THE TODAY AND FUTURE OF WSN, AI, and IoT

A Compass and Torchbearer for the Technocrats

CHANDRAKANT NAIKODI
SURESH L

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by

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Dedicated to

Vaishnavi and Rithwik
My daughter and son, who has made my life
more colorful!

About the Authors

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Preface

We are inventing many automated devices or applications triggered by WSN, AI, and IoT, directly or indirectly. This will fetch us many benefits as well as its own challenges. This bookmaking is an attempt to bring the few side effects of such collective technologies and highlighting curable upcoming invention areas. It also concentrates on the positive and negative impacts of embedded WSN, AI, and IoT technologies predicting over the next few decades.

The author will appreciate the suggestions or feedback from readers and users of this book, kindly communicate via email addresses chandrakant.naikodi @{davangereuniversity.ac.in,yahoo.in}.

Over the seven chapters in this book, you will learn the following:

Chapter 1: Introduction: This chapter describes a few latest terms and definitions used in Wireless Sensor Network, Artificial Intelligence, and the Internet of Things that also highlights comparative points on few research areas like ML, DS, DL, etc.

Chapter 2: WSN, AI, and IoT: Future Shock!: Discussed panicking situations majorly due to the collective impact of WSN, AI, and IoT. Alvin Toffler wrote in his book "Future Shock", says that "Every convenience has an equal and opposite inconvenience". We all commemorate Newton's third law- "For every action, there's an equal and opposite reaction". Edna Ferber said- "Perhaps too much of everything is as bad as too little". Keeping these things in mind and considering drastic growth in WSN, AI, and IoT, there's no doubt that new embedded technologies come with great aids, but at the same time, they also have some associated problems. Prof. Stephen Hawking, one of Britain's distinguished scientists, has said that "Efforts to create thinking machines pose a threat to our very existence even it could end humanity!".

Chapter 3: Active Research Areas of WSN, AI, and IoT: Details about active and recent research areas of integrated technologies. IoT is playing a major role nowadays, and some researchers and developers are staggered it with something like IoE- Internet of Everything", if you want to research IoT with applications, the areas of Smart Health, Smart Home, Smart Cities, Smart Grid, Agriculture and Public Safety issues are hot topics. Other areas would be IoT Network Design, model and Architecture, Virtualization, embedding and integration, cloud infrastructure, middleware, data management, etc. IoT is a set of devices that combines multiple technologies such as RFID, WSN, NFC, etc. The security protocols that are used by WSN can be integrated as an essential part of IoT security.

Chapter 4: Simulators of WSN, AI, and IoT: This chapter list major and popular simulators used for AI, WSN, and IoT. Also briefs about simulations steps of few popular simulators which are easily available on the web either freely/paid.

Chapter 5: BlockChain for WSN, AI, and IoT: How blockchain is used for the above technologies, and it's implications. A blockchain is an increasing list of blocks that are linked using cryptography. Individually block comprises a cryptographic hash of the preceding block, a timestamp, and transaction data (usually denoted as a Merkle tree). A blockchain is designed to resistant against modification of the information, which is usually managed by a peer-to-peer network collectively obeying a protocol for inter-node communication and endorsing new blocks.

Chapter 6: What is Next? Since technology is not standing water, it changes its face, pace, race withholding its base over a period! Hence, days are very nearer where WSN, AI, and IoT are treated as old fashion technologies! If so, then what is next? Predicting what is next is a tough guess because of the fact affected by many owing things such as competition, economy, politics, situation, laws, social values, education, commercial, etc. However, the below section tries to highlight a few predictable areas of research in Computer Science.

Chapter 7: State of AI and IoT by 2050: It is hard to predict or access anything beyond current technologies or the current period, but the author attempted to gather some information about the probability of upcoming technologies concerned with AI and IoT.

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CHAPTER 1
Essentials of WSN, AI, IoT

Introduction

In this chapter, we will discuss the most contemporary and popular concepts that are, Wireless Sensor Networks, Artificial Intelligence, and the Internet of Things. Furthermore, this chapter will help the readers to understand the fundamentals of these concepts before they read the subsequent chapters.

In this chapter, we'll discuss intended technologies at an individual level.

- WSN
- AI
- IoT
- Organization of the book
- Summary

Objective

After reading this chapter, the readers will be able to understand:

- The fundamentals of Wireless Sensor Networks and its components
- The fundamentals of Artificial Intelligence and its insights for the research
- The fundamentals of the Internet of Things and its significance

Wireless Sensor Node/Network

WSN is called a **Wireless Sensor Node/Network,** which has a sensing capability for various usages. The research trend is changing, and our society is adapting to sensing technology very fast. Sensors are widely used in military, manufacturing, health management, disaster management, agriculture, wildlife, construction, transportation, and so on.

What is a sensor?

The **sensor** is a technological hardware device that detects or measures or converts and responds (electrical signals) to some type of input from the physical environment, for example, temperature, sound, pressure, light, and so on. A typical block diagram of a sensor device is shown in *Figure 1.1*. The basic components of a sensor node are transceiver, microcontroller, memory, power source, and one or more sensors / actuators.

Transceiver

It contains a combination of transmitter and a receiver that shares a common circuitry to perform different operational states, typically— Transmit, Receive, Idle, and Sleep.

Micro-controller

It is a general-purpose processor, optimized for embedded applications, and it consumes less power.

Memory

The memory (flash memory) requirements vary from application to application. Typically, **user-level memory** is used for storing application related or personal data, and **program level memory** is used for programming the device or identifying the data.

Power Source

Typically a sensor node consumes energy for sensing, communicating, and data processing or computing.

Normally, power is stored either in batteries (rechargeable and non-rechargeable) or capacitors. The components of the sensor are shown in the following diagram:

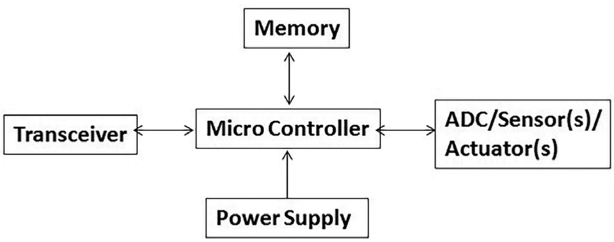


Figure 1.1: *Block diagram of a sensor device*

The synchronized interaction among power supply, transceiver, memory, microcontroller, and sensory modules would make the sensor system more meaningful.

Sensors/actuators

The **sensor** is a hardware device that produces a measurable answer to a change in a physical condition like pressure, light, temperature, etc. Sensors compute physical data of the parameter to be monitored. The recurrent analog signal produced by the sensors is digitized by an **analog-to-digital converter** (**ADC**) and sent to controllers for additional processing. Similarly, an **actuator** is a hardware device that is operated by a source of energy, typically electric current, hydraulic fluid pressure, or pneumatic pressure, and translates that energy into motion.

Criteria to choose a correct sensor would include its speed, accuracy, memory, range, cost, energy, environment condition support, calibration , resolution of data, repeatability, and so on.

The main characteristics of a WSN includes energy consumption constraints for nodes using batteries or energy harvesting, ability to cope with node failures (resilience), scalability to large scale of deployment, ability to withstand harsh environmental conditions, ease of use and cross-layer design, some mobility of nodes (for highly mobile nodes see MWSNs), heterogeneity / homogeneity of nodes.

What is biosensor?

Biosensor is an analytical device with combination of biological component and a physicochemical detector component which is used to check medical conditions like cancers, blood pressure, body temperature, pH, glucose, the presence of specific bacteria, pulse rate, DNA sequences, antibodies, enzymes, oxygen tension, the presence of some drugs, and so on. The block diagram of the biosensor device is shown in *Figure 1.2*.

The analyte is a substance or chemical constituent and biological elements. It can be tissue, microorganisms, organelles, cell receptors, enzymes, antibodies, nucleic acids, and so on.

Recognition Unit of elements can be immobilized on sensor support or sensor surface using different methods such as encapsulation, entrapment, adsorption, capture, and covalent attachment.

A **Transducer Unit** (detector element) which works in a physicochemical way—optical, piezoelectric, electrochemical, and so on that transforms the signal resulting from the interaction of the analyte with the biological element into another signal (that is, transducers) that can be more easily measured and quantified, here associated electronics or signal processors that are primarily responsible for the display of the results in a user-friendly way. The various units of a biosensor are shown in the following figure:

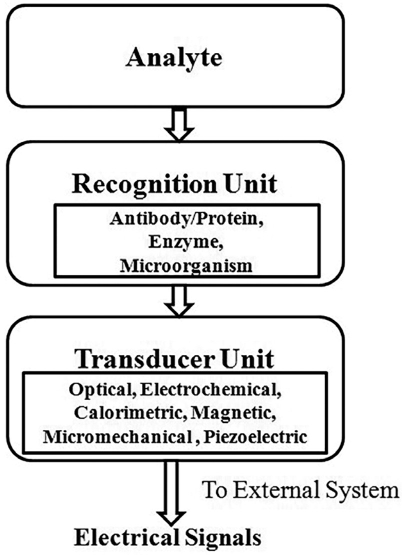


Figure 1.2: *Schematic diagram of a biosensor*

Biosensors can be used in quality assurance in agriculture, food and pharmaceutical industries, monitoring environmental pollutants and biological warfare agents, medical diagnostics, research and development of proteomics, drug, and so on.

What is the human sensor?

Few parts of the human body work similarly to engineering sensors or vice versa (robots). The human sensors can include eye (senses the light from the environment and relays that to nerve cells that transmit images to the brain), ear (gets the sound waves from air and this sound vibrates the hair cells of inner ear, then signals will be passed to the brain), nose (particles are breathed into the nose, and nerve cells contact particles and send signals to the brain), skin (the skin of the body is activated and sensed then send the signals to the brain through nervous system), tongue (small cells in the tongue will be activated by particles of the food, then, these signals passed through nerves to the brain). Light sensor and ultrasonic sensor act as eyes, sound sensors act as ears, and touch sensor acts as skin in robots.

Why sensors required?

Basically, sensing technology helps to make data computing, interpreting, and converting to the next level of human understanding about the environment, crimes, disasters, and so on, which will help to upgrade the life of civilization.

Hence, it will become an indispensable component of daily life.

What is a wireless sensor network?

A **wireless sensor network** (**WSN**) is a set of spatially distributed and dedicated sensors which are interlinked via the wireless medium for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location.

Types of sensors

There are hundreds of sensor and detector types available in the market. We should choose the sensors based on our applications. Few types of sensors are listed as follows:

- Heat/Cold sensors
- Light sensors
- Burglar sensors
- Air sensors
- Water sensors
- Fire sensors
- Movement sensors
- Agriculture sensors
- Flood/Tsunami sensors
- Chemical sensors
- Biosensors
- Count sensors
- Health sensors
- Speed sensors
- Voltage sensors

- Space sensors
- Acoustic, sound, vibration
- Automotive, transportation
- Chemical
- Electric current, electric potential, magnetic, radio
- Environment, weather, moisture, humidity
- Flow, fluid velocity
- Ionizing radiation, subatomic particles
- Navigation instruments
- Position, angle, displacement, distance, speed, acceleration
- Optical, light, imaging, photon
- Pressure
- Force, density, level
- Thermal, heat, temperature
- Proximity, presence

From the above list of sensors, it can be understood that for every specific function, there exists a specialized sensor that can address a solution.

Networking technologies for WSN

Wireless communication in WSNs is mostly based on standardized technologies about 802.11 (Wireless Local Area Networks) and 802.15 (Wireless Personal Area Networks). The technology would include Bluetooth, ZigBee (IEEE 802.15.4), UWB (Ultra Wide Band), Wi-Fi, and so on.

Architecture of WSN

The architecture for WSN is built based on the ISO OSI Model, as shown in *Figure 1.3*. This protocol stack contains the Physical layer, Data link layer, Network layer, Transport layer, and Application layer. And also there are few cross planes or layers used to manage the network and make the sensors work together in order to increase the overall efficiency of the network, the cross layers could include

Task management plane, Mobility management plane, Power management plane, and so on.

Physical layer

This layer provides an interface to transmit a stream of bits having the responsibility of frequency selection, carrier frequency generation, signal detection and propagation, signal modulation, and data encryption.

Data Link layer

This layer performs multiplexing data streams, data frame detection, medium access control, power-saving modes of operation, error control, and so on.

Network layer

Since WSNs are mostly data-centric, hence power efficiency is always an important consideration to preserve network life. This layer also does data aggregation, attribute-based addressing, and location awareness.

Transport layer

This layer is especially required when the system is planned to be accessed through the Internet or other external networks. It helps to maintain the flow of data if required.

Application layer

This layer uses **Sensor Management Protocol** (**SMP**), **Task Assignment and Data Advertisement Protocol** (**TADAP**), **Sensor query and data dissemination protocol** (**SQDDP**), and it has the responsibility of traffic management and provide software for different applications that translate the data in an understandable form or send queries to obtain certain information since WSN can be deployed in various applications like military, medical, environment, agriculture fields. The management of layers for a WSN is shown in the following figure:

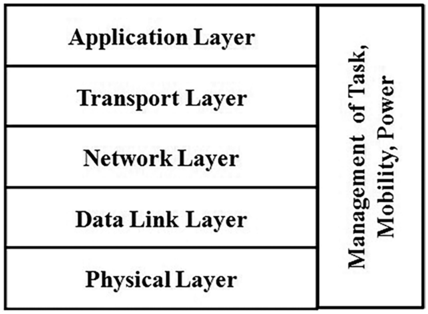


Figure 1.3: *Architecture of WSN*

The architecture perfectly depicts not only the communication scenario but also the significance of the task to the management of mobility and power.

What is MANET?

A **MANET** is a mobile ad-hoc network that contains wireless links and nodes. It is an infrastructure-less network, and it can change its topology and configure itself on the fly, it can communicate via multiple hops.

What are the similarities and differences between MANETs and WSN

Similarities

1. Both are infrastructure-less, distributed wireless networks
2. Routing Techniques are more or less same
3. Both are Ad-hoc networks
4. Topology can change over a period
5. Nodes can be operated on battery
6. Both wireless channels use unlicensed spectrum(cause of interference)

Differences

1. The data rate of MANETs is more than WSN
2. Number of nodes in the WSN is more than MANETs
3. Mobility is very high in MANETs(since nodes are less) than WSN
4. Sensor nodes of WSN are normally static and cooperate together to transfer the sensed data
5. Sensor nodes usually consume less energy than MANET's nodes
6. MANETs are usually close to civilization
7. Public key cryptography is used in MANETs whereas symmetric key cryptography used in WSNs for security purposes
8. Compared to MANETs, WSNs are smaller, more powerful and more memory-constrained
9. Mostly, MANETs are used for distributed computing whereas WSNs are used for information gathering from the environment
10. WSNs are more prone to failures than MANETs

What is the difference between sensors and detectors?

Sensors and detectors are devices that are used for signaling the presence. Sensors have the capability of finding the intensity of stimuli, whereas detectors cannot do it. A sensor measures a physical quantity like heat, light, cold, pressure, and so on, and a detector indicates the presence or absence of something like smoke, fire, carbon monoxide, and so on.

What is the basic working model of sensors?

A sensor measures a physical quantity and translates it into an electrical signal which can be read by an observer. There are many types of sensors available in the market that can be classified based on the unique ways of working; for example, some temperature sensors can sense the changes in the environment based on Planck's law, which deals with the amount of thermal radiation released by a heat source. Similarly, a light sensor glows a light on the image to be scanned and gathers the data as a simple variation between black and white based on the level of reflection. These changes are afterward transformed into digital form for processing.

What are the future trends of sensors?

Sensors are becoming part of life. Hence its usages are also spreading across machine/human health care, traffic control, home control, military operations, inventory control, area/forest/industry monitoring, air/water testing, etc. Hence this field provides a wonderful opportunity for researchers, students, and others to explore more.

What are the side effects of sensors?

As city and civilization improve over a period, cities are becoming more sensors networked, and people are becoming more sensor data-dependent, hence the usage of hardware devices increases, and we need to think about how to dispose them environment-friendly or think about alternatives if it is no longer useful.

What are the advantages and disadvantages of WSN?

The major advantages are listed as follows:

- WSN can be set up without a fixed infrastructure.
- Since it is an ad-hoc network, you can add/remove new devices at any time.
- Network structure or topology is flexible enough to change, including physical partitions.
- The base station of the central node can be used to relay the sensed data.
- It is a wireless network; hence it avoids a lot of wiring.
- WSN is good for unmanned or non-reachable places such as; sea, mountains, forests, rural areas, planets, and so on.
- Flexible if there is an ad-hoc situation when the additional workstation is required.

- The cost of network design and implementation is cheaper for smaller WSN than a wired network.

The major disadvantages are listed as follows:

- WSN is low speed compare to wired communication
- Quality of communication may not be as good as a wired network(link failure)
- Easy to hack the network as it is an open media access
- Costly for bigger network
- Limited resources like energy, bandwidth, processing power, memory, and so on

Though the WSNs do have disadvantages, they show their effect in a defined and controlled environment. Hence, the advantages can be considered while designing a system, and disadvantages shall be considered while it is being tested in a controlled environment.

Trends in sensors

From various industry reports, it can be understood that sensors market is growing faster to larger volume. This growth is more than that of computers and communication component markets., refer to *Figure 1.4*. Sensors are found in every unit, such as smartphones, automobiles, surveillance systems, apart from the everyday things such as lighting and air-conditioning units. Besides, the consumer electronics, the technology used for these are part of AI, nuclea, defense, medical, IoT, agriculture, aviation, deep-sea applications, and environment monitoring.

AI

AI stands for **Artificial Intelligence**, which is a collaborative task of science and engineering involved to make intelligent machines, especially intelligent computer software. AI is a consistent effort to make a computer, a robot, or a product to think about how smart a human can think. In a broad sense, AI is a study of how the human brain thinks and acts, determine, decide, and work. All these actions and behavior is captured in a virtual container called AI software, which makes intelligent software systems. As, AI's aim is to improve computer functions, which are related to human intelligence, for example, learning, reasoning, and problem-solving.

Nowadays, intelligent behavior in an autonomous agent trained by the human brain's behavior, hence AI of today can do specific tasks like Auto flying, Driving a car, Booking meetings, Military tasks, and so on. The intelligence is hypothetical, which includes: Perception, Linguistic Intelligence (NLP), Reasoning, Learning, Planning, Problem Solving, Vision, Prediction of past and future events, and so on.

AI's objectives include knowledge representation, planning, reasoning, learning, natural language processing, realization, and the ability to move and manipulate objects. And approaches include computational intelligence, probability, statistical methods, and software coding. AI is just not limited to Computer Science, but extended its arms to many fields of science, mathematics, linguistics, psychology, philosophy, biology, medicines, surgery, navigation, and so on.

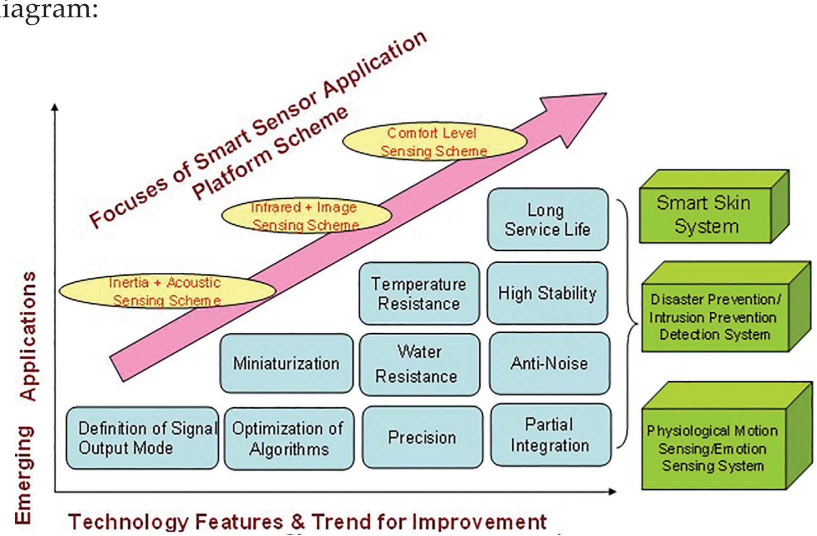
Applications of AI including research fields

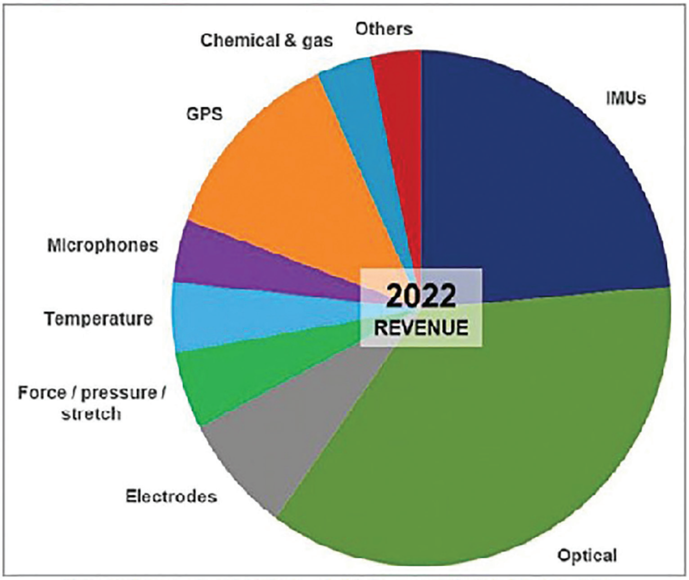
AI has its wings span across various research fields apart from the applications that can provide the solutions not only as a societal solution but also in the entertainment field. These solutions are listed as follows:

- Game theory and strategic planning
- Game artificial intelligence and computer game bot
- Natural language processing, translation, and chatterbots
- Nonlinear control and robotics
- Artificial life
- Automated reasoning
- Automation
- Bio-inspired computing
- Vision systems
- Concept mining
- Optical character recognition

- Handwriting recognition
- Speech/Handwriting recognition
- Face recognition
- Artificial creativity
- Computer vision, virtual reality, and image processing
- Cognitive
- Cybernetics
- Developmental robotics (Epigenetic)
- Evolutionary robotics
- Hybrid intelligent system
- Intelligent agent
- Intelligent control
- Litigation
- Photo and video manipulation
- Diagnosis
- Data mining
- Knowledge representation
- Semantic Web
- Email spam filtering
- Behavior-based robotics

Trends help to understand the future, which is shown in the following diagram:





Wearable chart (Courtesy: www.idtechex.com)

Figure 1.4: *Trends in Smart Sensing Technology*

There are many super active fields where AI is used at a maximum level; few of them are as follows:

1. Education
2. Finance
3. Algorithmic trading
4. Market analysis and data mining
5. Personal finance
6. Portfolio management
7. Underwriting
8. Marketing
9. Media and e-commerce
10. Music
11. News, publishing, and writing
12. Online and telephone customer service
13. Sensors
14. Telecommunications maintenance
15. Toys and games
16. Transportation

17. Geography and ecology
18. Government
19. Heavy industry
20. Hospitals and medicine
21. Human resources and recruiting
22. Job search

Though the list looks exhaustive, it keeps increasing as and when a new specialized scenario is identified.

