success of AI depends upon designing algorithms based upon data sets already available. Machines are to be trained in the past data and then based upon such data training, predictive analysis can be made for the problem in hand. Designing algorithms therefore plays a crucial role in AI, which further depends on the quality of data feed available. Focus should be on data that is inclusive and free of bias. We need to have people from different backgrounds at work on designing algorithms so that the other viewpoint is not missed out. iMerit[5], a data training company is doing something towards this end.

Reliance on the past set of data may involve challenges, since there may have been inherent biases and prejudices in the previously designed system, which may continue in the new system. Sometimes data may be biased because of history or encoding trends and patterns. Data collected may not be fair, so decisions based on that data may be biased. Therefore, designers and data scientists need to be made aware of the limitations and consequences of using such data.

Algorithms being designed have not been optimized for any definition of fairness, says Deirdre Mulligan, an associate professor at the University of California at Berkley, who studies ethics in technology[6]. Therefore those world-changing algorithms must be designed in a transparent and bias-free manner or else they will lose trust and faith of the larger community. This is the greatest challenge for the AI-era.

Monopoly of the Big Tech

In the AI-led world, the issue of monopolization has become

5 Unmasking AI's bias problem' Fortune, July, 01, 2018 at page 38

6 Unmasking AI's bias problem' Fortune, July, 01, 2018 (Page 30-38) at page 34

a raging debate among the policy makers. This monopoly arises automatically for various reasons. The big tech has huge resources and most importantly troves of data which brings huge advantages. AI in consumer services is all about getting more customer traffic. More users mean generating more data, which is a necessary input for designing AI solutions.

The big companies deploy so many apps and are also running open cloud programs which create huge data depositories for development of other services. Further it also allows them to expand into new services much more easily. Huge collection of data by the big tech companies has allowed them to not only develop personalized services but also seek larger and larger share of the ad revenue globally. The more they do business, more data they generate and better AI, machine learning, deep learning and neural network programs they can develop which helps them to corner still more customers and create a 'lock in effect' in their transactional behavior. More customers generates more ad-revenues, which means putting still more resources out of those earnings for designing better and newer services. This business cycle has allowed the big tech companies to become more and more monopolistic in character raising a hue and cry in the industry as a whole.

This has led to an unequal playing field in the development of a nascent technology where there is an unfair advantage to the big tech companies. It goes against the spirit of 'AI for all' and 'AI is everywhere and for everyone' as many of the big tech companies have highlighted as their primary philosophy. However the ground reality is that SME sector faces a huge data crunch and is severely handicapped in their growth. Question that arises is whether the big tech should be forced to share their data in limited or infinite ways with others or at least with the government to create a level playing field.

There are issues of scale garnered by the big tech, which prevents a healthy competition in the market place. They can easily scale up computing power required. Then AI talent is in short supply and the big tech can afford fat cheques for those

with specialization. More resources at hand mean you can still attract better researchers and everything else that they need.

Monopolization brings in good financial returns. On-line advertisement revenue, for example, is cornered by just a few of the big tech companies such as Alphabet (Google's parent company), Facebook and now Amazon. Alphabet posted a net income of $7.9 billion (without discounting fines imposed by the EU) in the second quarter of 2018, which is a 15 per cent jump from $6.9 billion in the same period last year. Advertising revenue earnings of Google soared by 23.9% (year over year) to $28 billion while the total revenue was $32.7 billion, with increase of 26.7% over Q2 of 2017[7]. So, the 'AI spring' could also create larger monopolies with greater concentration of power and wealth in the hands of a few.

Tech companies are acquiring greater power with the growing network effect in the digital age. Startups face a number of hurdles and it is not easy to scale up in the face of an onslaught from the big tech companies. What options are available for the policy makers to create a level-playing field? Should the behemoths like Google and Facebook be broken up to break their monopolies? Should Whatsapp and Instagram be divested from Facebook? President Trump has initiated an action under the Anti-Trust Law. Microsoft went through it in the 1999-2001. But the fact is that regulations haven't worked in the past. For any new technology like AI, new regulatory challenges are bound to emerge. But there should be a way out to work out an arrangement which would be a win-win situation for all the stakeholders involved. Countries also want to protect their national champions in view of the rising threat from the land of the dragon. So, anything radical seems unlikely.

Nevertheless, policy makers need to be sensitized to take appropriate steps to create a level-playing field, so that there is

7 Nathan Ingraham, Alphabet's quarterly profits fall after $5 billion EU fine, July 23, 2018 (https://www.engadget.com/2018/07/23/google-alphabet-q2- 2018-earnings/)

a fair competition in the market place.

Concerns on Privacy

As digital technologies spread, so is the power to intrude into citizens' privacy. Facial recognition technology, for example has been used for surveillance, violating privacy rights of citizens.

Human beings are creating ever more data and more and more of it is being collected for business purposes. The business model of the big tech companies like Google, Facebook, Baidu or Alibaba all rest on supplying free services to the users as a trade-off for collecting their data freely and to generate more and more traffic for earning revenues from the advertisers. Now that seemed quite nice till we noticed our data was being misused. The whole episode got vitiated after the Cambridge Analytica (which has folded since) incidence where personal data of 87 million users with Facebook was compromised.

Another bad news of security flaw surfaced when 50 million users' accounts of Facebook were stolen and taken over by some unknown attackers through its 'view as' feature which allows users to see their profiles to others. Facebook declared remedial measures by resetting the access tokens of those accounts. There has also been compromises on two other occasions in the past, when in 2013, a software flaw exposed 6 million users' phone numbers and e-mail addresses and another in 2008, when a technical glitch revealed 80 million users' birth days on users' profiles.

On the flip side, data is the prime engine for creating AI algorithms, so unnecessary fetters would impede the growth of AI industry. If a country wants to promote their national champions in AI, restricting freedom in collection of data puts those countries at a disadvantage. China is using computer vision and facial recognition technology for freely collecting citizens' identification details, including their facial features and IDs through surveillance cameras. These are being used for crime detection and for policing. In view of such practices, policy makers in liberal countries are in a quandary as to where

to draw the line between users' right to privacy and company's freedom to collect data for developing AI industry.

On the regulation side, the EU's tough law on data regulation through enactment of GDPR (General Data Protection Regulation) with effect from 25th May, 2018 has set a precedent for other democracies to work out a similar legal mechanism to safeguard users' privacy. GDPR has shifted the balance of data power into the hands of the users, who have the right to dictate the terms of usage of their data and have the freedom to ask the data owners to delete their data. Companies can use the data subject to certain safeguards by following certain requirements, the violation of which attracts severe penalties under the GDPR.

Other countries are also enacting similar laws. Government of India appointed a committee in August 2017, headed by a former Supreme Court judge, Justice B N Srikrishna, to examine issues related to data protection, to recommend methods to address them, and to draft a new data protection law. The committee released a white paper on November 27, 2017 and requested comments from the public by January 31, 2018. The objective is to *"ensure growth of the digital economy while keeping personal data of citizens secure and protected."* The committee suggested seven principles on which the proposed data protection law should be framed: (i) the law must be technology-agnostic; i.e., it should be flexible to take into account evolving technologies; (ii) the law must apply to both private sector entities and governments; (iii) any consent should be genuine, informed, and meaningful; (iv) the processing of data should be minimal and only for the purpose for which it is sought; (v) any entity controlling data should be accountable for any data processing; (vi) the enforcement of the data protection framework should be by a high-powered statutory authority; and (vii) the penalties should be adequate to discourage any wrongful acts.

Based upon committee's recommendations, government of India has put forward the The Personal Data Protection Bill, 2018, which guarantees citizens' privacy rights.