Data Science and AI mutually complement each other, which is shown in the following diagram:

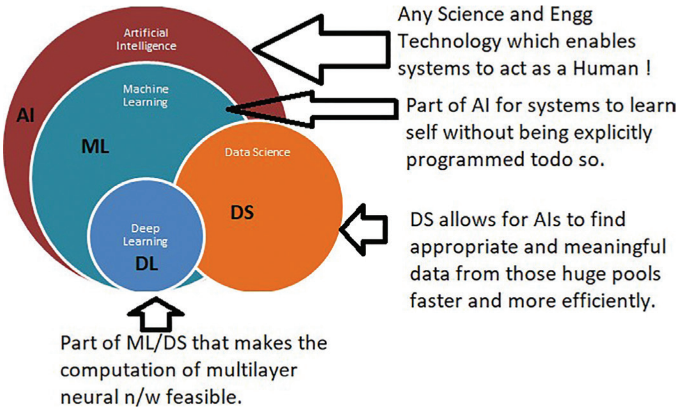


Figure 1.5: *Connection between AI, ML, DS, DL*

While DL is the branch of ML, which is further a branch of AI, however, data science works as an association between all the above three concepts.

What is the difference between AI, ML, DL, and DS?

Artificial Intelligence (AI) is the all ambient concept that initially appeared, then followed by **Machine Learning** (**ML**) that thrived later, and lastly, **Deep Learning** (**DL**) that is reassuring to intensify the advances of AI to another level. AI is a broader concept of Computer Science with loosely interpreted to mean incorporating human intelligence to machines. Advanced AI would be a system that can do anything a human can (perhaps without purely physical things). This is frankly universal and includes all kinds of tasks, such as planning, moving around places, speaking, translating, identifying objects and sounds, performing social or business transactions, creative tasks, and so on.

ML is a subset of AI that can be loosely interpreted to mean enabling systems with the ability to "learn" by themselves using the provided data (training data) and make accurate predictions (test data). ML is a method of training algorithms such that they can learn how to make determinations, this process involves giving a large number of data to the algorithm and allowing it to learn more about the processed information like identifying an object whether it is a Lotus or not, for that we need to identify the flower's characteristics like Lotus length, width, height, color, etc., then feed this data to ML algorithm as training set. Broadly, there are three types of ML algorithms: First, Supervised Machine Learning Algorithms look for patterns in the value tags assigned to data points to formulate predictions. Second, Unsupervised Machine Learning Algorithms are more appropriate where labels are not linked to data points need to explain the structure.

Also, to make complex data look simple and organized for analysis. And third is, Reinforcement Machine Learning Algorithms is used to choose an action based on each data point. To achieve the best results, after some time, the algorithm alters its strategy to learn better.

DL is one kind of ML which involves a particular kind of mathematical model that can be thought of as a composition of simple blocks (function composition) of a certain type, and where some of these blocks can be accommodated to predict better for a better outcome. Typically DL algorithms are more or less inspired by the data processing patterns extracted from the behavior of the human brain like we use our brain to find patterns and classify different types of data. DL Neural network consists of three types of layers: Input Layer, Hidden Layer, and Output Layer.

DS is an interdisciplinary field about processes and systems to extract knowledge or insights from the information in various forms. DS uses different techniques from many fields like mathematics, statistical modeling, data engineering and visualization, ML, computer programming, data warehousing, pattern recognition, and learning, uncertainty modeling, and cloud computing. DS does not necessarily involve big data, but it is the most widely used technique among AI, ML, and itself. The experts of DS are typically skilled in mathematics, statistics, and computer programming. The Data scientists evaluate complex data problems to bring out insights and correlations relevant to a business.

Figure 1.5 shows the overlaps and hierarchies of AI's concepts and its sub-areas.

AI for Good

AI is really good for many reasons; however, we are not discussing its side effects for now. AI provides powerful and very useful computer systems; it solves problems faster and better than humans, better data handling and projections, extracts concentrated date from legacy. AI's data is the same as the human brain's actions; hence it acts similarly to you ! Medical fields are hugely benefited from AI starting from diagnosing to surgery. The aviation sector, too, is not left alone!

AI gives almost error-free processing and can perform tasks without breaks, including repetitive routines.

Trends in AI

AI technologies are emerging to empower the next generations of commercial systems. Across these current running approaches, common trends recognized in the first movement of AI entrants in the marketplace endure, refer *Figure 1.6*. These include increasing speed, density, and efficiency, diversification in the mechanism, strategies to reduce noise and increase efficiency, smaller-scale engineering, the proliferation of advanced materials, and so on.

AI Trends help many sectors which are showing in the following diagram:

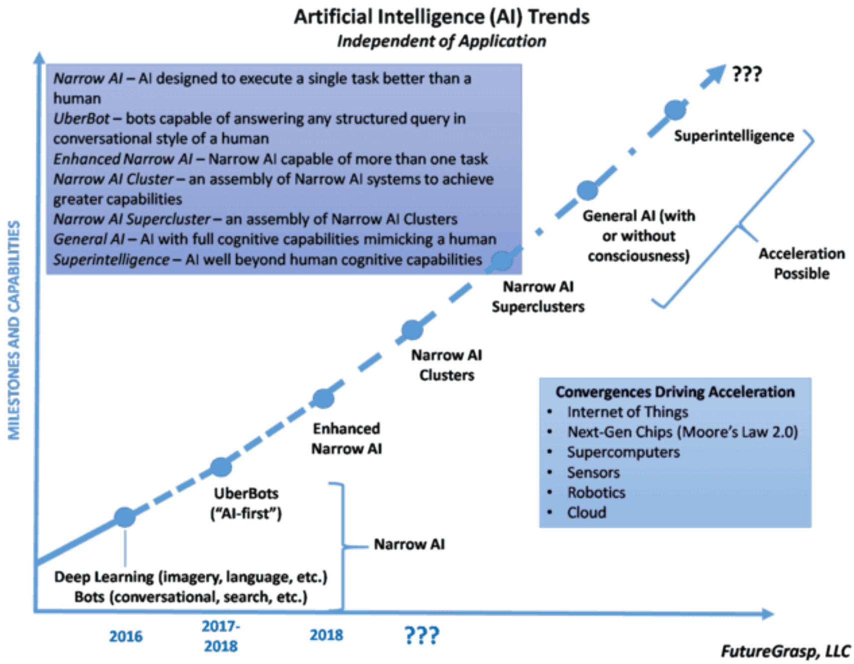


Figure 1.6: *Trends in AI*

The trend depicted in the figure exhibits not only the growth of specialized intelligence but also the need for involvement of other components in the growth. Extending WSN for IoT is shown in the following diagram:

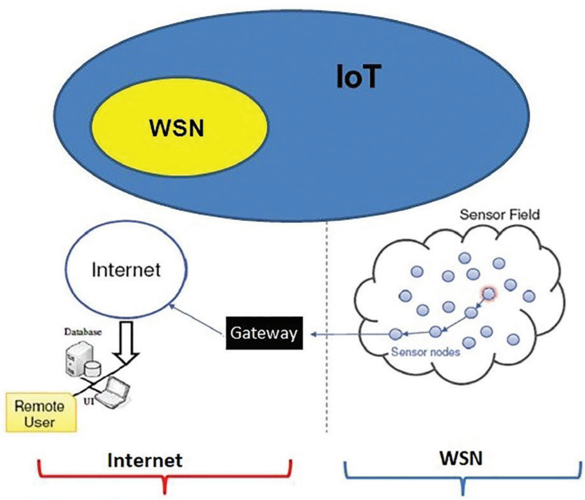


Figure 1.7: *Connection between WSN and IoT*

Those who can understand the WSN concepts and applications to the level of applicability can have a greater chance of understanding the degree of applicability of IoT.

IoT works much better when AI is integrated, which is shown in the following picture:

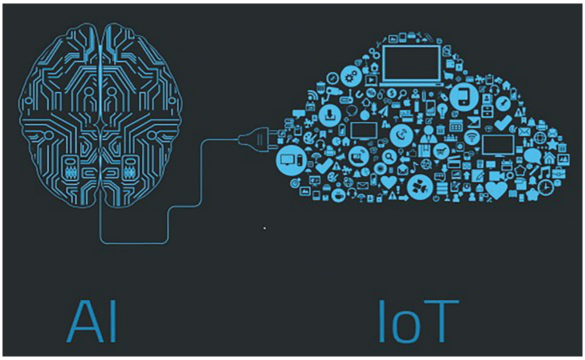


Figure 1.8: *Connection between AI and IoT*

When AI is added to the IoT logic, the quality of the outcome will draw the attention of not only the users but also the researchers to develop more sophisticated solutions.

IoT

Internet of Things (**IoT**) is the internet working of physical devices like home appliances, electronic devices, vehicles, sensors, actuators, and so on that are capable of communicating among themselves (device 1, device 2,...device N) or with the external environment like sensor to vehicles, vehicles to humans that are armed with devices adequate of communicating over a N/W. IoT resides at a higher level than WSN. The WSN is embedded in the technology used within an IoT system. A large collection of sensors, as in a mesh network, can be used to individually grasp the data and send data via a router to the internet in an IoT system, refer *Figure 1.7*. Some time WSN is not nearly as encompassing as IoT. WSN is just a network of only wireless sensors. If the network was to include a wired sensor, it could no longer be called a WSN. This is unlike IoT. Typically any device that connects to the internet can be considered an IoT device. Hence, an IoT setup can, therefore, be interpreted as a group of many IoT devices !

In the IoT, the engineering devices are given a fixed set of instructions like switch off the lights when a person departs the room, like communication between a light and a wearable device on the person based on GPS. In AI, a system will be set up with a learning mechanism and a neutral network, something similar to a human brain that enables a cognitive ability, where the system will learn by understanding and adapting to the environment that it is surrounded by, thus making rational decisions. Here the system/machine/devices are not coded with what to do and what not to do but coded with an ability to learn and understand itself what to do and what not to, refer *Figure 1.8*. In IoT, you can see what a system is capable of doing. In AI, you can never know what a system is capable of until it really does that.

A broad example, say we want to set up an environment where a spouse as soon as enters into their home, turn on A/C and lights but based on outside weather (IoT) and their body's temperature (if they are not feeling well, then no A/C required) and also play a music based on their mood (sad/happy and so on) but not randomly (ML).

When AI intervenes in regular human life!

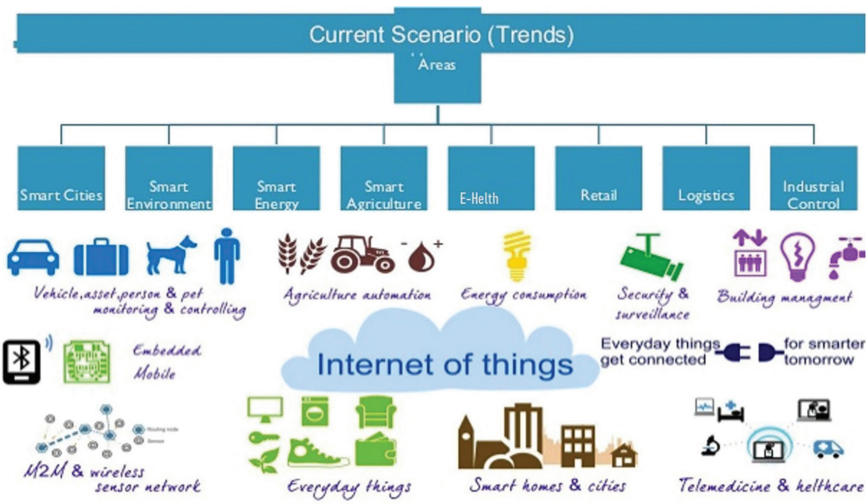


Figure 1.9: *Applications of IoT*

McKinsey projects the total IoT market size in 2015 was up to $900M, growing to $3.7 B in 2020, attaining a 32.6% CAGR, refer *Figure 1.10*.

Applications

Overall applications of IoT have been shown in *Figure 1.9*.

- Consumer applications like Smart Glass, Smart Phones, Smart Home, Smart Hotel Rooms, Smart City, Smart Grids, Smart Retail, Smart Farming, Smart Supply Chain, Smart Light Control, Smart Eye, Smart Switches, Smart Clothing, Elder Care, and so on.
- Commercial applications like Driverless car, Connected Car, Medical and healthcare, Transportation, Building and home automation, and so on.
- Industrial applications like Manufacturing, Agriculture, the Internet, and so on.
- Infrastructure applications like Metropolitan scale deployments, Energy management, Environmental monitoring, and so on.
- Personal use like Wearables, Pulse oximeter, Smartwatches, and so on.

Those who are very alert will capture the opportunity, as shown in the following diagram:

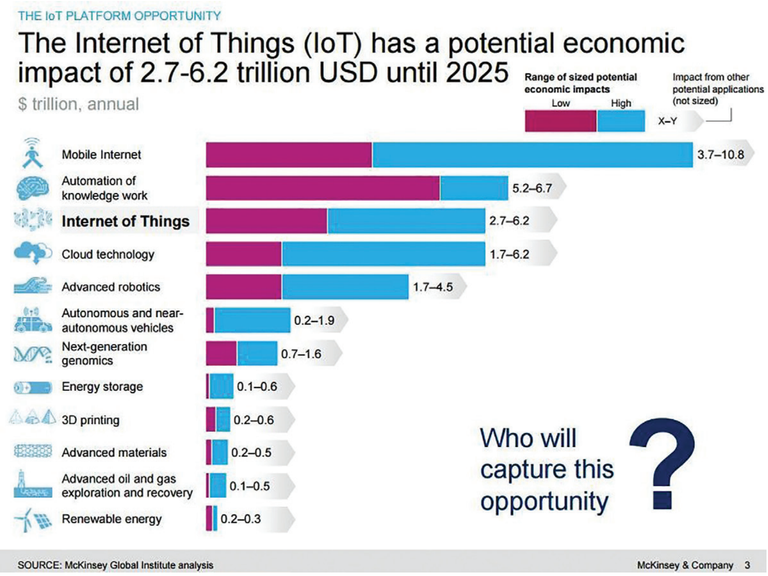


Figure 1.10: Total IoT market

The important point that makes more significant is what makes the IoT grow to the projected potential. The answer is simplified, miniatured pervasive devices that can connect to the Internet with no specific intervention from the user.

Roadmap clearly shows the right direction, as depicted in the following diagram:

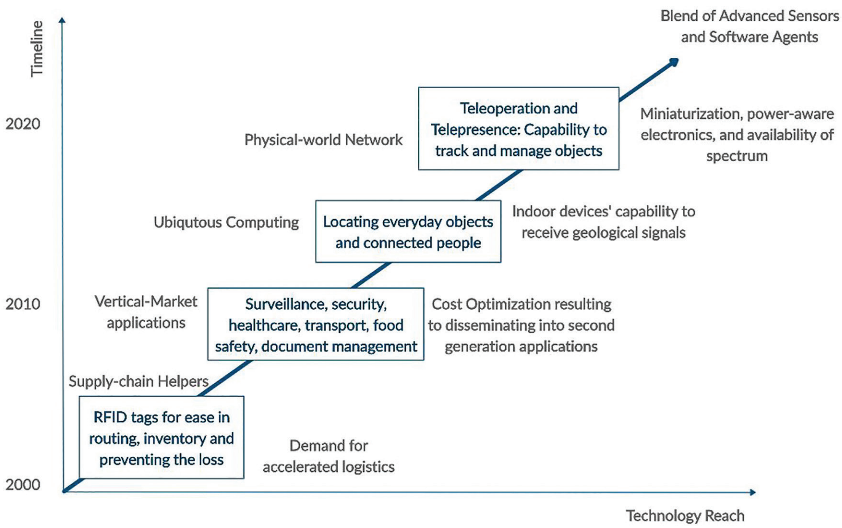


Figure 1.11: *IoT Trends*

The property of the IoT devices to be ubiquitous makes the technology roadmap more meaningful. This further adds strength to the technology developers to add more functions to the devices.

Trends and characteristics

IoT shows an explosive growth of devices connected and controlled through the Internet. This creates opportunities for more direct integration of the physical world into computer-based devices, resulting in efficiency developments, economic benefits, and reduced human activities. Figure 1.11 shows that the number of IoT devices increased by 31% year-over-year to 8.4 billion in the year 2017, and it is estimated that there will be 30 billion devices by 2020. The global market value of IoT is projected to reach $7.1 trillion by 2020.

Organization of the book

The current chapter introduces WSN, AI, and IoT technologies. *Chapter 2* Lists all possible side effects of WSN, AI, and IoTs, where the world needs to change its focus. *Chapter 3* gives a tour of all possible research areas where interested communities or individuals can address the problems. *Chapter 4* summarizes popular simulators used for WSN,AI, and IoT. *Chapter 5* explains the impact of Blockchain technology on WSN, AI, and IoT. *Chapter 6* and *Chapter 7* describes all predictions of AI done by AI, including IoTs.

Summary

This chapter has briefly discussed Wireless Sensor Networks, Artificial Intelligence, and the Internet of Things. After reading this chapter, the reader would gain knowledge about components of WSN and their functionalities, the significance of AI and its branches, and how IoT can be applied in day-to-day life. The next chapter is intended to understand the flip side of these technologies, which might create inconvenience if they are not properly understood or misused.

Questions

1. What are the significant differences between Bio-Sensors and Human-Sensors? In which aspects they are similar?
2. List a few scenarios where the sensors disturb human life?
3. What makes AI so important in the present era? Can't the systems perform better without utilizing AI?
4. Is IoT derived from WSN? If yes, or no, explain how? In how many ways IoT make use of WSN?
5. List various places where you have observed the applications of IoT.

Do some research:

Visit a place where a WSN is implemented, especially on medium- or large-scale. Enquire the frequency of communication failure among any pair of key nodes. Ask the team how did they solve the problem, manually or automatically. Prepare your own solution if their solution didn't satisfy you.

CHAPTER 2

WSN, AI, and IoT – future shock!

Introduction

A strong motive for the researchers and developers is to provide a better solution for the society around them. However, there is a possibility that if the technologies are misunderstood or misused, then the situation might lead to a worse status. This chapter provides a direction for the readers to understand which approach would lead to disasters and damage to society.

Structure

- Negative Impact of WSN, AI, and IoT
- Summary

Objectives

After reading this chapter, the reader will have knowledge of the negative side of the technologies.

Not every development is positive

Let us get into some discussions about panicking situations majorly due to the collective impact of WSN, AI, and IoTs, refer *Figure 2.25*. Alvin Toffler wrote in his book "*future shock*," says that "Every convenience has an equal and opposite inconvenience." We all commemorate Newton's third law- "For every action, there's an equal and opposite reaction." Edna Ferber said- "Perhaps too much of everything is as bad as too little." Keeping these things in mind and considering drastic growth in WSN, AI, and IoT, there's no doubt that new embedded technologies come with great aids, but at the same time, they also have some associated problems.

Prof. Stephen Hawking, one of Britain's distinguished scientists, has said that "Efforts to create thinking machines pose a threat to our very existence even it could end mankind ! ".

In the race to create that next IoTs product that no one can live without such devices, manufacturers and users are creating dangerous side effects called botnets (a group of internet-connected devices managed by a central system). The e-market has been pouring over with inexpensive devices—sensors, baby monitors, webcams, CCTVs, thermostats, mobiles, computers, etc.—that connect to the Internet with IP addresses. *Figure 1-24* shows some funny images but with self-explanatory serious messages! Apart from IoT Criticism, controversies and barriers like Intentional obsolescence of devices, Confusing terminology, Platform fragmentation, Privacy, Design, Environmental sustainability impact, autonomy control, Data storage, Security, Safety, Lack of interoperability and unclear value propositions, Privacy and security concerns, Traditional governance structures and Business planning models, we have serious negative impact on our life, few are listed in the following sections.

Figure 2.1: *(1)*

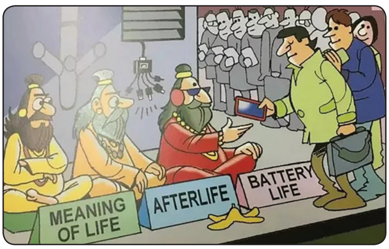


Figure 2.2: *(2)*

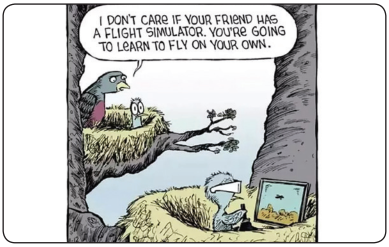


Figure 2.3: *(3)*

Figure 2.4: *(4)*

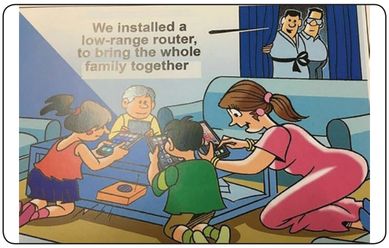


Figure 2.5: *(5)*

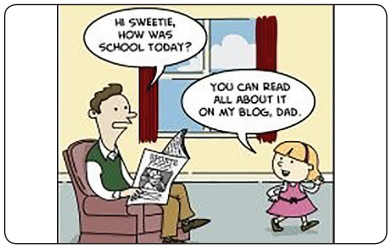


Figure 2.6: *(6)*

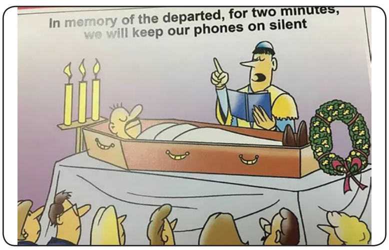


Figure 2.7: *(7)*

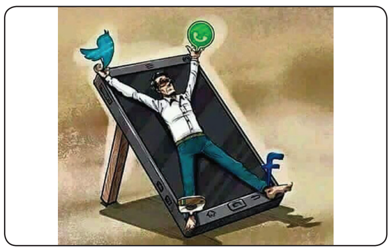


Figure 2.8: *(8)*

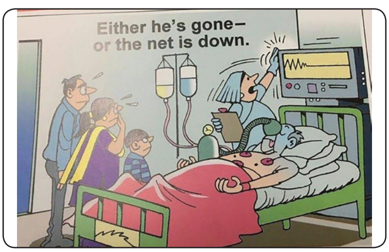


Figure 2.9: *(1)*

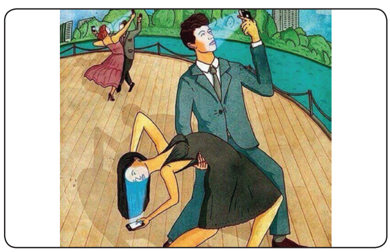


Figure 2.10: *(2)*

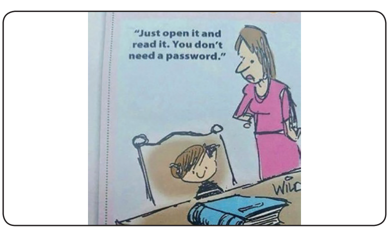


Figure 2.11: *(3)*

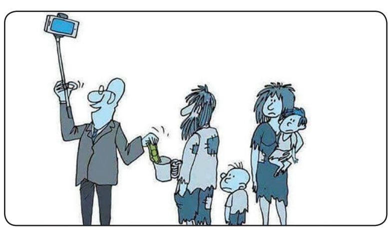


Figure 2.12: *(4)*

Figure 2.13: *(5)*

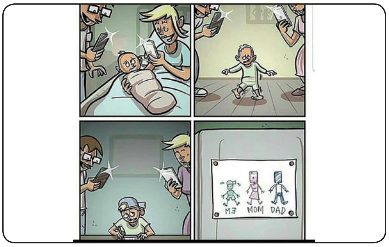


Figure 2.14: *(6)*

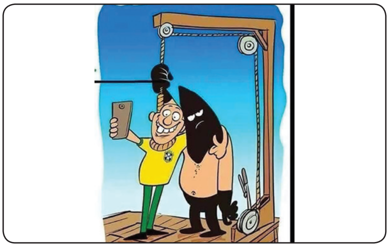


Figure 2.15: *(7)*

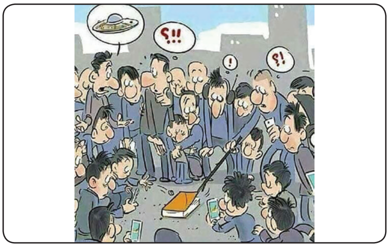


Figure 2.16: *(8)*

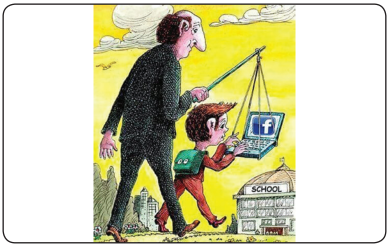


Figure 2.17: *(1)*

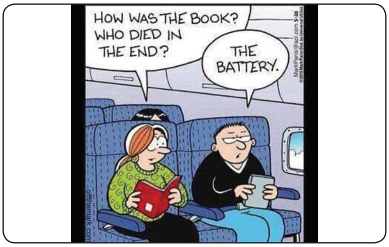


Figure 2.18: *(2)*

Figure 2.19: *(3)*

Figure 2.20: *(4)*

Figure 2.21: *(5)*

Figure 2.22: *(6)*

Figure 2.23: (7)

Figure 2.24: (8)

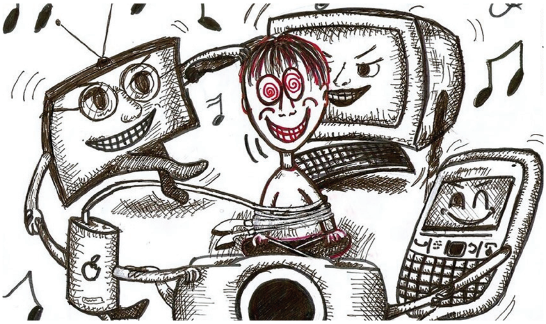


Figure 2.25: *Impacts of WSN, AI, and IoT tools*

The usage of technology is always helpful as long as the users are aware of the limits of usage. If not, the technology makes the user be in mire from which they deny to come out.

The negative impact of WSN, AI, and IoT

Based on the impact of these technologies, we can categorize into following types and its sub-types,

Fake v/s original

AI makes a copy of the human brain, which is copying and the same improving over the period with the help of ML. At the last stage, it may confuse us, which is original and which is fake. This breaks our trust, and we hold a Scrutiny Google for anything you see/hear. Day by day, it becomes better at forging video/audio/image, it will be increasingly more tough to distinguish fabrications from actual events. Coming future, censorship will be unnecessary — instead of deleting data / video / audio, people will simply flood the media with altered forgeries, causing turbulence and ambiguity in public! Some of its self-explained sub areas are as follows:

1. **AI for fake push us into ambiguity in recognition**: AI can gather enough information; it can come up with results that mimic the genuine information/video/audio etc. First came the static images — AI managed to create exactly convincing images of people who have never existed. Then it depicted it was perfectly capable of mimicking different seasons. Example: Lips movement of great personalities or editing their words and retaining their voice as is which was never told them!
2. **Fake reviews and news and medical reports and fake messages, aging, certificates, scamming, fooling, fake foods, fake educating students due to fake ppt, fake reviews AI for fake, fake for AI**: This is a deadlock situation, AI can be used to recognize fake images at the same time we can use it to create fake images!
3. **Fake technical books papers**: Many technical books/papers are generated from the AI algorithms since we have a lot of data on technical books online.
4. **Messed up agriculture**: AI is playing roles in most areas like engineering, agriculture, medical, arts, aerospace, navy, army, etc.
5. **Truth and non-Truth**: Extracting truth from the AI imposed/ manipulated subject is really tough.
6. **Court and trails**: If people are not happy about other's arguments, then they will approach the Judicial system, which can land in self-loop in finding what is the truth?
7. **Fake profiles and Fake humans**: AI can help to create fake profiles that will look like originals, and it can confuse those who look at these profiles!
8. **Fake news and propaganda are only going to get worse**: Nowadays, we see misleading news on social networks like Twitter, WhatsApp, Facebook is really bad. Such news is even produced by AIs, and it is really tough to find what is fake and what is real news.
9. **Manipulating public opinion**: Fake news/videos triggered by bots and AI could have a drastic impact on public opinion, discombobulate all layers of society, from politics to media.

10. **Fake food products**: AI-DL can help to produce fake food products that can potentially harm a human being.
11. **Fake videos**: People are using AI to create a fake adult video of many celebrities.
12. **News writer**: AI can able to write articles for news-fake/genuine.
13. **Hide from Plagiarism**: People are using AI to copy content from the internet and ensuring that it does not detect plagiarism.
14. **Fake Apps**: Including fake sites, we are hitting Fake Apps Attack, which can cause serious damages to IoTs.

As a function of time, the web miscreants keep working on to develop new ways to develop and deliver fake content. The content would look so original that unless it is cross-checked, no one can know.

Easy v/s complexity

Life is easy, but if the system fails, then it turns into complexity ! The statistic *Figure 2.26* shows the number of connected IoT devices worldwide from 2015 to 2025. For 2020, the installed base of IoT devices is forecast to increase to almost 31 billion worldwide, which indicates how the human being is going to be surrounded by IoT devices, and we cannot do without their support!

1. **Error reduction vs. increase**: AI can help to decrease errors, but what if it fails?

   When IoT shows its significance in the future too!

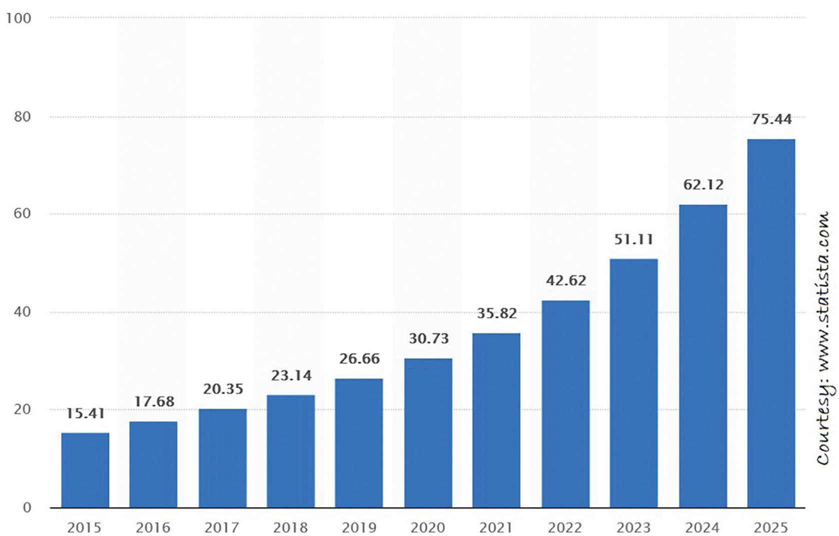


Figure 2.26: *IoT connected devices in billions*

2. **Education**: It is becoming easy for students to learn anything from the internet, but at the same time, they could not decide which is genuine/fake content as there is much fake content generated either for publicity or gaining money.
3. **Google Map**: More dependent on GPS to navigate. Less direction sense.
4. **Easy to write poems and letters**: Say 'I Love You' to AI because it can help you to write Love letters on behalf of you to your Girl Friend, hoping she is not virtual too!
5. **Hides real intelligence coding**: Software coding is becoming automatic, and people's knowledge is limited to the Application level.
6. **IA v/s AI**: This is called Intelligence Assessment v/s Artificial Intelligence, enable him to think and apply to him what he is thinking exactly like Search, Pattern, Image processing, ML, DL, etc.

To reiterate the ease versus complexity, the user of the technology must be aware of what exactly they expect from the technology. If the users do not have clarity in mind, they themselves make it so complex.

Underflow v/s overflow

A number of Experts underflow, unemployment overflow !

1. **Job loss**: This is a tricky situation. At some angle, it will show employment creation, but in another angle, it shows a negative impact on Jobs.
2. **Competition is high**: Not everybody becomes Einstein or rank holder, but it certainly enforces to learn more and more. Now we need to run 1000KMPH to catch the current speed/trends, whereas earlier, it was 100KMPH! because we have pumped a lot of technologies and data into the world, which is essential for everybody to learn!
3. **IoT troubleshooter also needs IoT**: IoT is a chain of devices, and they will be troubleshot using devices only!
4. **Cannot escape**: Since all in the race, so left out or side people cannot escape this race, so forced them to be on the same page.

5. **Increased bullying**: IoT and alias will increase in bullying and escalated the degree of severity.
6. **Addiction**: Day by day, people are addicted to IoT tools. They take devices like cell phones into the bathroom, too, or smart bathroom!
7. **Increases automation**: This will impact on the manual testing community and increases unemployment.

The definition of the overflow and underflow towards technology development varies with the varying minds of the users. Hence, the only thing that is permanent is change.

Compatible v/s non-compatible

Compatible with devices but non-compatible with humans.

1. **Relationships are compromised**: Nowadays, people are not sitting together for meals, discussions, meetings, and so on, hence they loose personal touch!
2. **Confusion**: No surprise, devices are more compatible/comfortable than a spouse ! Hence there will be confusion in choosing robots or girl/boy.
3. **Love letters**: Use AI devices to learn about your Girl/Boyfriends, then AI devices can form nice Love letters for them! Happy AI Love!
4. **Isolation**: People are busy with their gadgets hence a lack of contact with other people in normal daily living, such as- the workplace, with friends, and in social activities.
5. **Stop helping**: People are busy with their devices while walking, sleeping, running, jogging; hence they will either do not notice help seekers or they neglect even if they have watched them!
6. **No guide/teacher**: Teacher and student relationship will be washed-out in the coming era due to online content, YouTube, and self-studying.

Compatibility check before using the gadget or technology is always a safer step for the reason that users can always be aware of need versus availability.

Healthy v/s unhealthy

We have better health monitoring systems than making us healthy! Today we have Computer Technology touching every individual directly or indirectly. Statistics disclose that more than 60% of India does not have access to basic facilities, but people in these areas have access to mobiles, smartphones, or TVs. Ultimately IoT technology should help us make life easier, which we require to use effectively. When we become a slave to technology, the effects are definitely adverse. *Figure 2.27* shown how few negative impacts are too growing along with good things!

The researcher takes input from the negative side too!

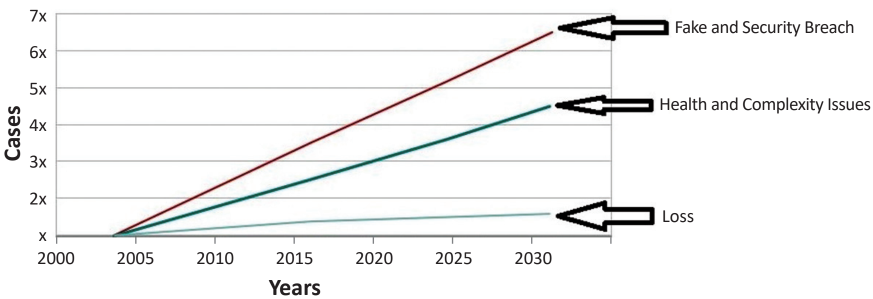
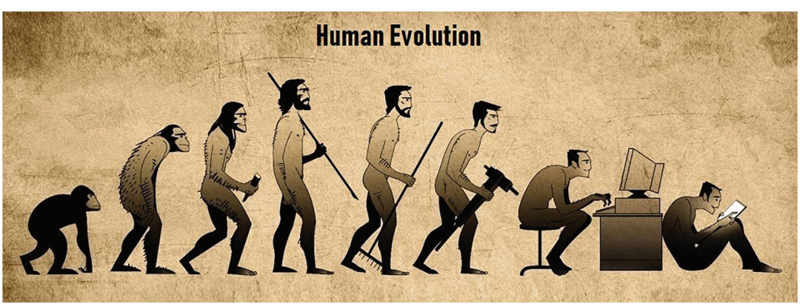


Figure 2.27: *Projection of negative impact over the years*

What can't be easily controlled are the rumors. Moreover, what excites humans more is the attitude of "*Break the rules*." So, in the wake of such scenarios, businesses must be careful to keep watching the fake content being spread about them as well as any security breach that is happening.

Pathos part of Techno-human evolution is shown in the following picture:



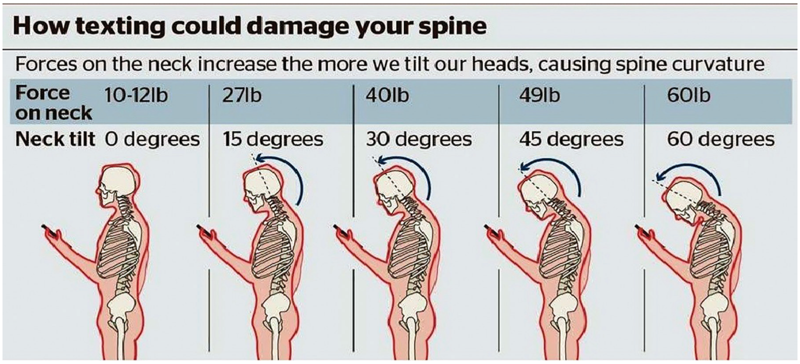


Figure 2.28: *Spine damage due to force on the neck!*

1. **Centralized failure**: Many medical devices are dependent on many devices with master and slave structure. If a master fails, then doctors become clueless! they are neither expertise in troubleshooting Engineering devices nor an expert in treating patients without these devices!
2. **More radiation**: More devices surrounded by humans means more radiation emitting!
3. **More stress due to devices**: People are stressed not just due to spouse problems but from IoT devices too! Most of the time, without their knowledge, they are busy doing nothing! Continuous working or restless working causes an extra layer of stress due to the overuse of technologies.
4. **Selling their organs**: People losing their organs like kidneys, liver for Mobile phones/devices becoming a common habit.
5. **Wearable devices impact**: Means radiation is constant around you!
6. **Useless parts**: Parts of Human brains become useless as we don't really use it for any purpose; hence our next generation doesn't have it similar to our human-tail story.
7. **Human body structure will change**: As we are always tied with devices like mobile, smartwatches, keyboards, and so on, this will certainly alter our structure of the body, but it is over a period, *Figure 2.28* illustrates the head tilts over a period due to using Mobile phones for Talking, Holding mobile phone for texting, Use of computer/phone keyboard and reading the screen, and so on.

8. **Fatal deceases**: Many devices have their limitations, or they do not know whats deceases comes in the future? so it may fail to identify future fatal deceases. It is also true w.r.t fatal diseases.
9. **Developmental issues in children**: Nowadays, more children use a lot of technology devices, certainly it poses negative impacts on our children like addicting to games, sex videos, funny videos, surfing, chatting, talking, and so on.
10. **Poor sleep habits**: Most of the time, we get stuck into work or online activities that keep us up too late or busy, and the continuous stream of data can make it difficult to turn off our brains.
11. **Obesity or laziness**: People will be spending their time on video games, mobiles, googling, chatting/ talking to friends online, YouTube, etc. and no time for activities or exercises.
12. **Shortened attention span or less concentration**: The gadgets shortened our attention span from 12 minutes to 5 minutes. People who are online on an average of 5 hours a day, have trouble remembering people's names, forget pots on the stove and forget wife's birthday, and even their own birthday!
13. **Neurosis**: It makes us suffer from mental and emotional disturbances, such as phobias, anxiety, and delusions, which are all indications of neurosis.
14. **Neck and head pain**: Continuously looking down at systems can cause neck pain and, over time, will cause the neck to lose its natural curve. Similarly, Eyestrain can also cause blurred vision, headaches, and migraines.
15. **Depression**: Due to lack of human contact, overeating, overworking, and lack of exercise will lead to depression.
16. **Lack of sexual boundaries**: Nowadays, people and children are more searching about sex irrespective of existing firewalls configurations, Government ban, and so on. This leads to early exposure to a sexual relationship.
17. **Remote-controlled car crashes**: Any inhuman controlled devices will be more prone to crash.

The funniest part of the users is they keep sharing the content which describes the adverse effects of the over-usage of the technology. But they keep spending more time using the technology to keep spreading the good, results in paradox.

Gain v/s Loss

We lost over intelligence due to machine help, and we gained their control to operate as of now!

1. **Knowledge loss**: We can use BCI (Brain-Computer Interface) or Human-Computer Interaction (HCI) technology to grab your knowledge without your knowledge!
2. **Creativity loss/intellectual death**: We will be degraded as we start using trained systems with improvements. Hence our knowledge could be limited to only coding or decoding intelligence or application level.
3. **Loosing cool on Earth**: Day by day environment gets hotter because more and more devices are added every day into our lifestyle. Even birds like sparrow too missing from the city areas!
4. **Lack of social skills**: Since we less frequently meet with people resulting in a lack of much needed social skills; hence, we lose the practice to read body language and social cues in other people.
5. **Kills time**: This technology can kill our time unknowingly.
6. **Benefits to a few people**: Extends and expands creativity for only a few people, but others are just end-users, and they do not know what is behind the scene of such devices.
7. **Troubleshooting is tough**: Systems are near to operate for any help, but troubleshooting techniques are really far from us. People have to run far to beat current system speed or calculation or fixing an issue, and maybe we can think of self troubleshooting?
8. **Killed Engineering and Non-Engineering branches/courses**: Using WSN, AI, and IoTs, we have almost handicapped other branches other than Computer Science ! This results in an imbalance system of learning and enforcing to learn Computer Science, whether they are interested in it or not.
9. **Expert in overnight**: BCI/HCI modeling can be used to pump/dump all required data into your brain just by sitting and need not study manually, all your brain cells are filled with required information!
10. **e-Waste v/s Waste-e**: We do a lot of electronic wastes(e-waste) on our environment; hence it turned into the waste environment(Waste-e). With the fast-changing world of electronics and technology, we forced to through out the old

electronic devices, in with the new is adding to the levels of toxicity in our land and air. E-waste can cause deadly chemicals to leach into the ground. Industries that manufacture the electronics are emitting toxic fumes into the air.

11. **Space v/s no-space**: We have a lot of space in Disk but not in Home to keep things!
12. **Too much data**: We have devices which generate lots of data, we need big data storage if we want history.
13. **Conclude v/s confuse**: We conclude which AI-based IoT devices need to be used for us, and we will have confusion to acquired new versions, and it's a priority!
14. **Loss of control**: If machines do get smarter than humans, there could be a loss of control that can be a detriment. Whether that happens or whether certain controls can be put in place remains to be seen.
15. **Loss of ethical values**: Day by day, people are losing their ethics due to ongoing growth in technologies.
16. **May kill us**: Set of masters can kill all non-AI experts!

One's loss is another's gain, a simple principle that prevails. However, more the loss might lead to depression, which further might lead to a loss for their dependents.

Security v/s non-security

We are using many AI-based security techniques, but at the same time, we can use AI to breach this security! Refer *Figure 2.31* and *Figure 2.32*, shows security is a top concern in IoT ! Webroot report that 91% of cybersecurity professionals are concerned about hackers using AI against companies in cyberattacks. Always data security is a cat-and-mouse game that continues with AI. Fraud/bad gang will be behind as soon as a security innovation comes to market, and they become part of their arsenal. Most cybersecurity professionals in both the U.S. and Japan are anxious that hackers will begin using AI against them in cyberattacks, refer to *Figure 2.29*.

AI does not ensure 100% safety: AI never meets the human brain's functionality; hence we cannot ensure 100% safety.

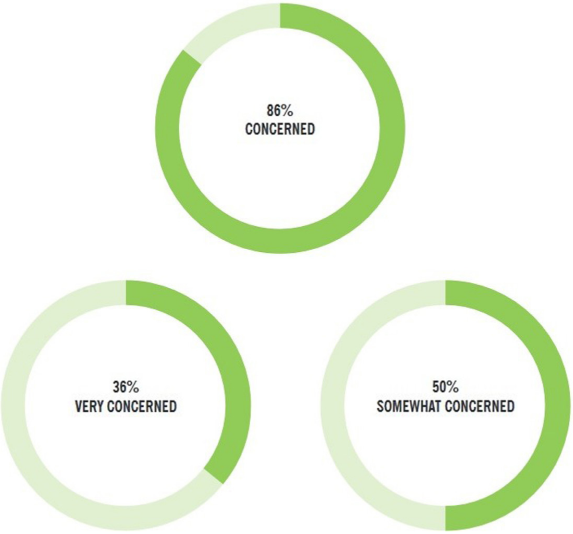


Figure 2.29: *Hackers will use AI in cyberattacks (Courtesy:www-cdn.webroot.com)*

Usage of AI has become pervasive, either for good or to create havoc. When used for creating damages, AI is equally potential to produce huge losses.

Knowledge shall be shared across!

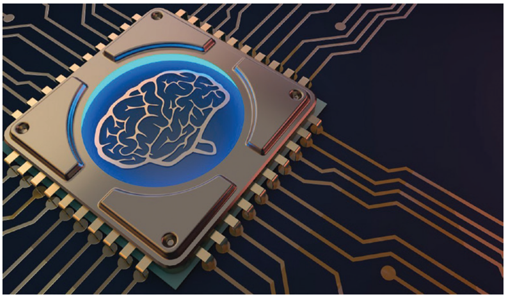


Figure 2.30: *A sample brain image of connecting to devices*

Why would a human brain be connected to the device? Answers could be two-way: serious and funny. On a serious note, a human brain is connected to the device to understand the next-generation Stephen Hawking, and on a funny note, the device reads my mind if I want to eat now or eat after two seconds. Obviously, Security and Privacy.