It may be pointed out that earlier, in a recent Supreme Court

decision, one of the dissenting judges held Aadhar (a citizen's identification through thumb impression) as unconstitutional, as the mechanism intrudes into citizens' privacy rights.

California State in the USA has passed a digital privacy law on the pattern of GDPR (effective January, 2020) that allows consumers to exercise greater control over their data available online. Under the new law, consumers will have the right to know what information companies are collecting and for what purpose and how it is being shared with others. They also have the right not to sell or share their data and ask for deletion. Children below the age of sixteen have special protection.

Then there is the Honest Ads Act, which has been supported by none else than Mark Zuckerberg himself, under which Internet companies like TV and radio stations must divulge who pays for the political ads.

There is an overall agreement that the privacy of citizens needs to be protected and data collection and processing needs to be regulated in some ways. So, in future, we can expect more regulations to safeguard citizens' right to privacy. GDPR has only shown the way.

Fake News and Fake Videos: Need for Regulation

The public case for fake news got adrenalin from the disclosure of viral fake news on Facebook's News Feed in the run-up to the 2016 presidential elections. The algorithms designed did not have any mechanism to filter out the fakes from the real.

Fake news, fake videos, hate speech, and misinformation campaigns run from public platforms like Facebook, YouTube and Twitter are now perceived to be some of the biggest threats to society in the digital age. They are promoting hatred, inflaming violence and sometimes riots have occurred on account of fakes being circulated to special groups. AI has made it easier to create fakes look real. They could be in the form of simple messaging, disguised as real news, shared through e-mail or WhatsApp or any other communication channel.

Fake videos are easy to create by using deep learning. A software, some pictures of the person whose face is to be transposed, an existing piece of film to paste into it and finally a script for the digital creation to read are what is required to create a fake video. Computers do the rest. As algorithms are refined and computing power becomes cheaper, deeper fakes can be created in future. People believe videos more easily and hence the danger.

The big tech social media companies had a free ride for long, but no longer. When the internet was in its infancy and the new age tech companies like Google and Facebook were small, laws such as America's Communications Decency Act, 1996 gave protection from costly lawsuits to online businesses from responsibility for their users' actions. Section 230 of the act treated them as intermediaries and not publishers, shielding them from any harm[8].

However, with the menace of abundant fake news and videos, the old defense of neutrality has collapsed. Therefore, there is pressure on the high tech companies to regulate their content. Chief executives of the big tech firms have been called upon to explain their business affairs and the malicious feed of fake news etc. before the US lawmakers. Facebook and YouTube had to remove content related to Alex Jones of Infowars, a conspiracy theorist. In Germany, offensive content has to be removed within a deadline. Europe as a whole is following in the footsteps of Germany. European Union has come out with a draft copyright law for updating the EU's copyright legislation. There are some draconian provisions under article 13 (which mandates detection of copyright violations as soon as any video, music or text is uploaded) and article 11 (which requires permission for news aggregation by the likes of Google, from news publishers).

Under pressure from users and policymakers, social media

8 The Deciders' *The Economist*, September 8th, 2018 (Page 51-54)

companies like Facebook have now deployed an army of human moderators to delete fake accounts and prevent misuse of their free platform by deleting fake news and videos posted by miscreants. Facebook came out with a 'community standards', which also flags racy content. It advertised for 'News Feed integrity data specialist'. They are supposed to flag objectionable content, articles, videos, and other posts in violation of company's code of conduct. Facebook removed huge content from its site by deleting 837 million spam, false advertising, fraud, malicious links etc., 583 million fake accounts, 21 million adult nudity, 3.5 million cases of violent content and 2.5 million cases of hate speech and 1.9 million of terrorist propaganda. Facebook now deploys AI to search for suicide posts. AI is being trained to detect cases of sexual exploitation and nudity.

Alphabet's YouTube with a user base of one billion is also acting to clean up its website. In the last three months of 2017, it removed 8.3 million videos for violating YouTube's guidelines, 80% of which were identified using machine learning algorithms. It is also getting humanoids to clean up the videos on its site and is expected to hire 10,000 people to scrutinize billions of videos available on its channel. It is already deploying AI to flag violent content since June 2017. But technology is yet to be perfected for this job. Twitter too has declared to make it a safer place for the real users. It deleted over 70 million accounts in a 2-month period.

These are welcome steps and surely after the bloodbath, these companies will grow stronger.

Policing and regulation has its own pitfalls, though. Firstly, it raises the basic question as to who will decide on merits. Whether policing of content would promote authoritarianism or elimination of honest differences of political opinions. There can be too much of regulation, content providers not knowing what is right. Secondly, content platforms may not know all. For example, uploading Ludwik Van Beethoven's music (Fifth Symphony) whose copyright has long expired, on YouTube

was rejected by ContentID, an automated copyright filter[9]. Copyright violations are flagged by algorithms used by the platforms. Thirdly, content screening raises the cost of service provisioning, which suits the big tech companies as smaller players just cannot afford to invest. Facebook expects total expenses to grow from 45% to 60%. It declared reduced profits for July quarter and its market cap went down by $100 billion.

Society would need to set standards or norms within which content would be permitted or not permitted.

AI for Weeding out Fake News

AI is coming to the rescue of the social media companies, which are committed to remove offensive content to pacify the angry public. Both Facebook and Twitter are now using AI to weed out fake accounts, fake or inappropriate content. *Logically*, a UK based startup set up by a Cambridge student, Lyric Jain provides a platform which uses machine learning algorithms to sift fact from fiction to tackle fake news. The platform goes through news stories from over 70,000 domains and determines their accuracy for each piece of the news story by applying machine learning algorithm which can detect logical fallacy, political bias or incorrect statistics. The platform will be available for service in the US, UK and India.

Microsoft has created a cross-disciplinary internal group Aether (AI and Ethics in Engineering and Research) after failure of Tay, a social chatbot. Various questions are being examined by the group.

Under pressure from the general public and the legislatures, who want to control the menace of fake news, this may turn out to be a good business opportunity for AI, to develop tools to combat the same.

9 'Screen Grab', The Economist, September, 15th , 2018 (Page 69)

Issue of Cyber Security and Hacking

The twin related issues of cyber security and hacking deserve equal importance, since with the rapid rise in the digital economy, everything digital has also become a target of cyber-attack. Banking transactions, share trading, online purchases of groceries and even military hardware using AI applications are vulnerable to cyber-attacks. Use of AI in cyber-attacks adds to the potential of harm caused, which could be much wider and deeper. Online merchants are losing revenue on account of fraudulent placement of orders. A secret meeting of army generals or political leaders can be geo-located and everything tracked.

As smartphone penetration reaches higher levels, the chances of hacking of these devices become critical, as some users are not so literate. A simple malware soft code can be installed on a phone by sending a promotional message sent by text, which when clicked will delete all the information on the smartphone. The access of the phone reaches the hacker and conversation can be recorded through the microphone. Phone makers may not be using the latest version of the Google's Android version of the OS (operating system), thus leaving the users vulnerable to malicious attacks. Some Android apps have hidden codes for location tracking and targeted advertising, among others. More than 50 apps with a malware called Judy were downloaded by users, which made use of the devices for false clicks in online advertisement.

Last year, Google removed 700,000 bad apps and 100,000 developers from Google Play for security reasons. iPhones are comparatively more secure, as Apple controls both hardware and software.

Startups have developed innovative solutions in AI to tackle the menace, and addressing escalating cyber challenges in new technology areas in connected cars, supply-chain attacks, and securing enterprise data. Governments too have to play a pro-active role to stop the menace of cyber-attacks, particularly to

tackle some vicious methods used by a few countries, who are putting-in surveillance chips in various hardware products designed by those countries.

In cyber operations, hackers have an advantage that they can plan attacks against the defense walls that exist already. AI should help in making those defense walls stronger as it can sift through large number of incidents to identify and take corrective measures instantly against any impending attack.

Over-indulgence on Social Media and Gaming

A debate is raging on whether public harm is being caused with children, adults and others spending too much time on internet, social media and playing games. There is an addiction to such platforms, damaging the larger social causes. AI power has promoted gaming as hardware companies like Nvidia are making ever more powerful hardware for games. With services of social media companies being more and more AI-enabled, they are becoming ever more attractive and fueling addiction among children and youth.

China recently regulated gaming for children, on reports of myopia spreading among school children. Tencent, part of largest tech-empire has been hard hit because of gaming regulations. Other countries being aware of such addiction are also concerned and want to evolve a suitable mechanism, not necessarily through an outright ban.

AI for Public Good

Rose Luckin, a Professor of Artificial Intelligence at University College London spoke on AI in the following terms, before the distinguished policy makers of the European Union[10].

> 'Embrace AI. It can bring enormous benefits, but as with everything with huge benefits, it brings huge responsibilities

10 Screen Grab', The Economist, September, 15th , 2018 (Page 69)

> because we need to ensure that those benefits are felt by the whole of society, not just a subset. The benefits will also come through disruption. In order to accelerate adoption, we need to make sure that, as a human workforce, we're ready to use AI effectively. It's a real job for the education sector not just to educate those who build AI but also educate people to understand enough about it.'

The big tech companies are all great believers in public good. 'AI for All', 'Democratizing AI', 'AI is everywhere', have been coined by these tech giants to convey angelical faith of these companies for taking technological benefit to the masses and solve problems of the whole society. Indeed many programs in agriculture, saving marine resources and solar electrification of villages in poor countries have been facilitated by them. That sounds welcome news.

Google after courting a controversy over use of its computer vision technology for the US military has announced adherence to seven principles in the use of AI. It vows for technology being socially beneficial and built and tested for safety. It committed not to provide supply of AI services for smart weapons violating surveillance techniques.

Fei Fei Li, a computer vision specialist who served at Google and now Director of Stanford Artificial Intelligence Lab has started a non-profit called 'AI4ALL' which focuses on promoting diversity in the field.

The mission of 'AI for all' or 'AI is everywhere' can be translated into action if the big tech companies collaborate with the national governments and academia to retrain and reskill workers in other industries by providing resources and on-job experience in AI to create a national resource pool.

AI for public good also involves promoting racial, ethnic and gender diversity. It is a social and business imperative, which leads to better outcomes, better customer satisfaction and better financial performance. There has to be a conscious effort to promote diversity or else there is an inherent bias to perpetuate

the existing structures.

AI has the potential to solve some of the peoples' problems and improve the living conditions of the people particularly at the bottom of the pyramid. More than half of the world population goes without basic amenities. AI can provide opportunities for economic inclusion. There are related areas of saving wild animals, marine life, saving whales and turtles in the sea from poachers. AI can help a lot for serving such public causes.

AI can also improve performance of the government in delivering cost-effective and better quality services. It can assist the governments in controlling crime and improve law and order, expedite hearing in the courts and improve the criminal justice system. In developing countries, AI can monitor children dropping out of school to bring them back to school; satellite images can identify poverty zones or public housing, installation of solar panels and host of other things to improve upon social infrastructure.

There are national governments which are also keen to lift the life conditions of the people at the bottom. The challenge is how do we create the necessary architecture for application of the new technology that creates equal opportunities for all and benefits the mankind as a whole, rather than just a few at the top of the pyramid. No doubt, AI provides an opportunity for humans to improve their lives, raise their productivity and create better living conditions. The challenge lies in implementation.

A related question that arises is whether governments should intervene in the matter through legal means framing regulations and if so, then to what extent or whether they should leave the matter entirely to the private players to encode a mechanism on their own to achieve the objective.

In the age of deregulation, nobody wants government interference. Any regulation raises the cost of services and burden of compliances and creates an uncompetitive atmosphere, which may not be in the national good. As different stakeholders debate on this issue, an amicable solution has to be found.

Dangers of Autonomy to Machines

Talking robot Sophia, developed by Hanson Robotics, Hong Kong has been granted citizenship by Saudi Arabia. Sophia has attained a celebrity status and the most popular question she faces is whether robots will destroy humanity. That is a serious question on automation that needs to be addressed seriously.

In the process of automation, the automated processes are still guided by human hand. Now, fully automated systems are guided by intelligence-based algorithms and would become completely independent of human control, like in self-driving cars, whereas in semi-autonomous systems, the ultimate command rests in a human head. Here we discuss the threat of autonomy in military and warfare.

Autonomous weapons for Military Use

Countries on the leading edge of AI are also developing autonomous systems for military purposes. That nice looking algorithms could also become a serious threat to the existence of humans is an area of serious concern for all. A new race among nations for developing algorithms for war equipment could destroy humanity and the human race.

AI and robotics in future could become the prime engine of warfare technology, both offensive and defensive. They can help anticipate the launch of a nuclear-capable missile or can track and target mobile launchers. Autonomous computer systems can think for themselves and collect data from various sources including satellite imagery to detect any unusual activity for a missile launch. Counter measures could then be planned. Surveillance and drones could escalate the warfare game raising the cost and wastefulness. Robots are being developed that will complement troops in the battlefield. They can detect hazardous materials. In the Iraq and Afghanistan wars, more than 7000 robots were used to neutralize improvised explosive devices.

Use of AI in weapons and military systems unfortunately

involves the highest risk for the humanity. Moving away from direct control of weapons systems raises legal and ethical questions. There can be a machine error or that there can be any unanticipated way that has not been planned previously. For example autonomous systems in military technology may wipe out the humanity itself, if the missiles were to take their own decisions to fire when they anticipate some attack. Such anticipation may not be accurate and may not warrant the kind of action missiles would take on their own. After all, AI system may not have been trained properly on account of proper data not being available, leaving algorithms weak or unreliable. There would be no hope for any mutual discussion, agreement or any arbitration between the parties involved. There would be large-scale destruction, if we allow our armies and military to go completely autonomous. Further there is a real risk of such autonomous systems being hacked, when the control will pass into the hands of the person or organization which could be a rogue element.

US, Russia, China, Japan, UK, France and Israel are putting in huge expenditures on research for AI-enabled weaponry. The Pentagon conscripted Google for a military partnership to interpret drone videos, which recently came under fire. Employees protested and then Sunder Pichai, the CEO had to announce that Google will end that relationship after Alphabet's contract with Pentagon expires.

Autonomy is not a desirable objective in military affairs. International community must sit together and take appropriate measures for regulating the use of autonomous or semi-autonomous weapons systems. 'Does and don'ts have to be worked out by the international community. There also has to be an appropriate response to control proliferation of such systems in the hands of undesirable or rogue elements. There has been some progress on discussion in the matter of deployment of lethal autonomous weapons systems by the international community, but the difficulty lies in enforcing any agreement as autonomous systems are software based, difficult to verify.

International Telecommunication Union (ITU) has initiated a move and held a global summit in 2017, where ethical, technical, societal and political issues were debated promoting dialogue on cooperation for AI innovation.

Tyranny of the Authoritarian Governments

Andrew Ng, founder of Google Brain says that the big data and superfast computing power 'allows information to flow quickly to the center.'[11] Social media can be manipulated easily to focus on extreme behavior and promote fissiparous elements in society. Elections can also be manipulated. While the US social media tech companies have high commitments, the Chinese tech has to abide by the dictates of their national government.