Figure 2.31: *Priorities in IoT*

Every connected device is on the verge of security. However, what matters the device for its security is how it is programmed to behave and which input it accepts. Security has always been a concern.

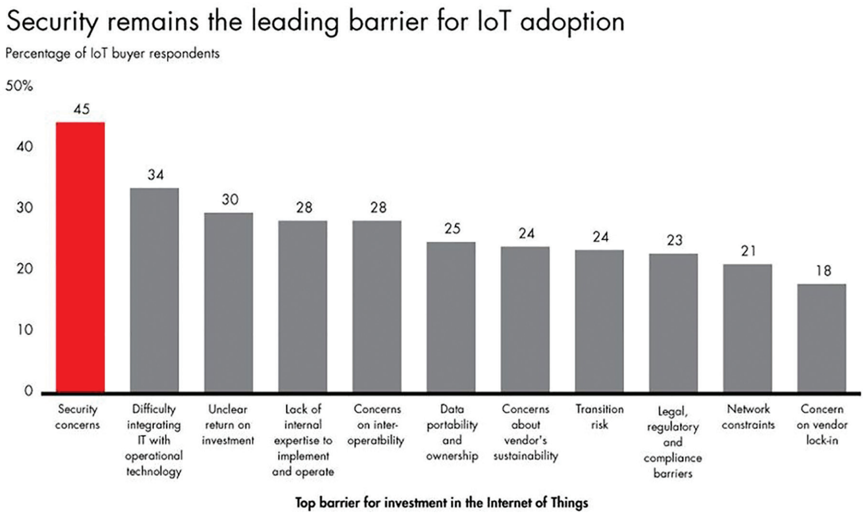


Figure 2.32: *Top Barrier for Investment in the IoT*

1. **Cannot ensure safety**: AI Safety can be broken by itself ! It is just similar to "A thorn can only be removed with another thorn," current community is working in this fashion. Hence it is a win-win situation.
2. **Your brain data copied**: BCI/HCI can be manipulated to train or steal other's brain data unknowingly- say you are traveling in public transport, and we can attach BCI/HCI devices inside vehicles and sense your brain's data. Though it is process-based, BCI/HCI can be improved, and this scenario could be possible, refer to Figure 2.30.

3. **Lost password**: Again, using BCI/HCI, we may lose passwords, which will become non-protective in the future!
4. **Target and kill**: AI to kill humans by feeding his face pattern into AI-enabled Drones with Gun to shoot accurately so dangerous than nuclear weapons!
5. **Master control**: In the future, we may hit a situation like few people will control the larger population.
6. **Lack of privacy**: Nowadays, people have more sinister intentions. The use of phishing, viruses, and hacking helps to find any data they wish to get, and people have no mind of privacy online.
7. **Compromising smart devices**: If any device compromised with malware/viruses, then these devices can act opposite sides of our need.
8. **Phishing scams could get even worse**: Phishing scams would form auto emails, bad websites, or links, and it could be sent from fake accounts that are able to imitate the writing style of people's friends; hence they look real.
9. **Hackers start using AI like financial firms**: One side banks and credit card firms adopt ML to improve their services, so too hackers do the same thing.
10. **Fake digital fingerprints**: AI can fool fingerprint scanners on smartphones, which is raising the risk of hackers using the vulnerability to steal from victim's online bank accounts or crucial things.
11. **AI could make weapons more destructive**: More improvements in AI could enable people, even a person, to cause widespread violence. Say, many algorithms that can detect faces or help drones navigate, self-flying drones with the ability to detect a person's face and then perform the attack.
12. **Sophisticated phishing**: AI can extract sensitive and individual data and can cause attacks more successfully than any human could.

In the digital era, no system is completely secured. Though it sounds weird, the fact is that with the tremendous increase in computational power and optimized coding has shown its impact on the security of the connected systems.

Summary

This chapter has provided the negative side of the technologies, for if they are not properly understood or mismanaged. Readers would have gained an understanding of which is not the right way to use these technologies. In the next chapter, we will discuss the research prospects involved in these technologies.

Questions

1. How AI helps to find the difference between fake and original?
2. What are the various compatibility issues that are related to various IoT devices?
3. Would IoT devices really require security? If yes, or no, justify your response.

Do some research

Pick your smartphone. Ask the assistant installed in your smartphone to play a song based on your recent searches, either over the browser or YouTube. Could the results produce satisfy your expectations? If not, what are your findings and probable solutions for the problem?

CHAPTER 3
Active research areas of WSN, AI, and IoT

Introduction

This chapter empowers the researchers at the beginners-level in the areas of Wireless Sensor Networks, Artificial Intelligence, and the Internet of Things. Also, the intention of this chapter is to inculcate the research attitude among the readers who do not have any thoughts of research.

Structure

- Introduction
- Applications of WSN, AI, and IoT
- WSN Research Areas
- AI Research Areas
- IoT Research Areas
- IoT and IIoT (Industrial IoT) Clouds
- Collective Research Areas
- Top Searching Topics based on Internet

Objectives

After reading this chapter, the reader would be able to understand:

- The applicability of WSN, AI, and IoT
- The importance of conducting research towards developing a solution
- The possibility of research in the areas of WSN, AI, and IoT
- How can these technologies be integrated!

Introduction

Wireless Sensor Network (**WSN**) is an emanated technology for the future due to advances in technology and the availability of small, cheap, and smart sensors resulting in cost-effective and easily deployable WSNs. How synergy between WSN and other technologies can help sensor networks accomplish their full dormant! The dormant synergies such as cloud computing, M2M, cognitive radio, RFID, vehicular networks, and content-centric networking, help the technologies to improve their comprehensive performance and efficiency. The research trend in this area is changing, and our society is adapting to sensing technology very fast. Sensors are widely used in military, manufacturing, health management, disaster management, agriculture, wildlife, construction, transportation, etc. Sensors are becoming part of the life hence its usages are also spreading across machine/human health care, traffic control, home control, military operations, inventory control, area/forest/industry monitoring, air/water testing, and so on, hence this field provides a wonderful opportunity for researchers, industrialists, students, and others to explore more.

AI is a process of training a computer to think intelligently in a similar fashion the humans think. AI algorithms are applied to a wide range of activities, including robot control, medical diagnosis, electronic trading, and remote sensing. AI has been used to implement and advance numerous fields and industries, including healthcare, finance, transportation, education, and more. IoT is playing a major role nowadays, and some researchers and developers are staggered it with something like IoE-"*Internet of Everything*" if you want to do research in IoT with applications, the areas of Smart Health, Smart Home, Smart Cities, Smart Grid, Agriculture and Public Safety issues are hot topics. Other areas would be IoT Network Design, model and Architecture, Virtualization, embedding and integration, cloud infrastructure, middleware, data management, etc. IoT is a set of devices that combines multiple technologies such as RFID, WSN, NFC, and so on. The security protocols that are used by WSN can be integrated as an essential part of IoT security.

Applications of WSN, AI, and IoT

Applications of individual or combinations of WSN, AI, IoT technologies are not limited to one or two areas but spread across many areas.

Applications of WSN

Major applications of WSN include military applications, safety applications, Inventory Management, Health Monitoring, Robots Management, Area monitoring, Environmental/Earth monitoring, Air quality/pollution monitoring, Forest Fire detection, Landslide detection, Water quality monitoring, Natural disaster prevention, Industrial monitoring, Agriculture monitoring, Smart home monitoring, and so on. Each application is explained below:

1. **Military applications**: Initially, WSN is used for military applications; for example, monitoring battlefields where a human cannot reach. Also used for monitoring or tracking the enemies and force protection; similarly, it can be used for monitoring nuclear/chemical attack, targeting points, and so on. WSN can help to alert the military command to targets of interest, such as moving vehicles and personnel in hostile regions.
2. **Safety applications**: WSN can be used for safety purposes in home, industry, health, and so on. WSN will have indoor safety detection devices and handheld terminals, temperature and humidity sensor, combustible gas sensor and smoke alarm, and disaster can be alerted using these device's data.
3. **Inventory management**: Monitoring the process of flowing units into and out of an existing inventory.

4. **Health monitoring**: Usually, a health monitoring network contains heterogeneous WSN nodes; for example, some sensors are wearable on the patient's body, and some placed inside the body of a human. Collaborative data collection of these nodes together provides the health status of the human being. Basically, data is collected, aggregated, pre-processed, stored, and acted upon using heterogeneous sensors and devices like pressure sensors, RFID tags, floor sensors, environmental sensors, a dust sensor, wearable sensors, and so on.
5. **Robots management**: WSN can be deployed instantly and provides a link to the robots; a WSN can aid the robot's navigation, localization, and also enhance its sensory capabilities.
6. **Area monitoring**: WSN can be used in place monitoring for a different purpose.
7. **Environmental/Earth monitoring**: WSN can monitor several environmental parameters such as underground water level, barometric pressure, ambient temperature, atmospheric humidity, wind direction, wind speed, rainfall and so on, and this data is passed to the end-users who can make use of this information.
8. **Air quality/pollution monitoring**: WSN consists of several distributed air monitoring stations that communicate wirelessly with a backend server using node-to-node communication.
9. **Forest fire detection**: WSN, like ZigBee, can use coordinator, routers, nodes, and PC computer for collecting and transporting the special environment parameters of the forest, including temperature, humidity, and light intensity and so on to the LabVIEW system.
10. **Landslide detection**: WSN, such as ZICM2410, is used for landslide monitoring, which includes acquisition nodes, base stations, monitoring hosts, and PCs. This information can be viewed via PC management software.
11. **Water quality monitoring**: This kind of application consists of Wireless Water Quality Monitoring Network and Remote Data Centre. This network collects the samples for evaluating the water quality and sends the data to the Internet with the help of the GPRS DTU, which has a built-in TCP/IP protocol. This testing of water can be used for regional water quality conditions, like

testing corporation water, industrial water, plant, and agriculture-related water.

12. **Natural disaster prevention**: WSN provides disaster-related data to the framework for disaster mitigation and rescue operation.
13. **Industrial monitoring**: Ad-hoc networks can be used to monitor the real-life industrial environment. It can monitor machine health, data logging, industrial sense and control applications, wastewater monitoring, and so on.
14. **Agriculture monitoring**: WSN can be used to monitor the greenhouse environments, control greenhouse equipment, and provide various and convenient services to the end-users. WSN Zigbee can be used for monitoring environmental conditions like weather, soil moisture content, soil temperature, soil fertility, weed-disease detection, monitoring leaf temperature/moisture content, and monitoring growth of the crop, precision agriculture, automated irrigation facility, storage of agricultural products, and so on.
15. **Smart home monitoring**: Smart home monitoring system can potentially provide information about device activities and their status, which is deployed at home. This information can be useful for a variety of purposes like monitoring home security, examining the status of devices, and tuning them.

The applications listed above are the most needed from the perspectives of the governments and the large-scale industries. However, small-scale industries might need specific solutions from the applications of the technologies.

Applications of AI

Broad usages of AI are gaming, NLP, Vision, Robotics, Speech/face/handwriting/disease/pattern/image recognition, and so on. Detailed applications are listed as follows:

1. **Optical Character Recognition** (**OCR**): Typically Artificial Neural Network (ANN) software, which takes characters of handwritten images as input and interprets them into machine-readable text, for example, depositing a handwritten cheque into a bank machine.

2. **Handwriting Recognition**: System will extract interpretation from the static handwritten text by processing an image, including disjointing characters from the background noise.
3. **AI-based automation**: A process or procedure is performed with littlest human assistance called automatic control. It uses various control systems for operating equipment such as machinery, switching on mobile networks, steering and stabilization of ships, processes in factories, boilers, and heat treating ovens, aircraft, and other applications and vehicles with minimal/reduced human mediation.
4. **Bio-inspired computing**: It is an extension of the related field of biomimicry, which solves problems using computer models based on the convention of biology and the natural world.
5. **Concept mining**: An exercise that results in the derivation of concepts from the artifacts. Solutions for the task generally consist of the aspects of AI and statistics, such as text/data mining.
6. **Data mining**: The process of determining patterns in large data sets having methods at the intersection of database systems, ML, and statistics.
7. **Knowledge Representation** (**KR**): KR is the process of encoding knowledge, feelings, actions, desires, preferences, goals, beliefs, and all other mental states in AI to find some kind of character set.
8. **Semantic web**: It is an extension of WWW about reasoning/logic and acts as an integrator across different content, information applications, and systems. It can give us a common framework that allows data to be shared and reused across application, enterprise, and community boundaries.
9. **Speech Recognition (+ speech to text)**: Capturing and digitizing the sound waves, transformation of fundamental linguistic units or phonemes, forming words from phonemes, and contextually analyzing the words to make sure the correct spelling of words that sounds the same.
10. **Face Recognition**: Detecting the location of a face from the given image. Do not confuse with the process of identifying who the person is. A general biometric system uses both face detection and faces recognition to perform the work. It avails face detection

to locate the face and then avails face recognition to analyze the person.

11. **Artificial/Computational creativity**: The goal of computational creativity is to model, simulate or clone the creativity using a system to achieve human-level creativity, to codify an algorithmic perspective on creative behavior in humans, to design programs that can improve human creativity without compulsorily being ingenious themselves.
12. **Image Processing**: It is an analysis and manipulation of a digitized image, notably in order to improve its quality.
13. **Computer Vision**: Computer vision is a process of making the automatic extraction, analysis, and compassionate of useful data from a single image or a set of images.
14. **Virtual Reality**: An operation of taking you out from the physical world and placing you in a visionary/imaginary world. e.g., a person can be carried over to a new environment, real or imaginary, within a few seconds.
15. **Photo and Video Manipulation**: AI would help in synthesizing facial expressions—including mouth, eyes, eyebrows, and even head positions.
16. **Diagnosis/Healthcare/Medicines**: AI-ML algorithms can learn to find patterns similar to the way doctors check them, but algorithm needs a lot of concrete examples in order to learn and get accuracy, this would help us to get diagnostic information like finding lung cancer or strokes based on CT scans, assessing the risk of massive cardiac death based on electrocardiograms and cardiac MRI images, classifying skin lesions in skin images, eye diseases, etc.
17. **Game Theory and strategic planning**: In this theory, multiple parties (agents) each have different preferences (utility functions) and different actions that they can take. Game theory studies how agents can rationally form beliefs over what other agents will do and (hence) how agents should act - useful for acting as well as anticipate the behavior of others.
18. **Computer Game Bot**: A bot is a type of AI expert system software that plays a video game in the place of a human. A bot written for a first-person shooter (FPS) works very contrarily from one written for an MMORPG.

19. **Natural Language Processing** (**NLP**): NLP is needed when you want a clever system like a robot to perform as per given instructions. The field of NLP involves making a system to perform helpful tasks with the natural languages that humans use. The I/O of an NLP system can be speech or written text or actions.
20. **Email Spam (junk email) Filtering**: Spammers who collect email addresses from chat rooms, websites, customer lists, newsgroups, viruses will send uninvited commercial messages in bulk by email (spamming). Whether commercial or not, many are not only irritating but also unsafe because they may contain links that push you to phishing web sites or sites that are hosting malware or include malware as file attachments.
21. **Hybrid Intelligent System** (**HIS**): This combines at least two intelligent technologies, for example, combining a neural network with a fuzzy system results in a hybrid neuro-fuzzy system.
22. **Intelligent Agent (IA)**: It could be AI hardware and/or software system with sort of autonomy and the capacity to make decisions and take actions, these are more advanced than conventional agents/bots whose actions are fully programmed.
23. **Intelligent Control (IC)**: These are characterized by pursuits to emulate imperative aspects of biological intelligence. Controlling dynamic systems because of their complexity, are very painful to control by other techniques.
24. **Litigation**: AI has opened up an ample new horizon of convenience to invent and change nearly every field.
25. **Robotics**: Types include Behavior-based robotics, Cognitive, Cybernetics, Developmental robotics (Epigenetic), Evolutionary robotics, etc. Robots are programmable systems that are typically able to carry out a series of actions autonomously/semi-autonomously. A robot constitutes Programs, sensors, and actuators, some other electronic devices, etc.
26. **Artificial Life**: Observing systems related to natural life, its processes, and its evolution, through the use of simulations with computer models (soft), robotics (hard), and biochemistry.
27. **Automated Reasoning**: Reasoning can spread across AI, theoretical computer science, and even philosophy. The

investigation of automated reasoning helps produce computer programs that permit systems to reason completely or approximately completely automatically.

AI is pervasive, and the applicability has proven its feasibility. However, there are areas where AI's application might lead to disturbing the ecosystem. Hence, before choosing to implement AI, conducting a study to evaluate its adverse effects on the system.

Applications of IoT

IoT would increase efficiency, improve health and safety, or create better experiences. A list of applications, as mentioned in *Chapter 1*, is depicted in *Figure 3.1*. Think smart for your home:

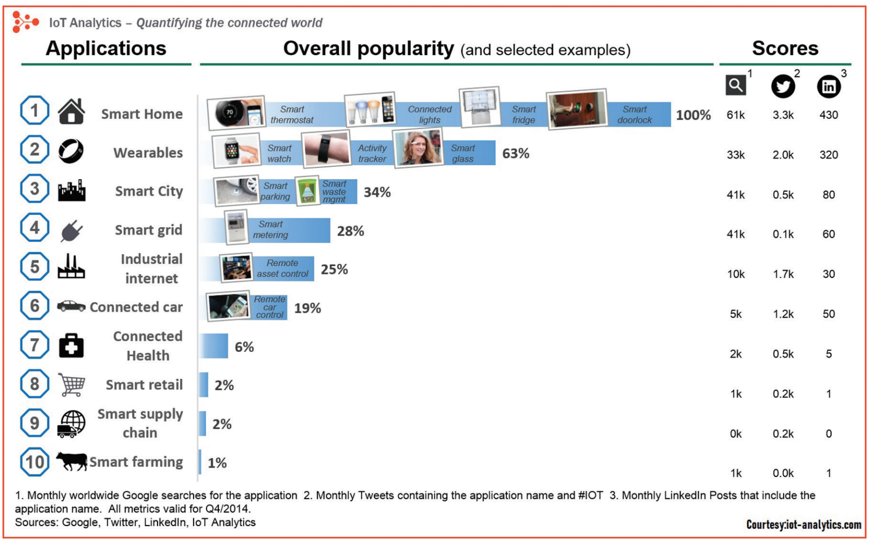


***Figure 3.1:** Applications of IoT*

While calculating the popularity of the IoT applications, IoT analytics have played a key role, which emphasizes the wide applicability of IoT.

WSN research areas

WSN is the most exciting area of research as it is an emerging technology that has a wide range of potential applications, hence the computer science community is running towards networking of sensor's technology. The following sections will explain about main areas of research where students/beginners can concentrate on it. This section briefs about research areas, which helps new researchers to find their areas. Broadly, there are 6 areas, and they are Management of Network, Data, Security, QoS, Resource, and Integrated Areas. Apart from this, there are plenty of application areas where the network is application-specific.

Network management

Network management is a process of monitoring and controlling the network. The fundamential objective of network management is to accomplish a network that is free from erroneous communication. For the today's network environment, various network management tools are available that offer the services as an integrated solution. Apart from these expectations, network management tools have to perform key functions, such as fault detection, performance management, maintaining quality-of-service, and network provisioning.

Topology management

Topology is a structure of a network, and it can be changed when nodes move from one place to another place; hence there could be changes in transmitting range and wake/sleep schedule of all/few nodes without affecting network connectivity and sensing coverage. Different network topologies will have different effects on the properties of the WSN, such as reliability, energy consumption, and latency. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network, including clustering. Many inventions have been carried out in this area, such as topology directed routing, cooperating schemes, sensor coverage based topology control, and network connectivity based topology control. The taxonomy of topology issues in WSNs is shown in *Figure 3.2*. Topology organizes many things!

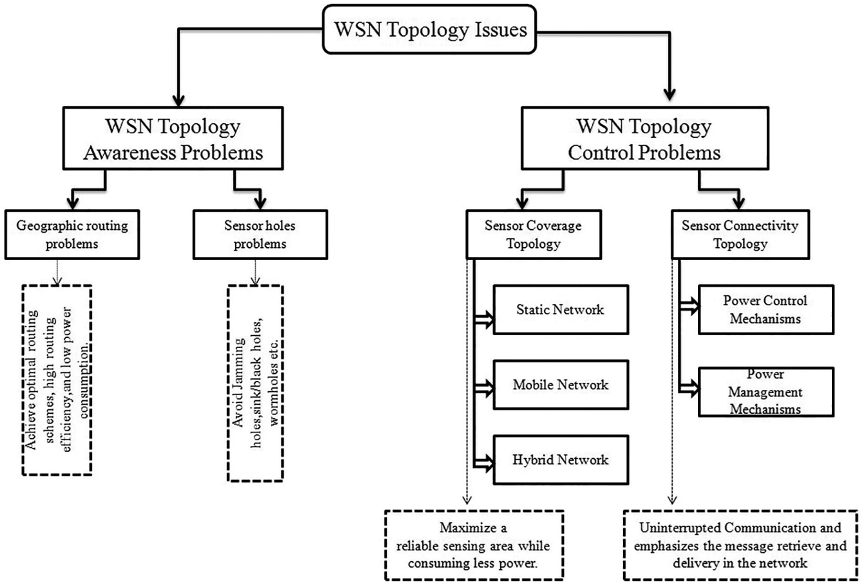


Figure 3.2: *Taxonomy of Topology Issues in WSNs*

The topology issues depict various connected problems, such as location-aware and connectivity. Solving these issues might lead to a better-connected network, which would further lead to better technology.

Heterogeneous nodes

A **heterogeneous WSN** is a network of different access technologies with different operating systems and/or protocols. This strategy is an effective way to increase the lifetime and reliability of a network.

Introducing heterogeneous nodes in a WSN possess high-speed microprocessors and high-bandwidth, long-distance network transceivers, which can be used in the network utility. These scenarios can face many problems, including how many and where heterogeneous nodes should be deployed. Since the heterogeneous network can have nodes with high process powers and significant energy (manager nodes or super-nodes), and some of the nodes are having normal process power (monitoring nodes/relay nodes) to support main/header/manager nodes in the path. In order to increase the lifetime of WSN, reconfigurable heterogeneous architecture is essential; similarly, intrusion detection needs to be aware of heterogeneous WSN. The nature of heterogeneity can be supported by WSN middleware, and this will support many real-time applications.