AI enables authoritarian governments to manipulate news and information to control citizens' behavior. Further surveillance through AI-equipped devices and systems keep a tab on citizens and punish any bad behavior. The developments in China on this front are particularly worrisome. A citizen receiving a 'social score' for his conduct from their national governments is an affront to the age of liberty.

Question that arises is what mechanisms we set in motion while promoting AI that will not impose excessive regulations on citizens' private conduct and freedom. The technology should be used in a manner that promotes the cause of humanity rather than providing a tool in the hands of certain autocratic governments.

Focus on how AI succeeds in the market place

While it is necessary that certain social and ethical issues are properly debated and appropriate framework for solving

11 LeVine Steve, 'How AI helps Tyrants', October 9, 2018 (https://www.axios.com/ai-artificial-intelligence-autocrats-tyrants-36384e0c-b389-43e1-8d8b-f08678b57f33.html)

these problems is evolved, it must be kept in mind that there is no alternative to the promotion of technology for growth, innovation, and raising productivity of the economy as a whole. Technology is now the growth engine for the whole society and it has to be properly ensured that new technological solutions are not stuck in the midst of certain controversial issues, which must be solved at the earliest possible by engaging all the stakeholders concerned. Probably at some stage in the future, we may be saying that we do not have enough of AI rather than reading about problems and challenges arising out of AI applications.

There are many reasons for the success and failure of technology in the market place as discussed here.

Technology must be safe and secure

One of the foremost factors in the success of technology is ensuring safety in the use of technology. For example, there has to be a proper and appropriate regulatory oversight to establish certain safety standards, wherever applicable to be followed in the use of technology, say for example in flying drones or in self-driving cars. When certain trials were going on for autonomous vehicle on the road, death of a pedestrian created a hue and cry against the use of technology itself. It has to be properly ensured that while trial runs are going on, there is no harm or loss of life. Federal Aviation Administration (FAA) of the US for example has designated test sites across the country for facilitating safe testing of unmanned air vehicles and has also provided blanket authorization at the sites. Certain sites have been earmarked in Columbus Ohio for testing of self-driving technology with the purpose of development of smart city project.

In another development, the German association has suggested that certain ethical values must be followed in the use of technology. For example in the case of self-driving cars, saving the life of a human being should be given the utmost priority no matter what other harm is caused. Such safety or ethical standards establish trust and faith in the use of technology

and overall the cause of technological growth and culture of innovation is served better.

Benefits to the customers

There has to be certain benefits to the customers or users from the application of technology. With AI, the cost of services should come down, customer convenience should go up and services should be available on demand. The benevolent cycle of beneficial enhancement of goods and services using the platform of AI must be maintained throughout as the technology progresses.

Continuous funding for R&D

There is no technological stagnation until we reach a stage of stagnation in our own creativity. Howsoever sophisticated an application may be, there has to be a continuous progress for improvement of the technology. For this purpose, investments are necessary and there is an encouraging sign that governments and the private industry particularly the big tech are already aware about the positive aspects of R&D investments. There is a keen competition among the industry players to attract the best talent. The government has to ensure that there is a proper institutional facility for development of knowledge and research in academia and other agencies, which provide continuous supply of skilled manpower for research to the private industry. This will ensure that the country concerned will stay ahead in the race for technological leadership.

There are of course many other factors for success of any new technology, like stakeholders' involvement, a facilitative eco-system, promoting innovation etc.

Conclusion

While AI and other new technologies offer the next big opportunity in the journey towards progress of sapiens, social and ethical issues must be managed well to ensure that all

sections of society benefit from it. AI is surely going to make sweeping changes to the world, but it should become a force that should make work, life and society better. Law and regulations come after a while as technology has created markets.

CHAPTER 12

Future of Artificial Intelligence

We know what we are, but we know not what we may become

- William Shakespeare

Predicting the future is indeed a very difficult job. Yet, based upon our current knowledge, we can predict certain possible directions in which knowledge may evolve in the future.

There are two aspects of the growth in AI. First part relates to how the current technologies as such (or with elementary changes) will expand in the market place. We are aware that in the history of technology, most of the changes happen in an evolutionary way in smaller shifts, after the 'big bang' change has happened. The second part of the change relates to the more important dimension of the whole eco-system of AI changing somewhat radically so that there is a substantial change in the outcomes. Questions like where would AI be heading in the next 5-10 years or after 10 to 15 or 20 years relates to the second part. So, to have an overarching view, we may explore all possible combinations of each and every thing surrounding AI that may change, either singly in isolation or in combination with one or more of the other things.

How Current Technologies will expand

There are many sub sets of AI, and all of these technologies are being experimented upon in multiple ways by entrepreneurs in different countries. There are already many products and services which are being improved upon. So, how will they evolve in the future? Following course may happen, when those products and services are further commercialized.

I. Expansion of Voice-based Systems

a. Voice-based systems, like Alexa, Siri and Cortana would expand their markets. New players in China, Japan and Europe with their own voice-based systems are coming into the market. The market-size in the next decade for such services could multiply by over 100 times or more.

b. Voice-based systems will penetrate into more and more devices like in the dashboards of the cars, drones, smart home devices, appliances like refrigerators, TVs etc.

c. There would be more AI applications in natural language processing where services would be designed for the local languages, like Mandarin, Japanese, French, German, Hindi or Indian regional languages like Bengali, Telugu, amil and other languages.

Text based messages and interactions would shift more and more to the voice based applications.

II. Expansion in Computer Vision and Machine Vision

a. Large number of AI applications will be designed based on computer vision. Physical inspections of agricultural commodities or site inspections at construction sites may be substituted with computer vision +IoT applications.

b. Machine vision will expand in a big way through inspection of plant and machinery, particularly of critical infrastructure at remote locations.

c. Computer vision applications are useful in quality management of manufactured goods

d. Drone based applications using computer vision will expand fast if national policies for use of drones are put in place. Use of drones and computer vision will expand in agricultural commodities and for marine life etc.

III. Robots taking charge

a. Robots will see some of the largest expansion everywhere. More and more of robots will be used on factory floors either in fully automated plants or in conjunction with human-labor.

b. Robots will be used in security services and in carrying out dangerous jobs which is otherwise risky for humans.

c. Robots will provide lots of convenience, entertainment and education for the children and elderly people.

d. Robots may become human's best companions. 'Robot-for-sex' also seems to be on the way.

IV. Expansion of Drone services in e-commerce etc.

a. Many developing countries have logistics problems to reach the farthest corners in remote locations. E-commerce is making great strides as digital infrastructure expands and more and more people are connected through fiber-based communication systems.

b. Drones would be used in e-commerce for delivery of goods, in search and rescue operations as also in emergency services like for providing medical assistance.

V. Self-Driving Vehicles

a. There are plans for mass production of self-driving cars by end-2019. It may surely make a debut sometime in 2020. But the progress may be slow. At the first stage, larger self-driving trucks may be used by e-commerce operators to reach inaccessible areas.

b. Self-driving trucks are already planned for use within mining areas, or within complexes of buildings, where driving may not be regulated by the onerous regulations.

c. Self-driving tractors are being used at farms

d. The full-blown application of self-driving autonomous

technologies may take 10-20 years, when technology improves further, for example, when 'diffractive deep neural network' is used in designing the system.

VI. New Services based on the new technologies

Entrepreneurs are aggressively seeking new solutions to some of the existing problems by applying AI technologies. Possibilities are endless. For example, a new service called 'fleet telematics' has emerged that manages all the vehicles in a fleet of vehicles or cars owned by fleet operators like ride-sharing companies or rental car companies. This connects every vehicle in a fleet to a wireless network, which facilitates communication between all the vehicles with their managers who can see the performance on the ground.

New opportunities will arise in the future in finance, retail, healthcare, emergency services etc. These changes could happen faster in the developed world or in China. With some time gap, these will make way in other parts of the globe as well.