Scalability of network

Scalability is the ability to handle a growing network by adding hardware (processors, memory, battery, and so on) and Software (efficient algorithms, operating systems, drivers, etc.). A scalable network system would be one that can start with just a few nodes but can easily expand to thousands of nodes. Scalability can help in increasing total throughput, whereas it can face many challenges like resource cost, efficient topology management, load balancing, network lifetime management, adaptable routing, number of hops in a path, cost of a path, and so on.

Routing management

Routing is a method of determining a path between source and destination upon request of data transmission. Routing is very challenging due to several characteristics like wireless connection, open media, bandwidth constraints, and so on. Broadly, there are two types of routing techniques; the first one is static routing, where the routing table is constant, or route is calculated (manually/auto-compute) during deployment of the network. The second one is dynamic routing, here route is computed on-demand or dynamically using daemon process or auto-computing routing algorithms. Similarly, there are many routing techniques based on network structure and protocol operations, as shown in *Figure 3.3*.

Would the future be contextual routing!

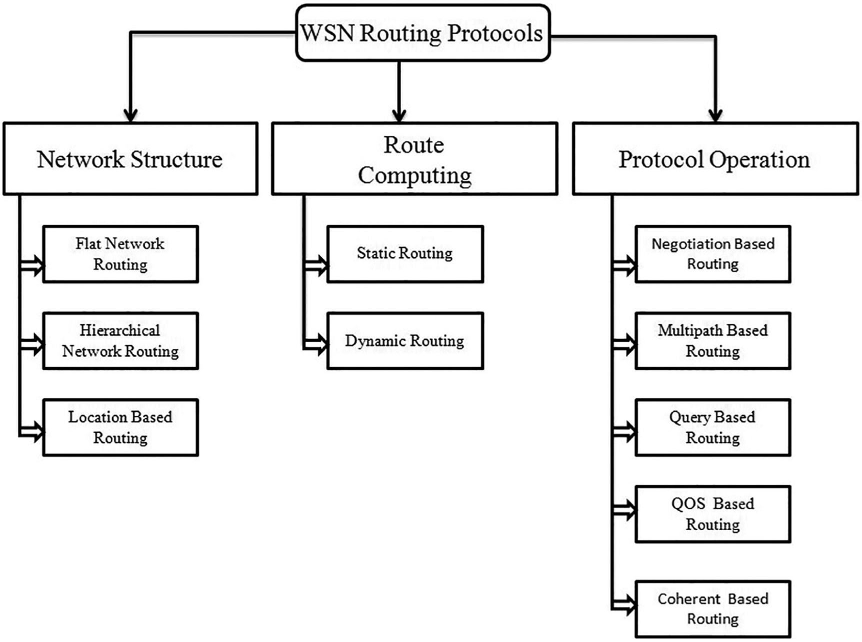


Figure 3.3: *Classification of Routing Protocols*

Routing has to address many challenges like Node deployment, Energy, QOS, Data reporting method (time-driven, event-driven, query-driven), Node heterogeneity, Fault tolerance, Scalability, Network dynamics, Transmission media (MAC), Connectivity, Coverage, Data aggregation, and so on.

Clustering techniques

Clustering is a technique of grouping of similar objects or context-sensitive nodes, which can be based on distance or proximity or logical organization, and so on. Clustering routing protocols have many advantages, such as more scalability, better connection, better QoS, less load, less energy consumption, collision avoidance, and more robustness. Major WSN clustering types are Static/dynamic, Single hop/multi-hop, homogeneous/heterogeneous. The taxonomy of clustering schemes is shown in *Figure 3.4*.

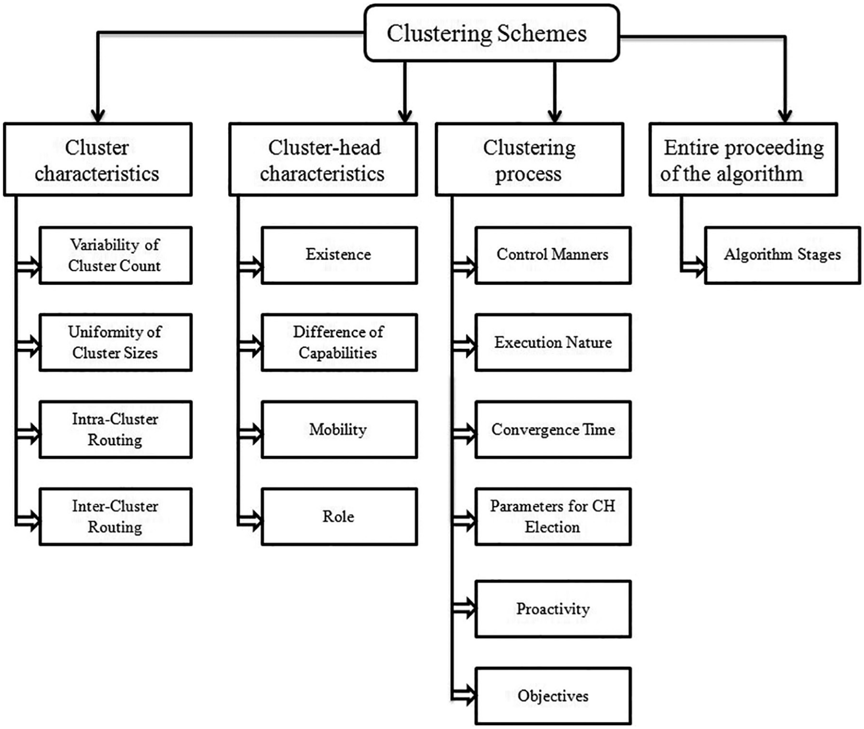


Figure 3.4: *The Taxonomy of Clustering Schemes*

Clustering schemes help the WSNs to resolve the very important issue that is, network lifetime. When the network's lifetime is increased, it obviously increases the reliability of WSN.

Clustering has proven to be an effective approach for organizing the network into a connected hierarchy.

Fault management

Fault management is the set of functions of network management concerned with detecting, isolating, and resolving problems. Thus, the fault management function should provide techniques for error detection, correction, log reports, and diagnostics, preferably auto-logging. Multihop communication, sensor nodes have made it possible to build reactive systems that have the ability to monitor and react to physical events/phenomena. Fault tolerance is as critical as other performance metrics such as resource constraints, energy efficiency. The taxonomy of fault-tolerant techniques is shown in *Figure 3.5*. Know-How to group similar devices.

Handle the faults correctly as follows:

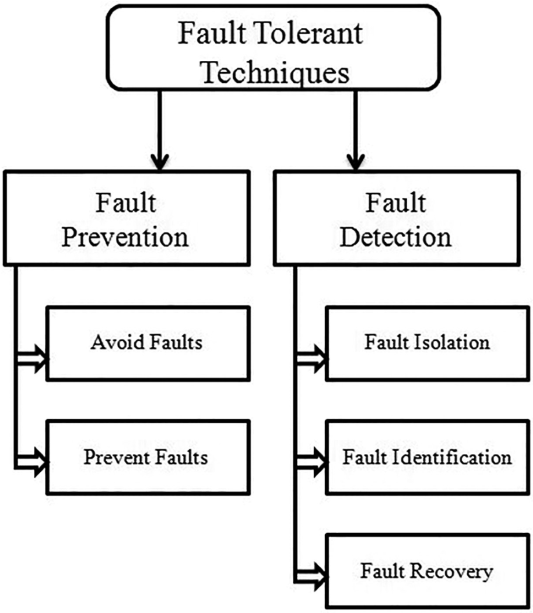


Figure 3.5: *Taxonomy of Fault-Tolerant Techniques*

The fault-tolerant techniques should address not only fault detection and fault prevention but also fault avoidance.

QoS, latency, and accuracy in supporting distributed sensor applications as WSN is a more failure-prone network.

Most of the fault avoidance techniques work in the network layer, and fault detection and recovery techniques operate at the transport layer, and a few fault recovery techniques perform at the application layer.

Security management

WSNs are vulnerable to security attacks due to the open or broadcast nature of the communication medium. Accessing any facilities or resources of WSN needs to ensure the proper authorization. Broadly, WSN attacks are classified as active attacks and passive attacks. Attacks can occur in a variety of ways, most notably as a **denial of service** (**DoS**) attacks, but also through traffic analysis, privacy violations, physical attacks, Sybil attack, node replication attacks, and so on. Attacks on WSNs challenge the mobile infrastructure in which nodes can join and leave easily with dynamic requests without a static path routing. Schematics of various attacks in the layers are shown in *Table 3.1*:

No	Layer Name	Attacks
1	Physical	Traffic Jamming, Interference, Eavesdropping.
2	Data Link/ MAC	Selfish Behaviour, Malicious Behaviour, Internal-External Attacks, Active, and Passive Attacks.
3	Network	Black Hole, Grey Hole, Worm Hole, Sybil, Location Disclosure, Link Withholding, Link Spoofing.
4	Transport	Flooding, Session Hijacking.
5	Application	Repudiation, Malicious Code, Data Corruption.

Table 3.1: *Attacks in various layers of WSNs*

Security requirements can include data confidentiality, data integrity, data freshness, availability, self-organization, time synchronization, secure localization, authentication, and so on. The overall security requirements are listed in *Table 3.2*:

No	Requirements	Description
1	Access control	Need to restrict the access of network resources by non-legitimate and unauthorized entities.
2	Authentication	Participants in communication are authenticated and not impersonators.
3	Integrity	Accounts for whether a given data has been modified in transit from its source to the destination.
4	Confidentiality	Confidentiality ensures that data should be accessed only by authorized parties.
5	Availability	Network resources should be available to authorized entities without any excessive delays. Availability applies both to data and services.
6	Nonrepudiation	Makes sure that the sender and receiver of a message cannot disown that they have ever sent or received such a message.

Contd…

7	Anonymity	Information that can be used to identify the owner or current user of the node should the default be kept private and not be distributed by the node itself or the system software.

Table 3.2: *Security requirements in WSNs*

All these requirements or security mechanisms must be implemented in any WSN so as to ensure the security of the transmissions along with network path. Hence, while considering any security issues, we always need to ensure that these security goals have been put into effect, and none of them are flawed.

Performance management

A necessary condition for the deployment of WSN is that the transmitted application's data is received correctly with trust or not. Hence monitoring WSN's performance is very crucial to cross-check the provided information about the transmission quality with/without feedback control actions. Hence measuring the network performance through analysis of statistical data or though simulations for bulk data/commands.

WSNs are vulnerable to the security attacks due to its properties, such as wireless connectivity and limitations in implementing the communication protocols. Hence, defining the security requirements would help to develop the appropriate solutions.

Configuration management

WSN configuration management helps to fill the gap between informal and standardized solutions. It consists of the definition of data models to configure (reconfigure, operate, or shut down) to improve network performance.

Data management

WSN can sense physical and environmental conditions and process data for data storage, computation, and communicating with others with energy efficiency. Many factors of WSN will affect data management like security, logging, processing, bandwidth, etc.

Data quality

WSN should provide a high-quality stream of data in the communication. The quality of data should reflect the timeliness and accuracy of collected information that is presented to interested recipients who make some computation based on these data.

Data transmission

Efficient **data transmission** techniques are required with the support of security solutions. Efficient data transmission depends upon routing, bandwidth, security, processing power, signal range, and so on.

Data integrity

Data integrity refers to assuring and maintaining the accuracy and consistency of data until it reaches the destination. Wrong or malicious data would result in incorrect decisions; hence we should make sure that data is delivered as is with resolving security challenges, limited resources, computational problems, lack of power, lack of storage capacity to the destination.

Data backup

Data backup is the process of copying and archiving of sensor's data, so it may be used to restore the original after a data loss event. The research trends should suggest arrangements so that the gathered data from an environment needs to be stored in the storage as a backup.

Security management

A WSN is often susceptible to security attacks due to its character of open medium, dynamic changing topology, cooperative algorithms, lack of centralized monitoring and management point, and often lack of clarity in defense. All these have changed the landscape of network security. The long-established way of protecting networks with firewalls and encryption software is no longer adequate and effective. We require searching for new architecture and mechanisms to shield the WSN infrastructure and applications. Providing communication among hosts in a hostile environment is primary anxiety. The unique features of WSNs present various challenges to the security design, such as open P2P network architecture, a mutual wireless medium, and a highly vibrant topology. These challenges increase the requirement of developing protected solutions that attain wider protection while maintaining advantageous network performance as there is no standard security mechanism in a WSN from the security design viewpoint.

Attacks on WSNs challenge the mobile infrastructure in which nodes can join and leave easily with dynamic requests without a static path routing. Schematics of various attacks in layers are shown in *Table 3.1*. The overall security requirements are listed in *Table 3.2*. All these requirements or security mechanisms must be implemented in any WSN so as to ensure the security of the transmissions along with network path. Hence, while considering any security issues, we always need to ensure that these security goals have been put into effect, and none of them are flawed.

There are two main security challenges in WSNs due to its nature: the first being **active attacks** (**AA**) and second being **passive attacks** (**PA**). AA can be defined as the unruly node has to bear some energy costs in order to perform some damaging operation. PA can be defined as a lack of collaboration with the purpose of energy saving. A node that performs AA with the intent of damaging other nodes by reasoning network outage is considered as a malicious node. A node that achieves PA with the intent of saving battery life for their personal communications is considered to be a selfish node. These nodes can severely degrade network performances and ultimately separate the network. Even though prevention sometimes works to defend WSNs, it is not sufficient to address all the security threats. Hence, we can use a middleware-based framework that adopts the prevention and detection techniques to protect WSNs.

Security goals

WSNs should have the following security goals:

- Integrity: Ensuring a message has not been altered by malicious nodes.

- Confidentiality: Protecting secret information from unauthorized entities.
- Data Origin Authentication: Authenticating the source of the message.
- Access Control: Restricting access to resources.
- Forward Secrecy: Preventing a node from decrypting any future secret messages after it leaves the network.
- Backward secrecy: Preventing a joining node from decrypting any previously transmitted secret message.
- Survivability: Providing a certain level of service in the presence of failures and/or attacks.
- Efficiency: Storage, processing, and communication limitations on sensor nodes must be considered.
- Freshness: Ensuring that the data is recent and no adversary can replay old messages.
- Scalability: Supporting a great number of nodes.
- Data Authentication: Ensuring that the data is originated from the correct source.
- Data Integrity: Ensuring that any received data has not been altered in transit by unauthorized parties.
- Data Freshness: Ensuring that no old messages have been replayed.
- Availability: Ensuring that services offered by whole WSN or by a single sensor node must be available whenever required.

Reaching the security goals is essential for a technology to be made available for the users in the real-time environment.

Types of attack

WSNs are more vulnerable to several key types of attacks. Major attacks to WSNs are explained as follows:

Denial of Service (DoS) attack

WSN jamming can block the network while communicating with neighbor/- header; in such cases, no messages are able to be sent or received, which is called constant jamming. If the jamming is only intermittent, then nodes are able to exchange messages periodically, but not consistently.

Sybil attack

This is also known as malicious behavior, and it can be routing algorithms, data aggregation, voting, fair resource allocation and foiling misbehavior detection, and so on. In this single attack, node pretends to be present in different parts of the network, hence it affects geographical routing protocols.

Sinkhole attack

The attacker creates metaphorical sinkhole by advertising wrong information, for example, the high-quality route to a base station, then a genuine node can use this route for communication, hence attacked. Sometimes most of the traffic is directed towards the sink, which can cause single point failure.

Node replication attack

An attacker seeks to add a node to an existing sensor network by copying (replicating) the node ID of an existing sensor node. A node replicated in this fashion can severely disrupt a sensor network's performance, including packets corruption or even misrouted.

Monitor and Eavesdropping

By snooping to the data, the adversary could easily discover the communication contents. When the traffic conveys the control information about the sensor network configuration, which contains potentially more detailed information than accessible through the location server, the eavesdropping can act effectively against privacy protection.

Traffic analysis

Even when the encrypted messages are transferred, it still leaves a high possibility of an analysis of the communication patterns. Sensor activities can potentially reveal enough information to enable an adversary to cause malicious harm to the sensor network.

Camouflage adversaries

One can insert their node or compromise the nodes to hide in the sensor network. After that, these nodes can copy as a normal node to attract the packets, then misroute the packets, conducting the privacy analysis.

Physical attack

Sensors include cryptographic secrets, associated circuitry, sensor programs, permanently. Once they are attacked, the physical destruction of the devices would only be the option. Hence, losses are irreversible.

Node subversion

The capture of a node may reveal its data, including the disclosure of cryptographic keys and thus compromise the whole sensor network. A particular node might be captured, and information (key) stored on it might be obtained by an adversary.

Node malfunction

A malfunctioning node will generate inaccurate data that could expose the integrity of the sensor network, especially if it is a data-aggregating node such as a cluster leader.

Node outage

Node outage is the situation that occurs when a node stops its function. In the case where a cluster leader stops functioning, the sensor network protocols should be robust enough to mitigate the effects of node outages by providing an alternate route.

Wormholes

Tunnel packets received on one part of the network to another, so it can completely disorder routing; hence this may lead to sinkhole if a node on the other end advertises a high-quality route to sink.

Routing attacks

The attacks which act on the network layer are called routing attacks. The spoofed, altered, and replayed routing information are the attacks that happen while routing the messages.

HELLO flood attacks

Many routing protocols require nodes to broadcast HELLO packets after deployment, which is a sort of neighbor discovery based on the radio range of the node.

Attacks against privacy

WSN can have privacy settings due to increased data collection capabilities. Adversaries can use even seemingly innocuous data to derive sensitive information if they know how to correlate multiple sensor inputs; the hunter can imply the position of pandas by monitoring the traffic.

Acknowledgment spoofing

An attacker may spoof acknowledgments to convince that weak link is strong, or that dead node is alive. Hence, packets sent through that link may be lost or corrupted.

Message corruption

Modifying the content of a message by an attacker due to which the integrity is compromised, is called message corruption.

Fake routing

Injecting fake routing control packets into the network, examples: attract/repeal traffic, generate false error messages, causes routing loops, increased latency, decreased lifetime of the network, low reliability, and so on.

Passive Information Gathering

Sometimes an intruder with an appropriately powerful receiver and well-designed antenna can easily pick up the data stream. The interception of the data containing the physical locations of sensor nodes allows an attacker to locate the nodes and destroy them. Besides the locations of sensor nodes, an adversary can observe the application-specific content of messages, including message IDs, timestamps, and other fields. To minimize the threats due to collecting the passive information, strong encryption techniques need to be used.

Selfishness

A compromised node might deny to forward packets or forwards selected packets; however, neighbors might start using another route.

False node

A **false node** involves the addition of a node by an adversary and causes the injection of malicious data, which potentially destroys the whole network, or even worse, taking over the network on behalf of an adversary.

QoS management

Quality of Service (**QoS**) is to provide best services by ensuring sufficient memory, processing power, bandwidth, power sources, controlling latency and jitter, and reducing data loss or improving data accuracy, aggregation delay, coverage, fault tolerance and network lifetime, and so on due to the difference in application domains and network properties. QoS is really a challenging area because it varies from application to applications with network properties.

QoS research can fall into three categories: traditional end-to-end QoS, reliability assurance, and application-specific QoS. Designing of QoS based energy-efficient routing protocol such as SAR, MMSPEED, MCMP, MCBR, EQSR, and so on to meet the reliability and delay of critical events is really a challenging task. The routing techniques can be classified according to the protocol operation, as shown in *Figure 3.6*.

Resource management

Resources of WSN include a processor, bandwidth, energy, memory, and communication resources, and a node should accomplish its basic operations without resources over tiredness. The objectives of resource management strategies are increasing the lifetime of WSNs, meeting the QoS, and achieving the scalability for large-scale sensor nodes. Resource management need appropriate routing protocols as mentioned in *Figure 3.6*.

Know-how WSN routing protocols:

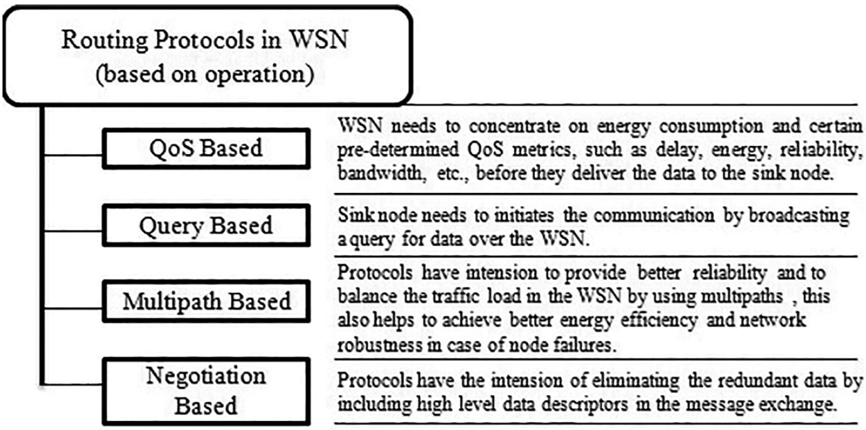


Figure 3.6: *Classification of Routing Protocols*

Though WSN routing protocols seem to be similar to the traditional network protocols, they deviate in terms of energy awareness in addition to the requirements.

Energy management

Most of the sensor nodes are battery-powered devices, and that may not have constant power supply; hence it is a critical resource to reduce the energy consumption of nodes so that the network lifetime can be extended to reasonable times. Most of the energy consumption is originated by environment sensing, data processing, and communication; hence it can help researchers to identify and exploit the energy-saving techniques. The taxonomy of approaches to energy saving is shown in *Figure 3.7*.

Optimized computing leads to power optimization:

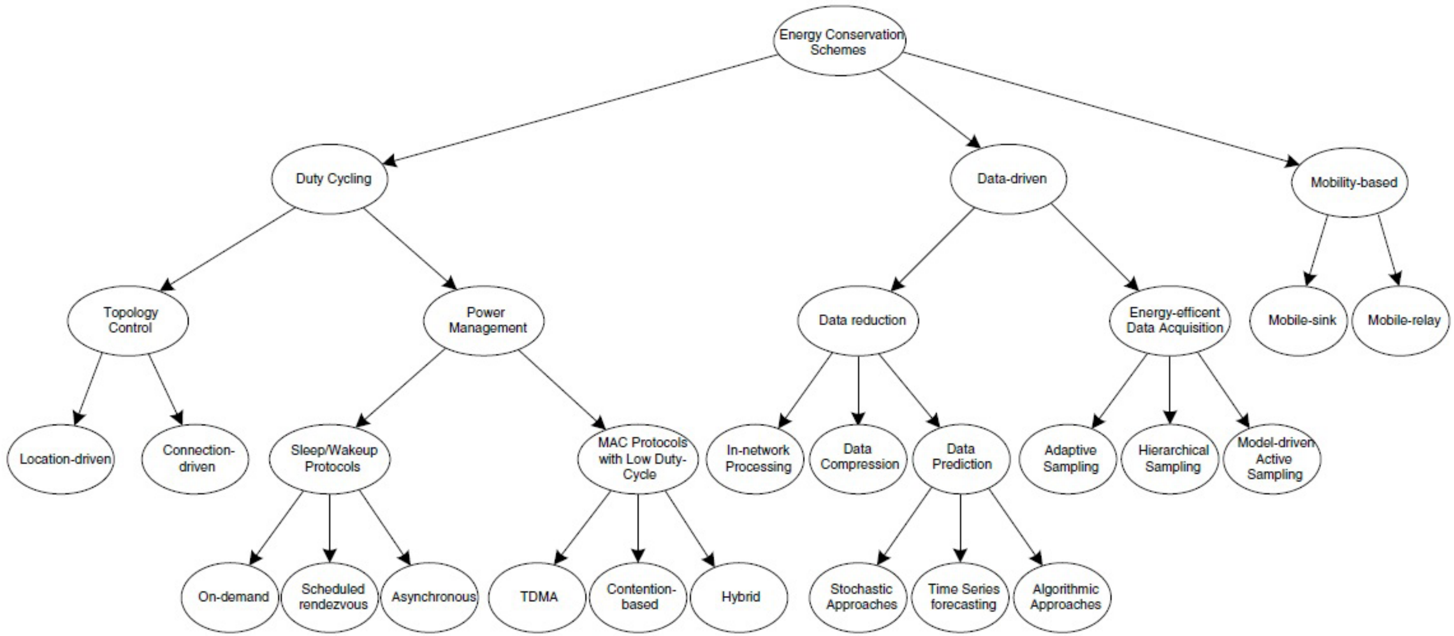


Figure 3.7: *Taxonomy of energy saving approaches*

Power management is an essential requirement for the WSN environment. If this requirement is not properly addressed, the network might lose its valuable lifetime, subsequently affects the reliability.

Memory management

Memory is one of the important resources of a sensor node that is limited, and it overflows very easily, which causes more packets loss. The memory can be affected in processing, computation, multi/single hop retransmission, congestion, data storage, and so on.

Bandwidth management

Bandwidth is the amount of data that can pass through a network interface over a time period (say a BPS-bits per second). As WSN grows larger in size, the bandwidth considerations will become increasingly more imperative and important. Researchers can think about allocating network bandwidth to sensor streams, controlling network congestion, improve the forwarding capacity of the network, etc. Since WSN has the limitations of energy and cost, most of the real-world implementations of WSN consider Carrier Sense Multiple Access (CSMA) and Time Division Multiple Access (TDMA) based schemes.

Data processing

Data generated by WSN needs to be analyzed and processed in order to extract meaningful information from the end-user. Hence, data processing techniques should be more efficient and should not be exhausting the resources like memory, energy, and so on. Data compression techniques can be used to achieve maximum utilization of resources. This can be more effective when we apply data compression techniques such as coding by ordering, pipelined in-network compression, low-complexity video compression, and distributed compression before transmitting the data.

Integrating areas Integration is the process of bringing together different technologies into one system and designed to work together to handle an application requirement. Considering ad-hoc networks, WSN should be able to handshake with web services, Internet, computing technologies, third party suites, and so on.

Internet and web services

The integration of WSN with wireless PAN, LAN, Mesh network, MAN, WAN, Cellular network, and the Internet is a challenging and important issue of future wireless networks. The issue could include reliable communication among sensors, actuators, and applications under the energy-conservation constraints, time-synchronization issue, system architecture issue, and resource constraints. Web services on top of IP based WSNs facilitate the software reusability and reduces the complexity of the application development. The application allows a user to access WSN data directly from a Web browser.

Radio Frequency Identification (RFID)

RFID is used for detecting and identifying the tagged objects by electromagnetic signals and WSN which consists of a huge number of sensor nodes, and both are two important components of pervasive computing where it does coupling the physical and the virtual world while facing the difficulties of feasibility, effectiveness, technical challenges, and so on.

The integration of RFID and WSN provides a new feature and improves the extension functionalities. The RFID and WSN integration in the supply chain provides system intelligence. Identification and detection of tagged items are provided by using RFID, and monitoring of the environment can be obtained by using WSN.

Healthcare equipment

Collecting physical, physiological, psychological data of people, cognitive, and behavioral actions using WSN, which includes ECG, accelerometer, and oxygen saturation (SpO2) sensors for healthcare and IP Multimedia Subsystem (IMS) have emerged in the recent years. This integration enables remote connectivity of patients, doctors, and hospitals; hence medical services are no longer confined to hospitals and clinics. The increased mobility in everyday life demands anywhere, anytime, that is, ubiquitous availability of healthcare services over the internet.

Computing technologies

Data extracted from WSN needs to be better explored and stored for future use like sensor data can be added to blogs, virtual communities, social network applications, etc. This transformation of data derived from sensor networks into a valuable resource for information-hungry applications will benefit from techniques like Cloud Computing, Green Computing, Grid Computing, Distributed Computing, Cluster Computing, Utility Computing, and so on.

Cloud Computing can act as the backend for WSNs to provide processing and storage on demand. Data can be used in real-time applications where the results of sensors are stored on the cloud.

Nowadays, home networks have become a heterogeneous environment in terms of technologies used and do not take into account any intelligent energy-saving mechanism. Hence, an energy-saving strategy by integrating a WSN with a Green Computing technology which should provide high speed, a hybrid home network that consumes a very limited quantity of energy.

Integrating WSN and distributed computing technologies can be leveraged for many resources constrained computing.

Similarly, Cluster Computing, Utility Computing, and Distributed Computing technologies are yet to integrate with WSN or yet to improve the existing research.

BCI model

The integration of WSN and BCI devices are linked, and commands are processed using neuron's signals of the brain. The brain's data is processed and provided as input to the nodes of WSN, where each set of mobile nodes are used for different applications. Based on the output from the BCI system, the WSN is operated and controlled using only neurons of the brain and its activities.

Middleware

Middleware is a connectivity software that consists of a set of enabling services that allow multiple processes running on one or more machines to interact across a network. Middleware is essential to migrate mainframe applications to client/server applications and to provide communication across heterogeneous platforms. Real-world integration and application development on WSN Middleware based networks composed of tiny, low power and limited resources devices are not easy. Therefore, middleware services are a novel approach offering many possibilities and drastically enhancing the application development on WSN.

Middleware does binding between the sensor OS and applications by providing programming abstractions to bridge the gap between application developers and low-level hardware. Hence it serves the purpose of simplified integration of components developed by multiple technology vendors.

Middleware simplifies the user programming process and improves the reprogramming performance by separating the application part from the low-level system as it gives sufficient functionalities for the application development and has low requirements for the memory and energy resources.

Smart sensors

Sensors that take data from the physical environment and uses built-in compute resources to perform predefined functions upon detection of specific input and then process data before passing it on.

Application areas

Research can happen in many application areas of WSN that would include environmental monitoring, acoustic detection, seismic detection, military surveillance, inventory tracking, medical monitoring, smart spaces, process monitoring, etc. Creativity can be applied on area monitoring, health care monitoring, environmental/earth monitoring, air quality, and pollution monitoring, forest fire detection, landslide detection, water quality monitoring, natural disaster prevention, industrial monitoring, machine health monitoring, data logging, industrial sense and control applications, water monitoring, agriculture, passive localization and tracking, smart home monitoring, and so on.

Other research areas w.r.t WSN

Cross-layer protocols, QoS in Wireless Multimedia Sensor Network, Multipath routing protocols , Topology or neighbor discovery techniques, Trust-based routing, Connectivity protocols, Opportunistic routing, Bio-Inspired routing techniques, Secure Data Aggregation techniques, Load balancing, Context-aware routing, Bio-Inspired clustering, MULE based WSN, ZigBee based Wireless Sensor Network, Intermittently Connected Delay-Tolerant Wireless Sensor Networks, Geographic and Opportunistic Routing for Underwater Sensor Networks, Distributed Database Management Techniques, Airborne relaying, Efficient Flooding techniques, Intrusion Detection System, Congestion control and avoidance in routing, Location privacy issues, and Management, Coverage Hole Issues and Hole Healing techniques, Localization algorithms, Coverage and connectivity, Clustering, Data aggregation, Energy-efficient MAC protocol, Mobility management, Underwater sensor networks, Trust and reputation-based approaches in wireless sensor networks, Security attacks in wireless sensor networks.

Figure 3.8 deptics the way the marketers and profesionals are using for various analyses.

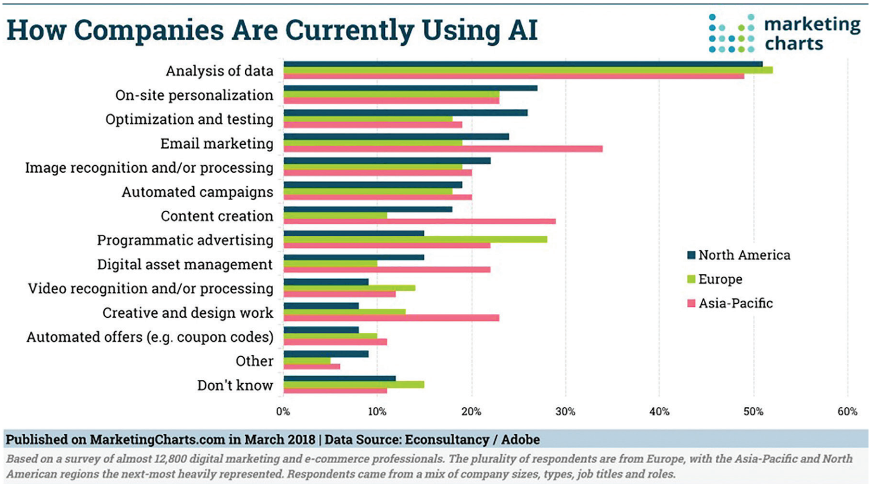


Figure 3.8: *How digital marketers and e-commerce professionals are currently using AI, sorted by respondents' region*

In addition to the above areas, it also includes Energy-efficient routing protocols in wireless sensor networks, Deployment strategies, Replica attack, Attack Detection, and prevention Schemes, Lightweight Cryptography algorithms, Provenance or Authorization issues, and management, Mobile sink based data gathering techniques, Secure Data Dissemination methods, Coverage and Connectivity issues in heterogeneous WSN, Clustering techniques in heterogeneous WSN, Congestion avoidance, Cluster-based routing techniques, Cluster-based data aggregation and routing techniques, Cluster-based Intrusion Detection System (IDS), Data Transmission Scheduling techniques for sensor nodes in MAC layer, Sleep or wake up scheduling for energy efficiency, Secure routing, Anycast routing, Multicast routing techniques, Multichannel protocols, WSN for smart cities, Cluster Improvement, Improvement over existing protocols, VANET's areas, Crowdsensing, Strategies in Data Collection, Multimedia, 3D sensing and coverage in underwater sensor network, under blood sensors and Multi-Sensor Data, etc.

Various companies use the data, they have collected, for various purposes, as shown in *Figure 3.9*.

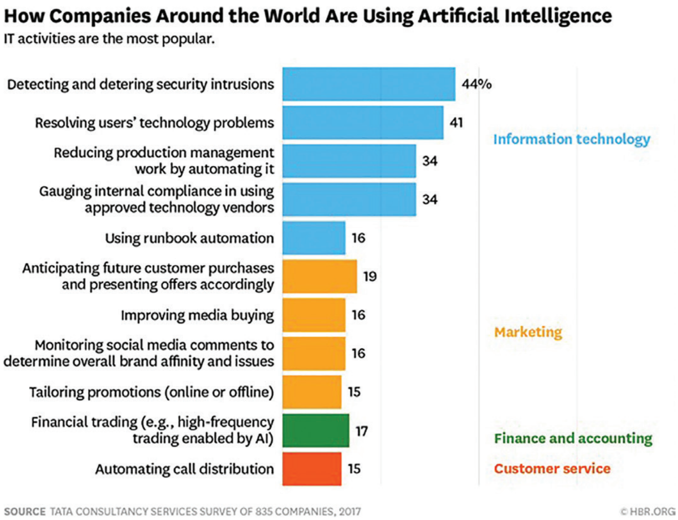


Figure 3.9: *How are companies using AI around the world?*

AI has shown its potential presence in solving the issues apart from developing new methods to improve the businesses. One of the industries that have benefited most in the IT industry with the automation of most of its tasks.

Decision making is the ultimate task for any industry that has adopted automation. Various tools that are considered have been illustrated in *Figure 3.10.*

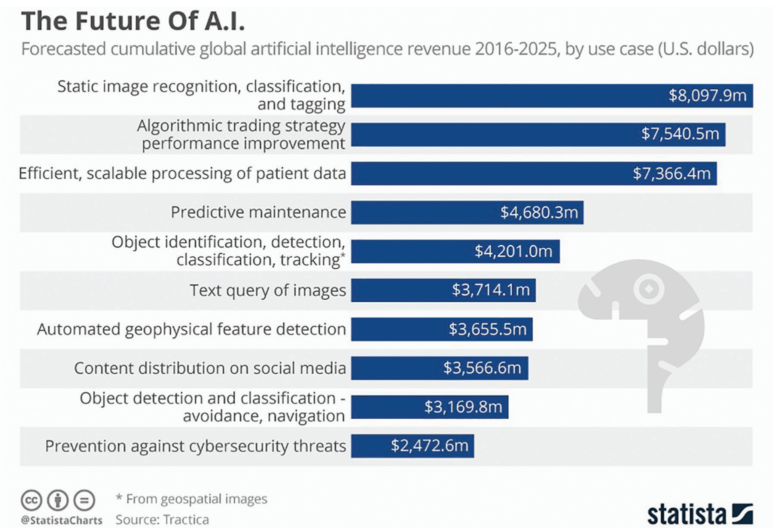


Figure 3.10: *Future Revenue of AI*

The projection of AI has always been positive with its intervention in many of the data analyses tasks. From the time the AI has been extensively used, data has changed its definition from numbers to many formats, which generated not only the intended results but also better revenue.

AI research areas

One of the applications of Artificial Intelligence is ML. Fundamentally AI is a broader concept which is intended to make machines be trained in such a way that they behave as same as a human in terms of decision making. Overall, the process of creating intelligence equal to the intelligence of a human is called Artificial Intelligence. In the process of AI development, many applications and branches have been evolved. In this section, a wide range of applications of AI have been discussed, both in the context of fundamentals as well as research. AI has a distinct ability to stun, hypnotize, leave us inspiring concurrently and appall hence left its impression everywhere so randomly helps people to imagine and could someday be materialized into reality ! Though applications of AI, as mentioned in section *Applications of AI*, are the outcome of AI research, so below are few extracted current AI research areas. *Figure 3.8*, *Figure 3.9,* and *Figure 3.10* show the trend with AI and for what purpose companies are using AI and how a hot topic is going to happen in the future is!

Large-scale Machine Learning (ML)

One of the familiar branches of AI by application is ML. The ML is a scientific analysis of statistical models and algorithms which computing systems utilize to execute a defined task without absolute instructions. The subject of ML is more related to statistics and statistical analysis. These statistics would consist of the data that are observed during a task, set of actions defined for each of the set of data. The algorithms that are applied to derive the expected action through the set of data and related actions are defined need to be trained. The data that is supplied is called trained data. Most importantly, the key factors that decide a good ML model are:

- Domain Knowledge
- Feature Selection

- Choice of Algorithm
- Training the Algorithm
- Evaluation Criteria
- Testing

Initially, ML was applied to a considerably manageable size of data as the machines were targeted for a specific task. But, when ML gained much popularity because of its success in achieving the objectives, various industries have initiated projects for ML to deal with a large set of data. Hence, the name Largescale ML. The ML can be incorporated by the Industries such as Automobile, Cloud Computing, Social Networks, Governments of the Countries, and so on. In day-to-day operations, a large set of data would be generated in a variety of forms. For example, an average of 2.5 million emails was sent across the internet. If an organization offering the email services wants to improve its services, it has to research through many of the statistics apart from the number of emails transferred through its service. In such a case, a simple statistical analysis through traditional ML might not completely achieve the desired outcome of the research. Hence, in such cases applying large-scale ML methods would provide a better result.

For better scalability and reliability, *Figure 3.11* gives you an overview of how Intent Media has been evolved the data platform through a variety of different approaches by AWS.

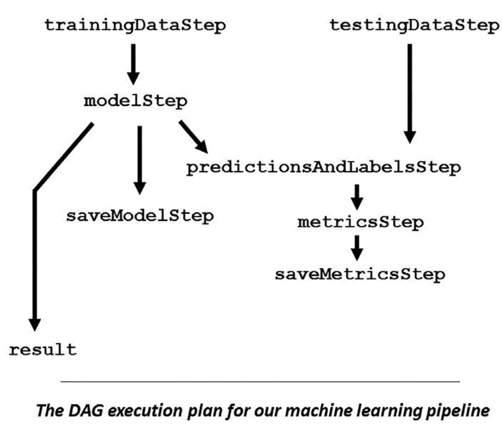


Figure 3.11: *DAG(Directed Acyclic Graph) execution plan for Large-Scale ML with Spark on Amazon EMR (Souce:https://aws.amazon.com/blogs/big-data/large-scale- machine-learning-with-spark-on-amazon-emr/)*

Most popular ML algorithms are classified into Supervised and Unsupervised algorithms. Among the most popular are:

1. Supervised Algorithms
   (a) Decision Trees
   (b) Naive-Bayes classification
   (c) Ordinary Least Squares Regression
   (d) Logistic Regression
   (e) SVM (Support Vector Machines
   (f) Ensemble Methods
2. Unsupervised Algorithms
   (a) Clustering Algorithms
   (b) Principal Component Analysis
   (c) Singular Value Decomposition
   (d) Independent Component Analysis

Figure 3.12 shows the training models with Azure Machine Learning using an estimator. Perfect training leads to accurate results.

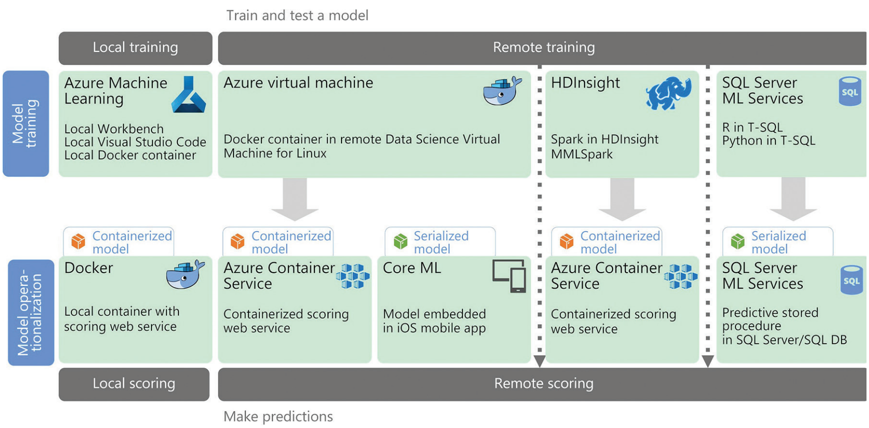


Figure 3.12: *ML model for training and deployment (Source: https://docs.microsoft.com/en-us/azure/architecture/data-guide/big-data/machine- learning-at-scale)*

To support the operations, ML does implement Associative arrays and custom data structures apart from the traditional data structures. However, large-scale ML algorithms need to deal with large sets of data and/or high-dimensional data. So, a set of data structures are identified and being implemented to deal with high-dimensional euclidean data and non-euclidean distances. There are two approaches to deal with high-dimensional euclidean data:

1. Dimensionality reduction, by which matrix do contain vectors as rows and components of vectors as columns.
2. Vector-Approximation (VA): Files by which primarily a summary of a specific file would be created by which the neighborhood would be complete.

The exhaustive list of concepts that the researchers at the large-scale ML can work upon are:

1. Dimensionality of the training sets
2. Size of the test sets and its overfitting
3. Online learning v/s Batch learning
4. Perceptrons
5. The algorithms used, such as Winnowing algorithms (learning a linear classifier from labeled examples)
6. Nonlinear separators
7. Support Vector Machines (SVM)
8. Solving the equations of SVM
9. Learning about Nearest-Neighbour
10. Regression methods

Moreover, the developers or the researchers working with large-scale systems or migrating from traditional ML, need to understand the methods to implement the parallelization of Support-Vector Machines, perceptrons. Algorithms such as batch gradient descent, stochastic gradient descent, and so on, are key factors.

Deep Learning (DL)

ML methods do deal with specific tasks, whereas deep learning does deal with learning data representations. Deep Learning is one of the broader classes of the ML algorithms, which mainly concentrate on dealing with the data that is represented at multiple levels. Other names for the DL are hierarchical learning, deep structured learning. By virtue of the name, deep learning, itself is evidence that the methods or algorithms that are designed shall deal at multiple levels or hierarchies. The fundamental base of the DL is Neural Networks (NN), particularly Artificial Neural Networks (ANN), and Deep Neural Networks (DNN).

ANNs for DL are modeled in different ways like as follows:

1. **Architectures**: Familiar architectures for Speech Recognition, Computer Vision are Deep Belief Networks (DBNs), Deep Neural Networks (DNNs), and Recurrent Neural Networks (RNNs)
2. **Training the multi-layer networks**: The most popular and successful method is the backpropagation algorithm. As it mimics the closed feedback loop, but with error correction, the efficiency and feasibility are high with this method.
3. **Components**: Neurons, Connections, weights, biases, propagation function, and learning rule.
4. **Functions**: Neural networks are used as functions such as feedforward networks and recurrent networks.

   In *Figure 3.13* architecture of Deep Belief Network (DBN), is depicted. The architecture is a collection of layers of Restricted Boltzmann Machines (RBMs) for the pretrain phase and then a feed-forward network for the refining phase.

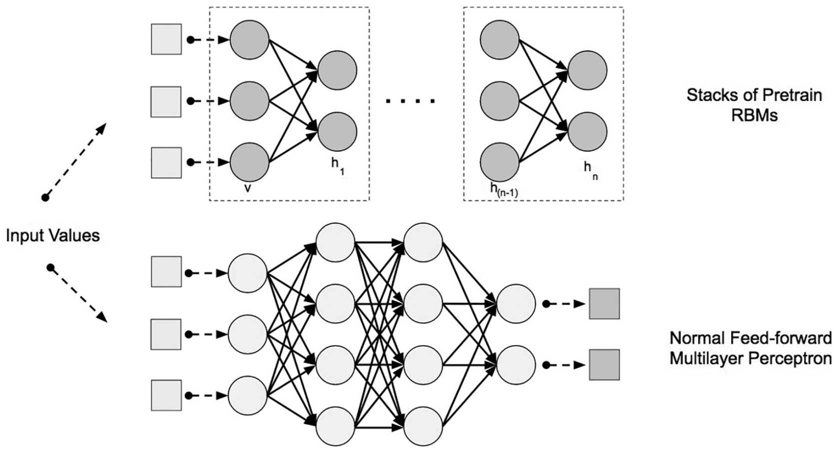


***Figure 3.13:** Deep Belief Network Architecture (DBN) (Source: https://www.oreilly.com/library/view/deep-learning/9781491924570/ch04.html)*

5. **Learning:** Reinforcement Learning, Supervised Learning, and Unsupervised Learning are the most prominent paradigms that are in use. How- ever, while learning the selection of cost function and backpropagation play an important role.
6. **Algorithms**: Among the most famous backpropagation algorithms are steepest descent, conjugate descent, convergent recursive learning, Levenberg- Marquardt.