How AI will emerge in longer term

The so called 'latest technology' of today becomes outdated as soon as something new and better is invented. The shelf-life of any new technology is indeed getting shorter and shorter. There are so many nodes in the entire ecosystem of the AI from conceptualization, designing, making and final delivery of products or services to delivery to the customer that any change happening anywhere in the entire chain may bring about large-scale changes. What will happen by 2030 or 2040 to any of those many parameters, we can only anticipate based upon our previous experiences. Technology will evolve with better quality of hardware, higher capacity of storage, higher processing speed of data, designing of algorithms and use of other technologies. If only one part were to change in a radical way, there could be a revolutionary change in AI products or services as a whole. The technology is bound to become

better, faster and cheaper. Designing is going to become more customer-friendly. This process is the whole genesis of human progress.

Further since a lot is being talked about man-machine competition, humans may themselves enhance their capacity to compete with machines and keep the AI systems under their control. Following manners of change may be visualized in the future.

A. Humans may Enhance their own Brain Capabilities

Machines acquiring General AI capabilities, where they can demonstrate human-like intelligent behavior as advanced as a human being across the full range of cognitive tasks, is something that haunts our scientists the most. What if we reach the point of technological singularity through artificial super-intelligence (ASI), where machines progressively become more intelligent in a short period of time causing an intelligence explosion resulting in powerful super-intelligence that would exceed the human intelligence?

Here we compare the power of the human brain vis-à-vis computing power available.

Power of the Human Brain

Human brain is unique and is far ahead of any machine in terms of their performance. Whereas machines are designed on logic and predictability, neurons in human brains behave in an unpredictable way.

Table 12.1: Comparison of Machine and Human Brain[1]

Sr. No.	Performance Criteria	Computer	Human Brain	Remarks on Human Brain
1	Organization of brain	Brain of computer divided into memory and processing	Human brain is a single whole with billions of neurons and trillions of connections which can perceive, interpret, store, analyze and redistribute	More efficient
2	Processing Speed	122.3 petaFlops, SUMMIT Computer at the USA	1 exaFlop, i.e., a billion billion calculations per second.	10 times faster than the fastest supercomputer
3	Calculations and processing	May take a few million steps	Few hundred million neuron transmissions	Less energy (20 watts) required and far efficient processing
4	Weight and Space	150 tons, and requires a space of 400 m2	1.4 kg and requires a space of 1300 cm3.	Human brain is much more compact in size
5	Flexibility	No flexibility, operates strictly	Has neuro-plasticity and flexibility. Neurons	Flexibility allows many more unplanned and

1 Staughton John, 'Human Brain vs Supercomputers-Which one Wins', (https://www.scienceabc.com/humans/the-human-brain-vs-supercomputers-which-one-wins.html)

as per design	connect and disconnect as per convenience	unstructured functions to be performed

Some Japanese researchers in 2014 tried replicating performance of 1% of the brain with the superfast computer and yet it took 40 minutes for the computer to perform one second of brain activity.

Machines have several constraints of memory, flexibility, processing power, besides being static and consuming more energy.

How people expect Machines to perform in the future

In a survey of AI researchers, 80% of the respondents believed that the human-level general AI will ultimately be achieved and 50% believed that it will be achieved as early as 2040[2]. That eventually general AI will exceed humans in general intelligence. There are of course optimists like Herb Simon who predicted in 1957 that computers would outclass humans in chess within a decade, an outcome that occurred forty years later.

What Humans will do to match Machines

Whatever way one may imagine, the ultimate truth is that humans will not be sitting idle and dancing before the machines at their beck and call. They will do everything possible to stay ahead in the race between man and machine.

Humans will upgrade their own brain capacity and capability and cognitive functions much before super-smart machines become a reality. Humans will invent chips that will artificially

2 Vincent Muller and Nick Bostrom, "Future progress in Artificial Intelligence: A Survey of Expert Opinion", Fundamental Issues of Artificial Intelligence, 2014.

enhance their brain functions in unimaginable ways and it may start happening as early as in a decade's time. Our five sensory organs may develop far higher and better qualities biologically or with an external aid. That may allow humans to perform extraordinary tasks.

Wearables are already popular and the natural next stage is implantable brain chips that may also be connected to computers. Nicholas Negroponte, director of MIT's Media Lab, first prophesied symbiosis between mankind and machine as far back as in 1968. Professor Gershenfeld had high hopes that in the next decade, computers will be everywhere; in 20 years, embedded by bioengineers in our bodies. More than three million people have got grafting of artificial implants done, which have helped the deaf people to hear sound. Retinal implantable chips have restored vision to the blind[3].

So, humans upgrading their capability will ensure that they are ahead of machine's intelligence. It is also possible that the same techniques and methods of creating artificial super-intelligence for the machines may come handy to humans to upgrade their own skills and capabilities.

Second evolutionary way could be that humans will be assisted by many 'machine-assistants' and robots working at the command of humans, which will guarantee safety and security of human beings.

B. A Unified AI Approach

Between General AI and Narrow AI, there is an intermediary stage. General AI if at all may come in stages and narrow AI capabilities may keep on increasing. This will produce better AI-applications involving more than a couple of functions which machines can do simultaneously.

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3 McGee Ellen M, Maguire Jr G Q, 'Ethical Assessment of Implantable Brain Chips' Trustees of Boston University (https://www.bu.edu/wcp/Papers/Bioe/BioeMcGe.htm)

Currently AI relies upon different approaches for developing different types of applications. It is possible that in future all these approaches are unified and a single approach or method is developed, which can be used in large number of applications. For example, there could be one single AI application for translation of different languages.

C. Using one AI Platform in many Services

In the current architecture, each AI service is developed independently. However, that may change. Nvidia under project Maglev is using the architecture of autonomous driving technology for developing AI services in other areas like smart city project, video surveillance, robotics, medical imaging and healthcare. This can economize development of services and save in time as well. Success by one vendor will trigger a mass copying by others, some of which may even improve upon the architecture.

D. AI Device that identifies Objects at the speed of Light[4]

UCLA engineers have developed an AI-enabled device that identifies objects at the speed of light. The artificial neural network designed with the help of a 3D printer, opens up vast opportunities in AI. Currently, our systems identify, say for example, a photo or any object with the help of a camera or an optical sensor, then processes the data and with the aid of a computer program and it figures out what that object is.

Engineers have been able to get the same thing done with a 'diffractive deep neural network', bypassing the complex mechanism. The neural network can identify the object at a

4 Chin Mathew, 'UCLA engineers develop artificial intelligence device that identifies objects at the speed of light', August 02, 2018 (http://newsroom.ucla.edu/releases/ucla-engineers-artificial-intelligence-device-identifies-objects-speed-of-light)

superfast speed from the light reflected from the object itself. It consumes much less energy in the process.

The neural network will have applications in data-intensive tasks, for analyzing big data, images and in classifying objects. It can be applied in medical technologies, microscopic imaging, robotics, security, medicine, where it could screen millions of cells for detecting any disease or any application where image and video data are essential. It can change the way self-driving car technology is being designed.

How the Process Works

Artificial neural network is created with a computer-simulated design. Then, a 3D printer is used to create very thin polymer wafers, whose uneven surfaces help diffract light coming from the object in different directions. Light (of submillimeter-wavelength terahertz frequencies) is used in the experiment, which travels through those wafers. Each layer is composed of tens of thousands of artificial neurons, the tiny pixels that the light travels through. Together, these layers function as an optical network, which identifies an object as the light coming from the object is mostly diffracted toward a single pixel that is assigned to that type of object.