Major application areas in which the potential research can be carried out are Healthcare, Military, Drug discovery, Network intrusion, Image processing, and so on.

Internet of Things (IoT)

IoT is one of the most trending and exciting areas of network devices. Internet of Things (IoT) deals with the devices which are networked over a LAN or even via WWW. With availability at a low price with more bandwidth, the internet has become a great available resource for information access. Operating a device by sitting at one location was once a dream, which became a reality now. However, credit for the researchers of various disciplines of engineering to achieve such a goal. The reachability of devices has reached to the extent that data can be fed to data that can be retrieved from, and they can be controlled through the cloud applications. However, there is a lot of research that various industries are doing and are expecting from researchers across the globe. As the human is even reachable to the distant space, it can be accepted that IoT research has to go miles.

Figure 3.14 shows the IoT's architecture, which is the system of numerous elements: protocols, actuators, sensors, cloud services, and layers:

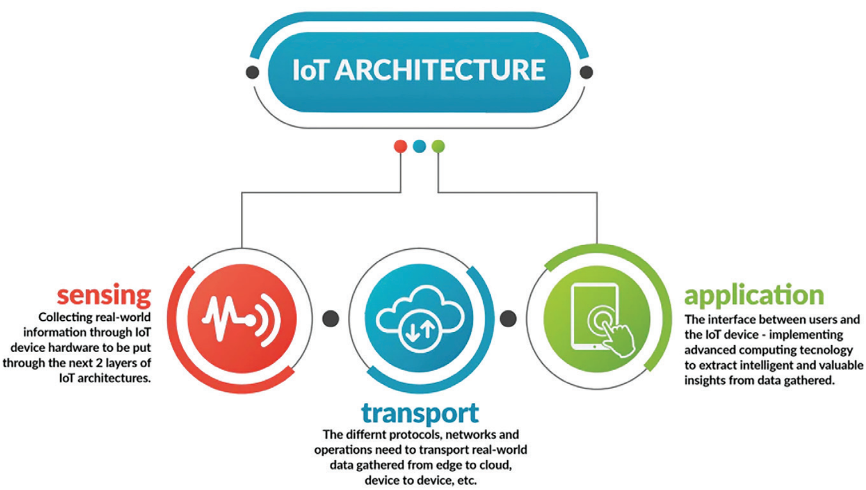


Figure 3.14: *General IoT's architecture*
(Source: https://www.cypress.com/blog/corporate/future-iot-architectures-cypress-based-hands-graduate-class)

Here are the main components of IoT:

1. Device connectivity
2. Network Gateway
3. Network standards and protocols
4. Platform for data storage
5. Data processor (such as converting the analog data to digital)
6. Data Analytics tool
7. User Interface for the customer
8. Device security
9. Network security

Users are able to use IoT devices for their convenience, such as using Amazon's Alexa, Google Home to give voice commands like a call from the contacts, send a message from your mobile phone, play a song for you, and so on. However, most of the products are highly personalized; in a sense, before they are used, the voice of the owner must be set by which the device can be used only by the owner. Though it addresses the security and privacy standards, there are areas where a voice command can be of anyone. For example, when a visitor checks in to a hotel room, he/she may want to switch on the Television or Lights or Air- Conditioner. This action shall not force the occupant to record and set the voice prior to usage.

A continuous IoT evolution with Amazon Web Services is shown in *Figure 3.15*:

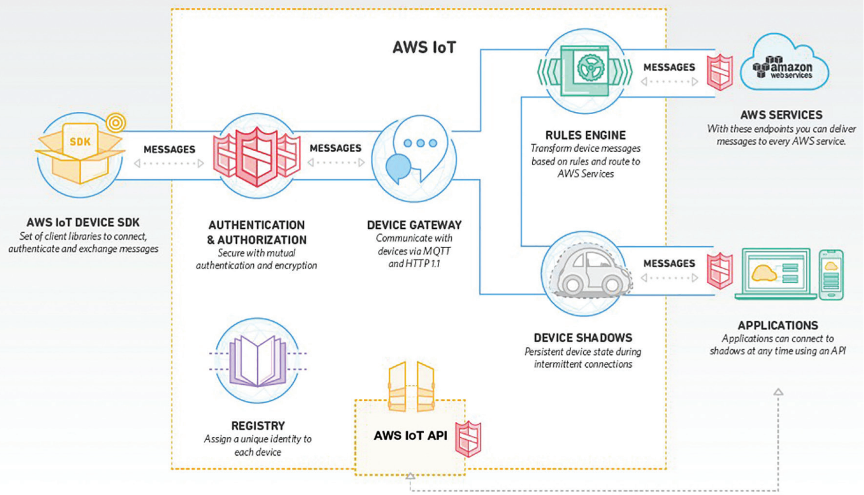


Figure 3.15: *IoT ecosystem of AWS (Amazon Web Services)*

Various research directions have been addressed by the industry and research community. Few key areas among them are as follows:

1. Architectural dependencies
2. Integrating big data sources
3. Large-scale computing
4. Constituting the knowledge system
5. Durability and robustness
6. Privacy and Security

To encourage the researchers and developers, many companies have launched IoT development platforms through which one can develop an application for any device, test, and deploy. Some of the major platforms are as follows:

1. AWS IoT from Amazon Web Services.
2. Azure Internet of Things suite from Microsoft
3. Oracle Internet of Things from Oracle
4. Google Cloud IoT from Google
5. Watson IoT Platform from IBM
6. ThingWorx IoT Platform
7. Cisco Jasper from Cisco
8. ARTIK from Samsung
9. Universal IoT platform from HP
10. Data from Bsquare
11. Mindsphere from Siemens
12. Bosch IoT Suite from Bosch
13. Carriots from Altair Engineering
14. Mbed from ARM

Reinforcement Learning(RL)

Reinforcement Learning is one of the areas of ML by which a belief can be created by establishing a pattern system. In the process, software agents are created and manipulated in such a way that they can take actions based on their environment. The system is depicted, as shown in *Figure 3.16*:

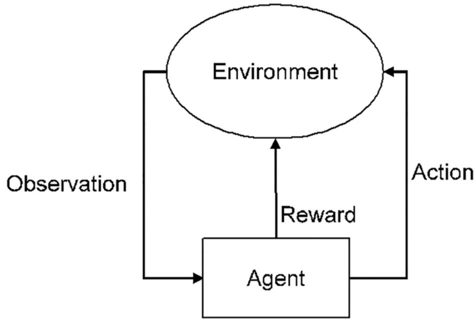


Figure 3.16: *Reinforcement Learning Agent*

The agent observes the environment and learns through various training algorithms. By the time the agent takes action, it takes the cumulative reward, which would be computed for a better decision.

Components of Reinforcement Learning problem are as follows:

1. Environment
2. Action
3. Agent/Actor
4. Reward/Value
5. Observation/State
6. Policy

Apart from the reinforcement paradigm, ML considers two other well-known paradigms: Supervised Learning and Unsupervised Learning. There is a substantial space for the researchers to apply their knowledge and efforts towards various research issues in reinforcement learning, as mentioned follows (but not limited to):

1. Robust procedures which work with few parameters in a massive conditional environment
2. Analysis and addressing the problem space in a considerably large Markov Decision Processes
3. Evaluation in the large-scale experimental scenario
4. Learning and applying the Predictive state representation when only partial information is available
5. Hierarchical and customizable RL
6. Enhancing the value function and policy methods

7. Developing the algorithms for the environment where large action spaces are required
8. Detecting various bugs in software and software projects

There are algorithms that are identified and applied, which would help the developers for their work. They are categorized based on State-space, as it is the one which is more important before applying any operator to derive the Action space. All the algorithms fall into three categories: Deep reinforcement learning, inverse reinforcement learning, and Apprenticeship learning. However, most of the State spaces and Action spaces are the same, whether they are continuous or discrete. Algorithms for Discrete State-space are as follows:

1. **Monte Carlo**: Every visit to the action space is based on Monte Carlo, and the operator is Sample-means
2. **SARSA**: The sequence followed is State, Action, Reward, State, Action; in which the operator is Q-valued
3. **SARSA-Lambda**: The sequence is the same as SARSA; however, the traces are considered based on the eligibility, in which the operator is Q-valued
4. **Q-Learning**: The sequence is State, Action, Reward, State; in which the operator is Q-valued
5. **Q-Learning Lambda**: The sequence is the same as Q-Learning; however the traces are considered based on the eligibility, in which the operator is Q-valued

Algorithms for Continuous State Space are as follows:

1. **DQN**: Deep Q Network in which the Action space is discrete, and the operator is Q-valued
2. **DDPG**: Deep Deterministic Policy Gradient in which the operator is Q- valued
3. **NAF**: It is Q-learning algorithm with Normalized Advantage Functions
4. **A3C**: Asynchronous Advantage Actor-Critic Algorithm with the operator is Q-valued
5. **TRPO**: Trust Region Policy Optimization with Normalized Advantage Functions

Though each algorithm has its own strength, a careful fusion of the algorithms would surely generate a better solution if a solution is very specific to the combination of characteristics of the combined algorithms.

Algorithmic game theory and computational mechanism design

When the algorithms are required in the strategic environments, then the Algorithmic Game Theory plays a vital role. When the game theory adapts Computer Science for the better output, then the algorithmic game resulted. The system is seen in two contexts: Analysis and Design. When the strategies for the game are designed, which consists of both the algorithmic and theoretical qualities, then the design is called Computational (Algorithmic) Mechanism Design. Most of the study in this area is the study of the framework of the algorithms as each strategy or approach leads to a different variety of applications. As shown in *Figure 3.17,* when Player 1 chooses one path, then every time the Player 2 has two possible paths through which the strategy can be designed in such a way that one keeps computing for the win with a better value.

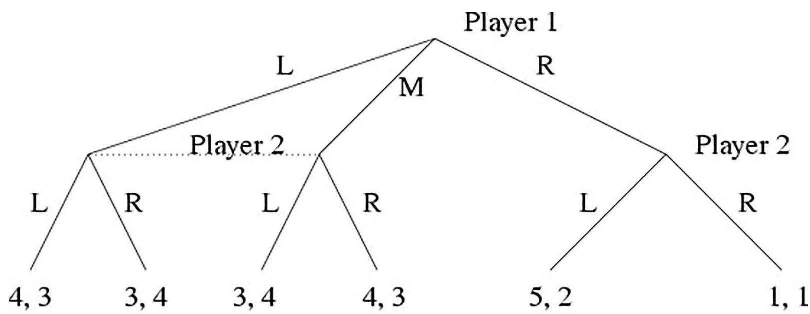


Figure 3.17: *Paths for Player 1 and Player 2,*
(Source: https://www2.cs.duke.edu/courses/fall06/cps296.2/)

Among the wide variety of applications, the algorithmic game theory has been so successful in the areas where routing is involved, such as packet routing in the computer networks where there is N number of nodes do exist between source and destination, but with different weights, as shown in the *Figure 3.18*.

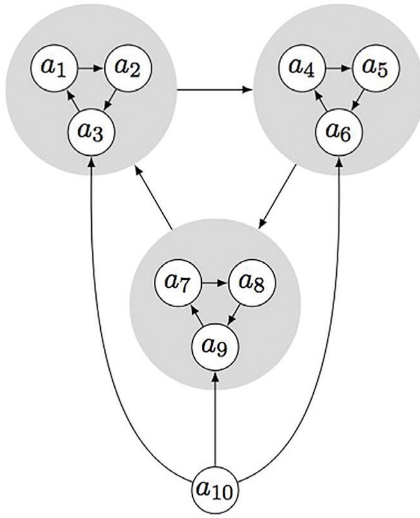


Figure 3.18: *Routing analogy using algorithmic game theory, (Source: https://dss.in.tum.de/14-research/research-projects/56-algorithmic-game-theory- and-computational-social-choice.html)*

The same has been extended to the Peer-to-Peer (P2P) systems, where there are multiple parallel stages do exist with various costs, such as the Supply-chain system. Likewise, this algorithmic game theory can even be applied to the search auctions.

Game theory has been a great help for the electronic market places in addition to computer networks. However, heuristics need to be correctly defined to achieve the desired result.

Various research challenges and areas in the Algorithmic Game Theory are:

1. An efficient mechanism for combinatorial auctions
2. Developing the algorithms from the winner perspective
3. Optimal mechanism design using Bayesian methods
4. Optimal mechanism design for Worst-case scenario
5. Enumeration algorithms
6. Computing Nash equilibria for N-players
7. Calculating the Price of Anarchy in the Networks
8. Load balancing in the networks, Cloud computing, etc.

Object-oriented programming languages such as C++, Java along with MAT- LAB, Julia, R, Python would be good to work for these areas as it needs dynamism and speed at execution.

Robotics

Wherever and whenever the human involvement is tougher or becomes unsafe, there the robotics play a great role. Robotics is a combination of various engineering disciplines that has Artificial Intelligence becomes the core if it has to work by its own decision. Electronics Engineering for the physical components, embedded systems, Mechanical Engineering for the construction and locomotive movements, Computer Science and Engineering for the control, sensory system, logic implementation, and information processing. Hence, Robotics has become the greatest application of many engineering disciplines, hence inter-disciplinary. As shown in the *Figure 3.19*, these layers have to be implemented for most of the Robotics applications.

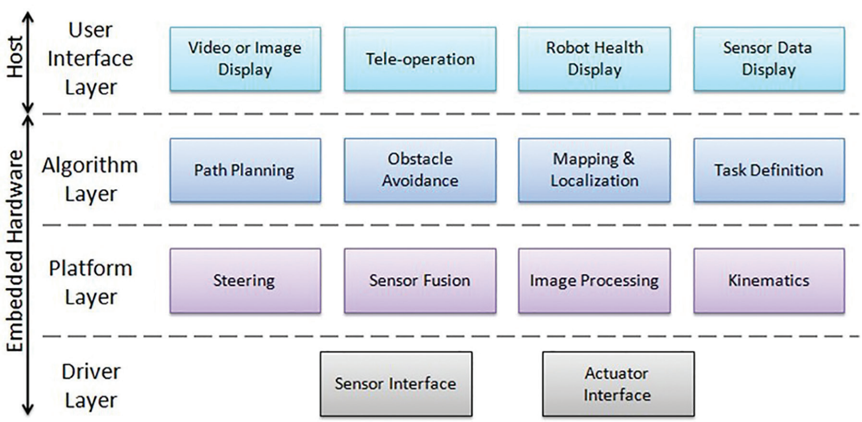


Figure 3.19: *Layers of a typical Robot Embedded system*

An entire stack of layers has been divided into two sections wherein the Host layer can be implemented as an integral part of the robot, or it can be separated to be a part of the computer such as desktop, or laptop, or even a tablet. The robotics industry has created a lot of opportunities in many sectors, such as employment and research by which the education system is also trying to implement for its needs.

For any robot typically following components are required:

1. Sensors
2. Actuators
3. Power Source
4. Manipulators
5. Controllers
6. Locomotive Devices
7. End Effector
8. Artificial Intelligence

More hardware programming

However, innovations are going to enhance the system to minimize the number of separate components. More research is possible to improve the system based on the needs of the industry. As there are many engineering and applications involved in this work, every small change or innovation leads to a variety of products. Recently, the prominence of the robots has gained in the aviation and space industry as it becomes very safer to make them be landed on various planets to gather the material and make a smooth journey. This avoids human involvement by which a lot of training for human scientists can be reduced and the same time can be spent on a lot more research.

The robotics industry needs a variety of algorithms for the purposes of, such as follows:

1. Movement of the hand and its parts
2. Movement of legs in coordination with sensory tracking
3. Control system
4. Decision making
5. Increasing the strength and robustness of the robot to deal with tougher situations
6. Dynamic balancing

Typical components of development platforms for the robotics are as follows:

1. Programming environment
2. Service execution environment

3. Collection of reusable components
4. Debugging environment
5. Simulation environment
6. Drivers to deal with robotics hardware
7. A package to interact with computer vision, navigation or a robotic arm control

With the fast evolution of the system, many organizations, research labs have released a wide variety of robot development platforms, simulators, and libraries. This makes even an independent researcher work for the improvement of the system.

Computer vision (CV)

The most recent development in the latest Android smartphones is Google Lens. Let us try to understand the purpose of Computer Vision from this application. If a user wants to copy the text from a document in the real world, the user need not take a snapshot or scan the document. Instead, just point the smartphone's camera at the document, instantly the text would be copied on to the clipboard for further use. If a botanist wants to know more about a flower or a plant in a garden, he/she need not go to the library, just point the camera through the Google lens application. Whichever appropriate information that is available over the internet, resources would be displayed for the use of botanist.

So, the Computer Vision comprises of various methods as depicted in *Figure 3.20*,

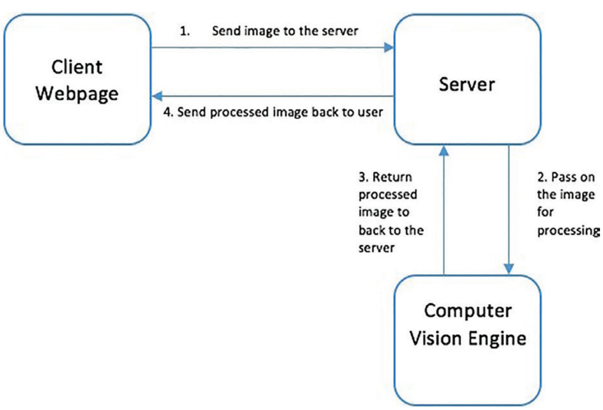


Figure 3.20: *Workflow using a Computer Vision methodology*

Various activities that are designed for computer vision are as follows:

1. Image acquisition
2. Image pre-processing
3. Feature extraction from the acquired image
4. Image detection or image segmentation
5. High-level processing such as verification and close estimation, and
6. Decision-making

Applications of the Computer vision which encourages the innovators and researchers to work upon are as follows:

1. For Manufacturing applications which need methods for Automatic inspection
2. Species identification system which would assist humans in identification tasks

Automate the tasks that a human visual system can do, which is shown as follows:

1. For Industrial Robots in terms of Controlling processes especially robot eye
2. For people counting or visual surveillance in order to detect the events, especially in crowded events such as carnivals, music events.
3. For computer-human interaction especially recognizing the specific entity
4. For medical image analysis which makes use of modeling objects or environments,
5. To build a navigation method for the use of autonomous vehicle or mobile robot
6. For the proper indexing of the image databases and sequencing them

With the advent of Computer Vision, a lot of research is going on and also invited by the industry, in terms of:

1. To achieve more accuracy in the calibration of web camera-based eye-trackers
2. Multi-part body segmentation based on depth-based algorithms or methods

3. Increasing the speed to detect the face and eye center in still images in a faster way
4. Multi-modal segmentation for the human body

Another example is Species identification as shown in *Figure 3.21*:

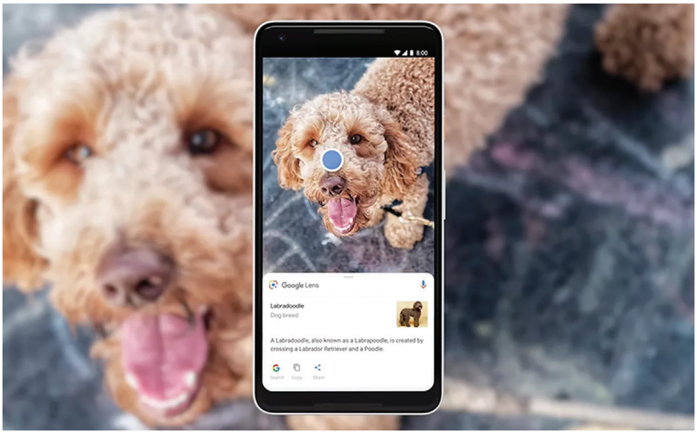


Figure 3.21: *Species identification through Google Lens application (Source: https://www.theverge.com/2018/5/11/17339450/google-lens-android-camera-app-how-to)*

Various functions that are defined for the species identification are mentioned below:

1. Evaluation and characterization of natural image
2. Recovering the images from the human poses
3. Recovering the images by the human gestures
4. Analysis of optical flow performance in the real world situations when the ground truth is absent

There are many libraries and software tools that are available in the market for the developers to work towards Computer Vision. Few of the familiar tools are OpenCV, MATLAB, SimpleCV, CUDA, TensorFlow, Amazon Rekognition, Microsoft Azure Computer Vision APIs, and so on.

Natural Language Processing (NLP) and Text Analytics

There would be at least a situation for once in everyone's life; they get annoyed by typing large text on the desktop or laptop. They might have felt that if there is a tool that can read the words when they dictate and produce as the text in the text editor. Now it is no more a dream, and even such tools are integrated to search for the information by giving voice commands. Hey Siri, Hello Google, etc., are the tools that take human voice commands as input, convert them into text commands, apply those text commands to the search engine, and produce the appropriate results. Though it looks pretty simple, the voice processing is not that simpler to find the appropriate words. It needs a considerable number of algorithms and processes to convert the voice command to the text as natural as the human brain converts. There are many stages in the process, as shown in *Figure 3.22*.

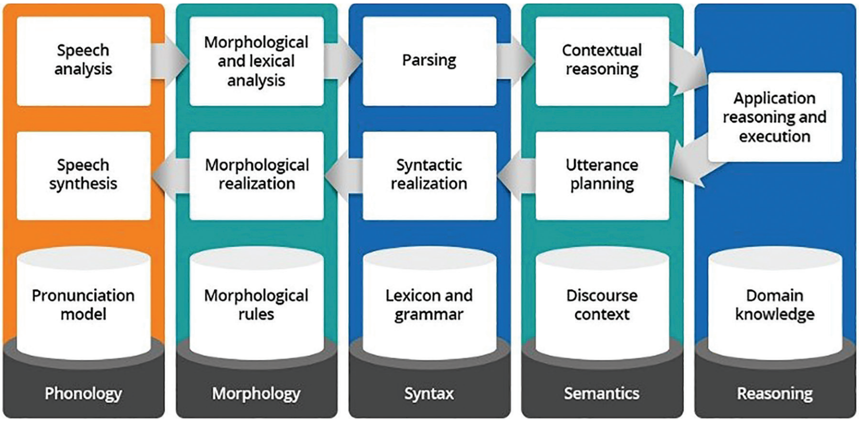


Figure 3.22: *Various stages in the NLP*

Though the background work and research for achieving the desired results in the area of NLP is not new, with the evolution of power in computational devices, it is becoming easy for greater performance. NLP is one of the fields of Computer Science, especially Artificial Intelligence, in combination with Information Engineering. To develop the applications for NLP, it does not need much hardware in terms of both inputs as well as output, unless a specialized task is planned. The challenges involved with this concept are as follows:

1. Speech Recognition
2. Understanding the language
3. Processing the voice
4. Evaluation of the accuracy of results
5. Reproducing the results in natural language

ML algorithms have helped this field to improve the pattern matching and accuracy of results to be produced both in the textual form as well as in the form of Natural Language.