The network is then trained through deep learning to identify the objects in front of it by learning the pattern of diffracted light each object produces as the light from that object passes through the device. This is somewhat similar to complex maze of glass and mirrors, where light enters a diffractive network and bounces around the maze until it exits. The system determines what the object is by where most of the light ends up exiting.

The artificial neural network can be made with larger and additional layers, with visible, infrared or other frequencies of light or by using even lithography or other printing techniques resulting in a device with hundreds of millions of artificial neurons. The larger devices could identify more number of objects at the same time or perform more complex data analysis. Devices through 3-D printing could be made for less than $50.

The technology will fundamentally change the way AI technology currently operates.

E. Edge Computing

Edge computing is the practice of processing data near the edge of the network, where the data is being generated, instead of processing the data in a centralized warehouse, servers or in cloud. This makes the whole process faster and time is saved in to and fro communication process.

In this set up, intelligence will reside on the device itself. The best example is of autonomous driving technology, where the information collected by cameras, sensors, Lidar etc. from the surroundings by the vehicle is processed locally and instantly to take a decision. Personal devices like Alexa or Google assistant could also be trained locally to interact in the user's language and identify faces, which will save resources travelling to a distant destination.

F. Capsule Networks – Alternative to Neural Networks

The conventional Convolutional Neural Networks (CNNs) have limitations of performance and security as sometimes data is lost in the network. Internal data representation of CNNs does not take in to account of spatial hierarchies between simple and complex objects. CNNs also consume lots of data and images to identify objects.

Capsule Networks (CapsNets) is a new neural architecture that works with a different algorithm called 'dynamic routing between capsules', which identifies general pattern with less training data. They use capsules, a small group of neurons that learn to communicate with each other, much like in computer graphics to recognize an object. They do not need exhaustive training and a small change in input gives a corresponding change in output. They operate by taking relative position and orientation of an object with much more precision and the information is always preserved throughout the network.

CapsNets originally introduced in 2011 by Geoffrey Hinton and his team has improved upon its performance tremendously, though they are slow and have limitations of identifying objects too closely or working with larger images. Nevertheless, they hold good promise for the future[5].

G. Alternatives to existing Algorithmic Model[6]

The concept behind AI today is to design algorithms based on past set of data and train them to make predictions based on data feed. Another approach is to set a specific goal within a highly structured environment and let the algorithm experiment on various possibilities to find the one that meets the objective.

There are many limitations under the algorithmic model, which requires huge computing resources, tons of data, incurs heavy expenses in supervised learning and requires loads of power.

As an alternative to the existing algorithmic model, another approach has been developed by Pierre-Yves Oudeyer, an AI researcher at the French National Institute for Computer Science at Intria. Idea is to explore on human curiosity by developing artificial agents that can inspect their environment and gather data on their own. The first idea tried out on 'curious AI' was 'prediction error' method. The software explored the environment and detected for novel data by detecting things that deviated from its predictions. But it had its own flaws. So, the next idea was to focus on rate at which the 'prediction error' changed. The curiosity algorithm was tried out on primary school children to optimize on each child's learning (rather than comparing children's learning against each other). The system called as KidLearn focused on each child's strengths and his curiosity.

Another experiment on Curiosity Algorithm was conducted at

5 Géron Aurélien, 'Introducing capsule networks' (https://www.oreilly.com/ideas/introducing-capsule-networks)

6 *The Economist*, September 1st, 2018

the University of California, where it was found that curiosity learning worked well across a range of virtual environment.

Other alternatives to conventional algorithms are also being tried out. Kenneth Stanley, a researcher at Uber AI lab is working on machines exploring themselves. The system starts with a random algorithm, selects one that appears good for the task, and then generates a set of algorithms derived from it. It finally arrives at the one most suited. The model is based on evolutionary process.

Both methods of designing algorithms through curiosity or evolution offer hope for improvements against the traditional model.

H. Brain inspired computing[7]

Researchers at New Jersey Institute of Technology (US) in collaboration with IBM Research Zurich Lab have demonstrated a synaptic architecture that could develop brain inspired information processing system, which could be used widely in a range of big data applications. The system would be capable of learning and adaptation in the real world and would be more energy-efficient. Here, computing systems that are inspired by the architecture of the brain is being used to develop the system.

Deep learning algorithms based upon artificial neural networks are being used successfully in solving complex cognitive tasks mimicking the functioning of human brain. They work on certain mathematical models of the neurons and synapses of the brain, which are fed huge amounts of data, so that the synaptic strengths are autonomously adjusted to learn the intrinsic features and hidden correlations in these data streams.

However, the implementation of these brain-inspired algorithms on conventional computers is highly inefficient, consuming

7 'Novel synaptic architecture for brain inspired computing', July 11, 2018 (https://www.sciencedaily.com/releases/2018/07/180711131144.htm)

huge amounts of power and time. This has prompted engineers to search for new materials and devices to build special-purpose computers that can incorporate the algorithms. Nanoscale memristive devices, electrical components whose conductivity depends on prior signaling activity, can be used to represent the synaptic strength between the neurons in artificial neural networks.

While memristive devices could potentially lead to faster and more power-efficient computing systems, they are also having reliability issues, common to nanoscale devices. Their efficiency stems from their ability to be programmed in an analog manner to store multiple bits of information, however, their electrical conductivities vary in a non-deterministic and non-linear fashion.

In the experiment, the team showed how multiple nanoscale memristive devices exhibiting these characteristics could be configured to efficiently implement artificial intelligence algorithms such as deep learning. Prototype chips from IBM containing more than one million nanoscale phase-change memristive devices were used to implement a neural network for the detection of hidden patterns and correlations in time-varying signals. Several memristive devices could be used in parallel to represent the strength of a synapse of a neural network, but only one of them is updated at each step based on neural activity.

The conventional machine learning algorithms have limitations of usage in mobile devices and sensors. They require new technological solutions that consume lower energy and should have higher efficiency. The new nanoscale memristive devices, though slightly noisy can be used for such applications.

I. Mind Waves - Looking beyond Computer Vision

In 'Hindu Dharma', there is a concept of reading someone's mind, and this quality is apparently possessed by only a handful, particularly by seers who practice meditation. There are some science-fiction stories as well. But that fiction is somehow

progressing to be real and the next level of technology is in the pipeline.

Recent advances in research shows that machines could decode human thoughts or images a person is seeing or reconstruct memories or what videos they are watching[8]. Our brain processes information hierarchically extracting different levels of features. Here, the effort is to create 'deep image reconstruction', which uses an algorithm that can decode a hierarchy of complex visual information from brain, like shapes or colors. Algorithm also optimizes the pixels of the decoded image to make it look a bit like an object and then through deep neural network, the same is processed to identify the object.

Work in progress is to build a hat that will make telepathy possible in the next decade. Efforts are also on to make a chip that can be implanted in the brain to enhance neurological functions. Elon Musk has already started a project to merge human brains with a computer.

Currently though, there are huge limitations to this nascent technology as images reproduced do not look much like the original objects and only a few images could be reconstructed. As technology advances, it might be possible for patients with speech disorders to communicate. This technology could also become helpful in developing brain-machine interfaces that can facilitate communication by mere thought[9]. Advantages lie in giving the disabled people like the deaf, or people with dyslexia, a voice to be able to communicate in a better way and not feel let down among their own peers.

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8 Clifford Catherine, 'Japanese Scientists just used A.I. to read minds and it is amazing', CNBC, January 1, 2018 (https://www.cnbc.com/2018/01/08/japanese-scientists-use-artificial-intelligence-to-decode-thoughts.html)

9 Mok Kimberley 'Mind-Reading AI Optimizes Images Reconstructed from Your Brain Waves', Newstack, March 1, 2018 (https://thenewstack.io/mind-reading-ai-optimizes-images-reconstructed-brain-waves/)

J. Hardware changes

AI got a leg up with increase in hardware capacity and processing power. These two are keeping apace and boosting AI with more complex problems being designed in various application areas. The changes in hardware, among other things would include changes in the following:

i. Change in hardware like GPU technology
ii. Faster chips with billions of transistors
iii. Alternative to CPUs/GPUs and Chips
iv. Storage and processing of information

For improving the hardware efficiency and overall robustness of the computer systems, Neuromorphic computing is being developed which uses biological neural networks and shifts emphasis from separate methods for input/output, instruction processing and memory.

K. Chip Manufacturing- New Designs

AI applications are growing in number very rapidly. Further, AI requires more specialized chips, the future demand of which would grow steeply. The demand for processing power for AI projects has been doubling every 3.5 months since 2012, beating the Moore's law of doubling the capacity of processors every 18 months. But the availability of such computing resources has been a constraint. GPUs initially meant for video games gave an extra leg-up for AI, but that has also hit a roadblock since they do not have enough specialization for AI.

Startups are trying to match the new demand for AI chips, which is likely to reach $30 billion by 2022. *Graphcore*, a startup is making chips for intelligent processing units (IPUs), which creates many mini-brains inside the chip and the memory is placed right next to it to minimize data traffic, since compartmentalization of the two areas of memory and the brain for processing as in the GPUs means that there is too much of traffic between the two areas creating bottlenecks in running

AI applications. Chip's capacity is huge, so it can hold entire neural networks, used in AI applications.

Cerebras, another startup is designing a specialized AI computer apart from chips, which are similar to Graphcore's. Still others are designing now application-specific integrated circuits (ASICS), which can be used in edge computing and in devices like smartphones, sensors etc. A processor is already trained in a particular AI model[10].

The big tech companies too are experimenting upon design of chips to serve their own devices and services. Apple is using its own designed AI chip, A11, in iPhone8 and X, which has features like FaceID, which can recognize a user's face with an invisible spray of light, without uploading user's data. Intel too is ramping up innovation through buy-outs for specialist chip design. Google introduced Tensor Processing Units (TPUs). Microsoft, Amazon and others too have jumped into the ring.

Chip designing can speed up AI applications, so future designers have a great stake involved. New innovations will crop up in the future to take care of the demand.

L. 5 G Network

With the US carriers, AT&T, Verizon, Spring and T-mobile planning to introduce 5G services sometime in the middle of 2019 and the mobile companies in other countries following suit, the communication technology and the services built around the same is going to change dramatically.

Moving up the ladder on communication, from 4G or LTE networks to 5G or the fifth generation mobile network with a speed upto 10,000 mbps, the new technology will drive up the next-generation changes in various services and many more new services will emerge in the future. With more than 10 times speed upgrade, data collection through devices at home

10 Hyenas and cheetahs', The Economist, July 9th, 2018, page 53-56

or at work would multiply many times over. Smart homes and smart-cities, self-driving cars, augmented reality or virtual reality based services, medical applications and many other types of services would change dramatically. It will become easier handling the data in emergency-like services, like in self-driving cars, at the edge, i.e., at the device level itself where the data is collected and handle it right there rather than sending it to cloud. Cloud-based services too would become faster, which means that the hardware would become more efficient requiring less storage capacity. Drones can make low-cost, fast and secure delivery to the customers, giving a boost to e-commerce[11]. Personalized services from the tech giants would see a complete makeover.

Lots of changes are going to happen soon and the AI built around the communication technology will see revolutionary changes.

Can AI become Creative?

Ongoing experiments are going to make AI more creative. There are two opposing views on the subject. While, some believe that with repetitive training, AI can learn to become creative, as it has already done some creative work for example, in film-making, in drawing paintings and in writing pop ballads, there are however, other people who maintain that AI can never be creative[12]. Jason Toy, CEO of Somatic believes that AI can never become creative for a while.

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11 NEW GSMA REPORT HIGHLIGHTS HOW 5G, ARTIFICIAL INTELLIGENCE AND IOT WILL TRANSFORM THE AMERICAS, SEPTEMBER 12, 2018 (HTTPS://WWW.GSMA.COM/NEWSROOM/PRESS-RELEASE/NEW-GSMA-REPORT-HIGHLIGHTS-HOW-5G-ARTIFICIAL-INTELLIGENCE-AND-IOT-WILL-TRANSFORM-THE-AMERICAS/)

12 The Quest for AI Creativity, IBM, (https://www.ibm.com/watson/advantage-reports/future-of-artificial-intelligence/ai-creativity.html)

Conclusion

Designing a whole new architecture and end to end innovation in AI, taking a 360 degree view will see rapid progress in designing AI products and services. Innovators have the right incentives for doing so. History of technological progress shows that even incremental additions spread over several years do add up to substantial changes.

Finally, AI one day would be taken over by another more powerful technology. AI would then no longer be exciting, so let us get the most of it when technology is young and evolving.

CHAPTER 13

Conclusion

Artificial Intelligence is set to Change our World

Artificial Intelligence is the next wave of technology that is set to change our lives and businesses for the better. It is going to have a revolutionary impact on the way all of us spend our productive time at work, spend our leisure time for vacationing and the way we interact among ourselves at home or in close circle of our friends and communities. Nothing will be left untouched and the world will emerge as a different place in the next 10 to 15 years when the technology would have penetrated more deeply into our lives.

Our Personal Lives set to Change

In our personal lives, we will be benefitted by greatest factor of convenience and saving of time that attracts the entrepreneurs to design solutions that can meet the challenges of the present-day society. Different sections of society, in terms of the economic background, age group or any other differentiating factor have different expectations from the new technology. For example the governments expect that the technology will be an ameliorating factor in removal of poverty, generation of new employment and bridging the inequality in society.

The elderly people expect that there will be new applications that will help them in managing their lives better. The size of population in the age group of 65+ globally, is rising very fast. The club of the senior citizens has their own demands for care, comfort and convenience. They need better protection against certain diseases that afflict them at their age. Precision medicines, treatment for heart, brain, kidney and other vital

organs at that age require new inventions. AI should help in early detection of such diseases, better and faster treatments and making their lives better, overall. There are robots being designed that take care of the elderly persons by acting like human companions. There are robots in Japan that take care of the elderly in the night, take them to the washroom when required and bring them back on their beds without getting hurt from any obstacles or walls. There are people suffering from dementia, and for them, robotic assistance will be a boon in carrying out their daily chores.

The younger generation has different expectations. They require new AI skills to find employment and flourish in their careers.

Businesses are experiencing a Revolution

On the business front, entrepreneurs and innovators have spent their creative time and energy in coming out with applications with different models of AI in different practice areas of businesses. The change is end to end and it is just the beginning of just the first phase, but there is no finishing line since the changes would be taking place continuously as the technology itself keeps on evolving and becoming more and more effective.

We have seen by examples how entrepreneurs working in different areas like finance, healthcare, HR management, fashion, retail, travel and even law have disrupted the entire industry. These changes will continue in the future as we discover more in molecular biotechnology, discover more efficient ways of doing things, organizing our enterprise level work, finding new ways of reaching the unreached customers in finance or insurance and improving our cities with better infrastructure and creating a community living which is far superior to what we are experiencing today.

Businesses must adopt everything Digital

The key point is that those who are ever willing to adopt digital transformation or start their business with the latest digital

tools will become leaders of their industry. Those who are late-comers to the party may still do well ultimately. But those businesses which refuse to move with the times may have to file for bankruptcy proceedings as happened with Sears (a retailer in the US).

Benefits of AI to Businesses

The benefits of application of AI for the businesses are tremendous. They can organize their work better, utilize their man power for more productive work and save time and money in delivering products and services to their customers. It is these benefits which makes the technology attractive for the enterprises.

There is also large scale explosion of data and the organizations have to manage data collection, keep them safe, apply data for designing better solutions to customers' problems, and exploit the data in commercial ways that meets the requirements of law in national and international jurisdictions. The compliance has to be more robust as the business keeps growing with those data volumes. National governments and the general public have become more aware about misuse of such data in unethical ways which is not in the interest of the general society as a whole, so a careful approach is required.

Benefits in Agriculture, Health etc. for the Larger Society

Agriculture could be one of the largest beneficiaries of AI, particularly for the developing countries, since productivity could rise dramatically. Large swath of population in the developing world still survives on agriculture. Further, relatively speaking, agriculture has remained untouched by technology. AI will ensure that the benefits of mobile and computing is drilled down to the farming fields, where crops can be sown on the basis of better feedback from the ground on soil conditions, water required for the crops, control of pests etc.

Farmer's income will surely improve with technology coming to their aid.

Health is another key area where benefits could flow to different strata of society. Hospitals, pharma companies and healthcare service providers have to join hands to improve the overall quality of services, reduce costs and also provide critical care by early detection of diseases related to cardiology, ophthalmology, cancer etc. Developing world can gear up their primary health services through better organization of the entire system. Some of the innovations by the startups in the healthcare can be adopted suitably to to ramp up their services.

Technology will keep improving

While AI appears to be a disruptive technology, not everything that could be invented has been invented already. There is bound to be changes in architecture, the systems, hardware and the software and the rest. Many incremental changes that will happen in the future will improve the deliverables for the customers. For example, Alexa, the voice assistant may turn emotionally intelligent. Amazon has been granted a patent for the technology that detects users' physical, emotional and behavioral state. Alexa can recognize if the user has cough and then alert him the treatment required.

Maybe after 15 to 20 years, the current AI technologies will look quite rudimentary. The engine of growth of AI will last for many years till another revolutionary technology emerges.

AI creates National and International Competition

Artificial intelligence has created competition among nations to be the first. China has set out a strategy to take advantage of the new technology and become a global leader in AI by 2030, which is a great challenge for the sole superpower of the world namely the US, which is doing all it can to retain its supremacy. Other countries like France, UK, Japan, Germany, India, Sweden are also in the race to get the most out of the new technology in

their own ways and compete globally, particularly in the areas where they dominate in the current economic structures.

Countries are willing to change laws, regulations in a manner which promotes the new technology and which creates new sources of employment. They are also willing to tinker with the existing ecosystem that frustrates the new entrepreneurs in launching applications designed with the new technology. Obviously, the current economic laws and regulations, the procedures, the banking system and sources of capital are all designed to look after the current businesses. However changes are happening rapidly. For example, for capital generation for entrepreneurs, venture capitalists have been coming forward in a big way to take advantage of the future returns that the new technology may generate. They have spurred national and international competition to make more and more investment in more and more industry verticals spread throughout the world so that they do not lose opportunity for the future. Countries are also willing to provide the necessary critical infrastructure in a supportive way so that there is greater facilitation for entrepreneurs. The entry is made easier and exits are also made easier so that entrepreneurs can experiment upon their ideas with less amount of capital. Society has also changed in a manner that entrepreneurs, who have failed are not looked down upon and are given respect for having experimented upon something new for the benefit of the society as a whole. Therefore, there is an all-round change in the entire ecosystem for promotion of new businesses.

Social and Ethical Issues

There are always uncertainties surrounding any new technology. Loss of jobs strikes the people and the policymakers first, as it can potentially create unrest in the short-term. But looking at the long term prospects, one can extrapolate that any new technology, though being a disruptor in the near term has created huge opportunities in the medium to long term.

There are other important issues of privacy, data protection,

fake videos, addiction to social media as discussed earlier. Such issues have arisen in the transitory process as society is moving from one platform to another. Similar issues like protection of IPR (Intellectual Property Rights) arose in the previous two waves of internet and mobile technologies. It takes time to settle. Surely, policy makers, technology companies and other stakeholders would be able to sort the out in the overall interest of the society.

There is another lurking fear of humans becoming more and more dependent on machines. Addiction to smartphones, iPads, Laptops and other digital devices comes at a price and is taking away time from our own families. Our necks are bearing ever more weight and spines getting damaged because of our body postures. Whether in the long run, our habits will lead to physical changes? Our brain activity too is becoming narrowly focused as our dependence on smart devices is increasing. This is causing temperamental problems; younger generation does not know how to cope up with adversity, and there are a host of other psychological problems. As AI spreads digitalization, we must find appropriate solutions for the digitally-enhanced humans to become more humane.

Another important issue relates to machines becoming autonomous that takes away control of those systems from human hands. This is particularly important for applications in military hardware and warfare. What type of autonomy should be created and tolerated by the society must form part of an agenda for an international discussion and agreement. Countries feel their sovereignty is at stake and they might be over-powered by their rivals by stealth, since any agreement to control software designs may be difficult to detect and keep an eye on, if a rogue element is bent on creating such a thing in secrecy. But the stark fact is that human's own existence is at stake and no one can afford to take a chance. What mechanism can be developed to control such autonomy should be a challenge for the scientists as well.

Humans will remain relevant

One of the greatest fears that human beings face is the competition emerging from automated machines. What if the intelligent machines exceed the power of human brain at some point of time, what is referred to as AGI (Artificial General Intelligence)? Human brain has a special attraction for fears and that is how the civilization has grown out of 'the fear of the unknown'. Will AI-robots really become more intelligent than humans or this will remain just a pipe dream?

Humans have emotions, empathy and sympathy for the fellow beings. They can appreciate art, culture, make drawings and express their creativity in numerous ways. They lead a community life, whether in ghettos or on Facebook. Whether intelligent AI-robots will develop all those abilities and start behaving like or even superior to humans? The answer to this question is certainly in the negative. In the foreseeable future, this is not likely to happen. Further, humans will upgrade their own capabilities and make sure that the automated intelligent machines are subservient to humans.

Get ready for an AI-society

Our societies are organized on technology of the era we are living in. Many of us in our own life-time have traversed through several stages of technological changes that have brought about societal changes in the way what we learn at school and college, where we work or how we create our own business and what kind and quality of life we lead.

AI will bring all round changes that will affect every pillar of the society. Best way to deal with change is to anticipate it and organize around the changes expected. Therefore, we must set in motion those macro and micro structural changes in education, government, businesses that will bring benefits to the society. Any resistance to change will only bring negative dividends. Positive outlook is necessary to ensure a better future for the society.

Manage the Unexpected Developments

Many things in the transformation process will not happen as planned. We must be ready to deal with the unexpected. As technology moves towards maturity, importance of management of technology becomes even more important to ensure that there is no hard landing in case of a bust, like the one in the dotcom era. There would be social challenges as well, which humans should be able to maneuver well to reach the ultimate destination. We must build the scenarios to deal with such unexpected turns.

AI Growth Engine Must Keep on Rolling

No matter what challenges we are facing, we should not introduce measures that will retard the growth of AI and its associated technologies. Data is the biggest issue, but some appropriate way for use of data (through anonymization or pseudonymization or with any other safeguard) must be found so that businesses are not stuck and the growth engine of AI is not halted. Challenge for the policy makers is to shape up an appropriate mechanism to solve all contentious issues in a harmonious way.

Concluding Remarks

There is a great opportunity to build a new future with the technology of artificial intelligence. In transition from one stage to another, we need the services of a sailor who can help the larger community to cross over to the other side in a smooth manner. We must begin with a positive note and end with a positive note expecting bigger returns from applications of technology in different areas of our lives and businesses for the benefit of all sections of society.