Few of the Open-source libraries to work for NLP are:

1. Apache OpenNLP: This is an ML toolkit of libraries that provides
   (a) Tokenizers
   (b) Segmentation of sentence
   (c) Tagging the part-of-speech
   (d) Extracting the named entity
   (e) Chunking
   (f) Parsing
   (g) Coreference resolution, and so on
2. Natural Language Toolkit (NLTK): This is a Python library that provides potential modules to
   (a) Process the text
   (b) Classification
   (c) Tokenization
   (d) Stemming
   (e) Parsing
   (f) Tagging, and so on
3. Stanford NLP: This is a package of NLP tools which provide
   (a) Tagging the part-of-speech
   (b) Recognizer of the named-entity
   (c) Coreference resolution system
   (d) Analyzing the Sentiment (or emotion), and so on
4. MALLET: This is a Java package which provides
   (a) Latent Dirichlet Allocation
   (b) Classification of the document
   (c) Clustering
   (d) Modeling the topic
   (e) Extracting the information, and so on

The advantage of using Open Source tools is that users can customize them as per their need for developing the packages.

Game Theory (GT)

Fundamentally, **Game Theory** is a derivative from the study of mathematical models that are oriented towards strategies needed for decision-making. Just a few years before 1950, John Von Neumann has proposed a theory along with the proof by using Brouwer fixed-point theorem, which has helped many people working in mathematical economics. Game theory was developed into many types based on various mathematical models that were existing, and also with the help of evolutionary models. Modeling a typical game theory can be seen in *Figure 3.23*.

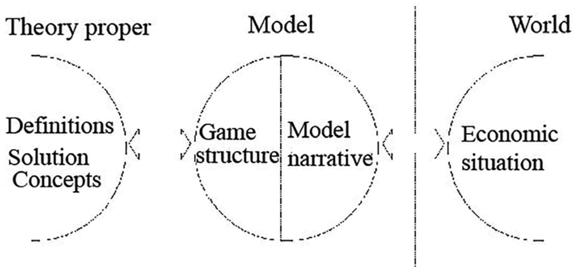


Figure 3.23: *Modeling a typical Game Theory*

Based on the alliances or commitments that the players can form, the game type was named as a Cooperative / Non-Cooperative game. While the cooperative game theory works on what type of coalitions would fetch a better payoff, Non-cooperative game theory, too, would work for a better payoff with no coalitions been formed but by distributing the payoffs among each coalition. In the process, there would be bargaining through which Non-cooperative methods try to achieve a similar performance as when cooperative theory is applied.

1. Another type of game theory is Symmetric/Asymmetric. Here the payoffs of the players depend on how the strategies are adopted. If the overall theme of the solution space is not changed even when the identities of the players are changed without changing the payoffs, the game type is Symmetric. Here the strategies are the same for both the players. But, if the players have their own strategies and payoffs, then the game type is asymmetric.
2. In the Zero-sum/Non-zero-sum GT, the total effort of all choices of the players would never be greater or lesser than the available

resources. In a game where the loss of one player results in the gain of the opponent, and if the sum of all the player's effort is calculated to zero, then it is Zero-sum. But there are games in which loss of one player would necessarily equal to the gain of the winning player, which are called Non-zero sum games.

3. Simultaneous/Sequential games are modeled in the way the players move during the game. If the players move simultaneously, then the game is called Simultaneous. In this theory, if they do not move simultaneously, then other players would never know the moves of their associate players. Whereas, in Sequential games, players need not move simultaneously. Representations of these games are different: Simultaneous games are represented using payoff matrices, Sequential games are with Decision trees.
4. Another type of GT is based on Perfect information and Imperfect information. If a player knows the moves played by the other previous players, then it is the game with Perfect information. But most of the game theories are with imperfect information, as there is little probability for a player to know the moves played by the other previous player(s). A variant of Perfect information game theory is a complete information game in which a player would have information about all the moves of the games, but not to be confused with perfect information.

Likewise, there are other game theories such as Combinatorial games, Discrete and continuous games, Infinitely long games, Pooling games, Differential games, Metagames, Evolutionary game theory, Stochastic outcomes, Mean-field game theory.

Intelligent Interaction (II)

When humans are considered for the interaction with each of the others, then it always differs from everyone. For example, in the instance of a family, the interaction between the husband-wife, father-child, mother-child, and so on can never be the same. Interaction depends on the contexts, people involved in the interaction, environment, and so on. In the same way, the instance at which the Human-Computer Interaction (HCI) is imparted with the intelligence, say Artificial Intelligence, then the concept is called Intelligent Interaction. The best example of such Intelligent interaction can be the Semantic Web.

Generally, the framework of the intelligent workstation consists of Usability at first place apart from the other three: portability, maintainability, and robustness. Many of the present-day computer systems are equipped with intelligence but has to go a lot more. Remembering the last state of the work and reminding that state, where the work was stopped, in each application over the workstation, is one of the best examples that every computer user might have experienced in recent times. In such a way, the ease of use can be made better on the systems for the greater convenience of the users. Architecture for the Intelligent Interaction over the cloud environment is as shown in *Figure 3.24*.

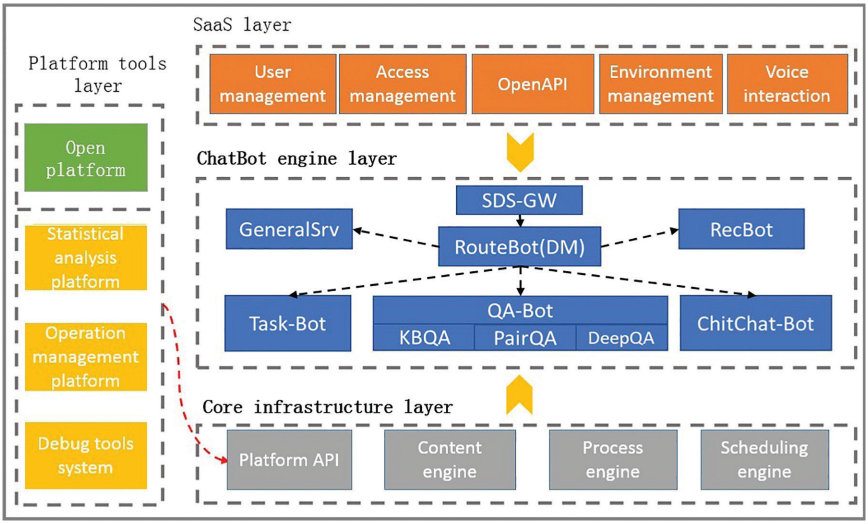


Figure 3.24: *Architecture for the Intelligent Interaction*

Various application areas where the intelligence can be embedded into Human-Computer Interaction are:

1. Affective computing
2. Semantic Web
3. Internet of Things
4. Cultural User Experience
5. Games designed explicitly for educational purposes
6. Mixed Reality
7. Speech Recognition and Analysis
8. Ubiquitous Computing

Because the human mind more dynamic than that of a programmed computer, preparing the strategies for a better HCI has always been a challenging task.

Recommender Systems (RS)

It might be the situation a YouTube user has watched 5 or more videos in the subject of politics, one after the other. That user has closed the application for some time and opened it again. Guess, which would be the first video among the list displayed! It's again related to politics. What made YouTube display such videos for the specific user? It is the Recommender System designed for the YouTube application. The same is the case to display the advertisements over the web pages. The user might have searched for shoes of a specific branch for twice or thrice; or even have spent for about 5 minutes looking at a variety of shoes of that brand. When the user opens a web page that allows displaying the advertisements, then the recommender system of ads display would choose for the same brand or other similar brand shoes. The workflow of the Recommender system is depicted in *Figure 3.25*.

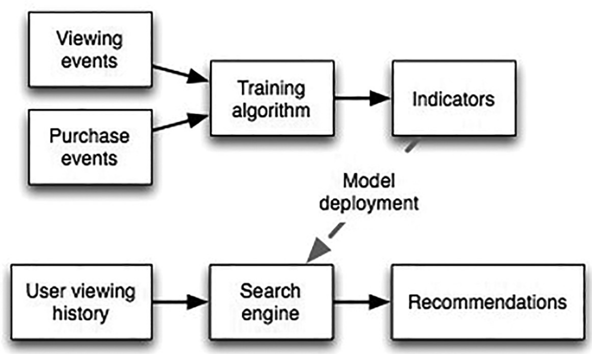


Figure 3.25: *Workflow of the Recommender Systems*

There are four approaches being used for RS for various applications such as: Collaborative filtering, Content-based filtering, Demographic, and Knowledge-based filtering. Each one is accepted based on the context. As an example, if your device is permitted to access your contacts, then the system would keep observing at the ratings, likes, dislikes of your contacts, and then recommends those content. Such recommender systems use Collaborative filtering, and they generally use nearest neighbor algorithms to recommend the user. In the approach of Content-based filtering, when a user gives ratings for a product or product features, then the future content that would be suggested is based on those products or similar products.

Most of the online shopping applications or e-commerce applications would suggest those products based on the user's likes, dislikes, and ratings. In the context of Demographic filtering, based on the statistical data of the user, such as the age group, location, race, gender, etc., the recommender system would filter the content or products to display. The higher-grade approach is called knowledge-based filtering, which uses various needs, priorities, and inferences of the user. The recommender systems which use KB filtering might sometimes use explicit functional knowledge to produce the desired results.

Most of the recommender systems are being integrated for the better user experience, such as Mobile recommender systems using Risk-aware recommender systems when a particular website is opened by the user to find the risk being involved in terms of malware, trojans, etc. Many of the recommender systems are now working on Anticipatory designs to offer better usability to the user based on ML techniques.

To achieve efficiency and performance of the recommender systems, research is being conducted to improve the algorithms that are being used in several aspects are:

1. Privacy of users: without compromising the sensitivity of the user's information
2. Labeling the recommendations based on the user's ratings
3. Diversity of the recommendation list
4. Recommender persistence: to repeat the display the items that user liked, instead of displaying new items
5. Trust: building trust among the users is very important where users do not believe in such systems
6. Demographics: in many situations, younger ones tend to take their own choice by searching through much of the information in contrast to the elder ones, who are more satisfied by the recommender systems.
7. Serendipity: suggesting an appropriate item based on the location you visit would be more satisfying, sometimes surprises the user.

The performance of these recommender systems based on the precision of the user's satisfaction keeps changing based on the mood. So, the researchers need to take the assistance of the other systems which work on psychological factors of the users.

Social Network Analysis (SNA)

The present human community is connected more via the Social Network applications. They share their emotions, purchases, opinions, and so on over the SNs. So, the research community has started working on understanding human behavior and trends by analyzing the User Generated Content (UGC) over Social Networks. So, analyzing UGC would generate a lot of potential reports which further help the industry to reaffirm, reformulate, redesign the strategies of their businesses. In day-to-day works, a wide variety of data is being generated, which either belong to one category (text, image, video, etc.) or belong to a combination of categories.

Studies related to Social Networks are related to many social elements such as social psychology, political science, economics, etc.; all are processed through computer science algorithms. All the software for the analysis is based on the key Social Network Metrics: Social connections, distribution degree of social network users, and segmentation of social circles. The area of Predictive Analytics is gaining more success with the growth of social network users, growth, as shown in *Figure 3.26*.

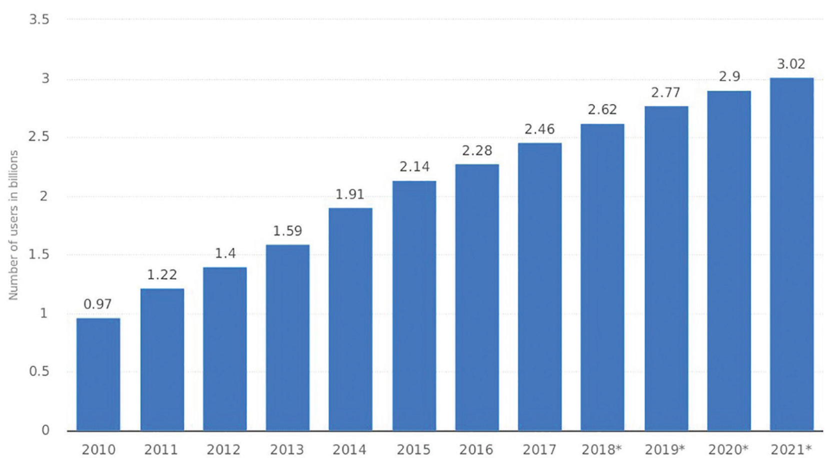


Figure 3.26: *Growth of Social Network users worldwide*

SNA relates a good number of application through which more research can be applied to generate qualitative data which would further help the industry be benefited in:

1. Criminology
2. Security
3. Textual analytics
4. Internet applications related to Social media
5. Computer-assisted collaborative learning
6. Advertisements
7. Trend analysis

For the analysis of Social Networks, there are a good number of software tools that are available in the market, both open source as well as proprietary. For their benefit, owners are releasing the social network data which is available open for every developer or researcher, but strictly for their study or academic use. In the wake of a data breach, few of the companies are implementing the restrictions to the data upon user settings. The graphical representation is the most important feature to understand and represent social networks.

Among the many software tools that are used for Social Network Analysis, few are listed:

1. Wolfram Alpha: for categorical data analysis, time series analysis, and graph analysis.
2. Tulip: for generalized social network analysis.
3. UNISoN: allows us to download USENET messages and also to save output generated through SNA.
4. R: is most popular for the data analysis.
5. NetworkX: which is a python package to create, manipulate, and study the structure, functions, and dynamics of the complex networks.
6. Mathematica: for image recognition, data optimization, data visualization, network, and graph analysis.
7. InfiniteGraph: To analyze a highly scalable distributed graph database.

Many of the big data companies are releasing their projects as well as software platforms to work upon and for further development of those.

Virtual Reality (VR)

All the great ideas cannot be realized in the realtime environment because of its complexity and/or size. But the applications of Virtual Reality can make the people understand how the idea looks like when it is developed into a product, so as to analyze the shape, accessibility, appearance, performance, etc. In the education sector, VR applications have gained popularity because of its presentation in ease of understanding complex topics, such as number theory, machine design, construction of civil facilities such as bridges, dams, high rise buildings (in the *Figure 3.27*).

Figure 3.27: *Visualization of high rise buildings with the VR system*

The gaming industry is also being glorified with the development of VR games for the multiplayer and single-player modules, with the availability of VR headsets with visual and audio equipment.

The general architecture of the Virtual Reality system is shown in *Figure 3.28*.

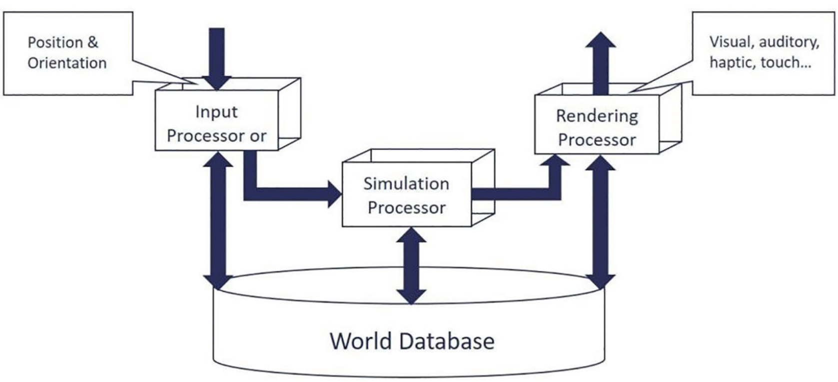


Figure 3.28: *Generalized VR system architecture*

Each module in the architecture itself is a research area. Apart from all these elements, User Experience, i.e., visualization is the key component, at the time of producing the visual output, for the success of VR applications. Work would never be completed just by completing the flow of information, but rendering the images for the best of its quality wins the performance benchmarks. Though the cost of the quality VR headsets is limiting the usage of VR system in the regular community, soon, the cost optimization would lead the VR to reach a larger community. This further leads to another research area, which can be an integration of VR with the cloud.

Few of the best VR SDKs / apps to work on PCs or Mobiles are:

1. Open VR/HTC Vive SDK
2. PSVR Development kit/Playstation VR
3. Oculus SDK/Oculus Rift
4. Oculus Mobile SDK/Samsung Gear VR
5. Google VR SDK/Google Daydream View, Google Cardboard

For all the above SDKs, Unity tool supports for rendering the image and flow analysis. However, a separate tool would work better to implement the business logic for each application.

A generic VR system might not address the specific requirements such as VR systems for video gaming that are different from those of education systems.

Pattern Recognition (PR)

For an automated recognition of regularities and patterns in the data, systems do use Pattern Recognition. PR is extensively applied in the Image Processing, Data Mining, Knowledge Discovery among Databases. One of the architectures for video data mining is, as shown in *Figure 3.29*.

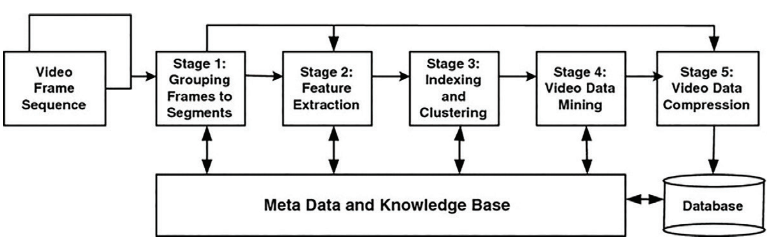


Figure 3.29: *Pattern Recognition in Video Data Mining (V. Vijayakumar and R. Nedunchezhian)*

Any of the methods, such as Heuristics or ML techniques, can be used for PR. Most of the algorithms developed for PR are probabilistic, which means they use statistical inference to derive the best result. Probabilistic algorithms have a greater advantage over non-probabilistic algorithms in a way that: these algorithms can be incorporated into larger ML tasks, and confidence values are generated as an output along with the choice. In order to reduce the larger dimensional vector to smaller dimensional vectors, feature extraction algorithms are used. Defining the problem statement is the more important task in PR, as it itself supplies a lot of information towards the solution.

Various algorithms that are used in the area of PR are listed below:

1. To predict categorical labels by using Supervised algorithms or Classification algorithms such as SVM, Perceptrons, Neural networks, Naive Bayes classifier, K-nearest-neighbor, and Kernel estimation algorithms, Decision trees, Linear/Quadratic discriminant analysis.
2. To predict categorical labels by using unsupervised algorithms or Clustering algorithms such as Kernel principal component analysis, Correlation clustering, K-means clustering, Hierarchical clustering, Deep learning methods, Categorical mixture models.
3. To combine multiple learning algorithms by using Supervised meta-algorithms or Ensemble learning algorithms such as a hierarchical mixture of experts, Ensemble averaging, Bootstrap aggregating, Boosting.
4. To predict arbitrarily-structured labels by using General algorithms such as Markov random fields, Bayesian networks.
5. To predict multidimensional data labels by using tensor representations or Multilinear subspace learning algorithms such as Multilinear principal component analysis.
6. To predict sequences of real-valued labels by using real-valued sequence labeling algorithms such as Particle filters, Kalman filters.
7. To predict real-valued labels by using Regression algorithms such as Gaussian process regression, Linear regression and extensions, Neural networks, and Deep learning methods, Independent component analysis, Principal components analysis.

8. To predict the sequence of categorical labels by using Sequence labeling algorithms such as Dynamic time warping, Hidden Markov models, Recurrent neural networks, Maximum entropy Markov models, conditional random fields, Hidden Markov models.

The evolution of pattern recognition algorithms has been a big boost for the IT and other related industries who are able to develop detailed data to derive a better outcome.

Knowledge management

Knowledge management (**KM**) is actually a process to create, share, use, and manage the information and knowledge of an institution or organization. Any business organization has its own knowledge. But how it is formally created and managed is the actual problem for the researchers as well as the business owners. Knowledge is an asset to any organization. Organizations would be benefited from the systematic organization of knowledge. Overview of organizational Knowledge Management System is as shown in *Figure 3.30*.

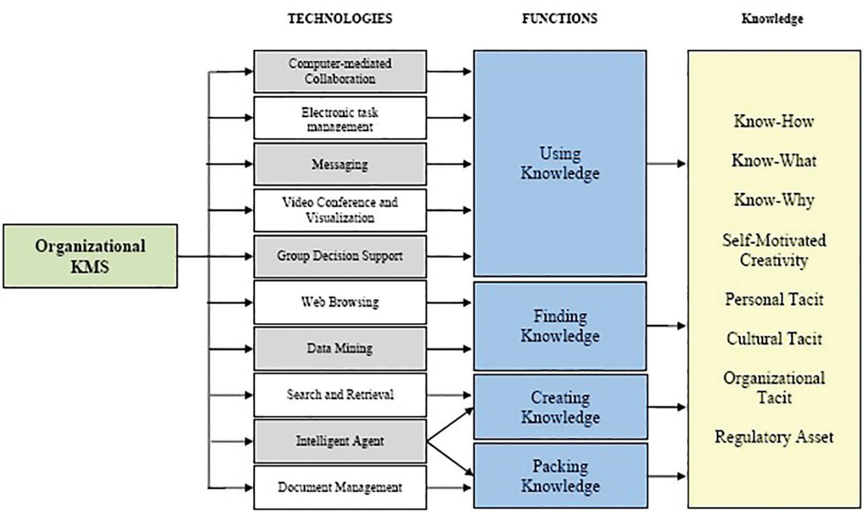


Figure 3.30: *Overview of the Knowledge Management System*

Most of the Knowledge Management Systems (KMS) have their own level of research potential; however, the baseline of the KMS is common, i.e., storing the knowledge, sharing the knowledge. But how to use the knowledge of the organization leads to a lot of research. It is for the reason that every situation in the present world is unique, and the solution cannot be the same. Hence, at least a small change in filtering the knowledge or enhancing the knowledge results in a unique solution. Any AI technique can be used in order to understand the effect and efficiency of the application of the subset of the knowledge to a real-world situation.

Autonomic computing

Autonomic computing (**AC**) is related to those resources which are distributed across various geographical locations either by means of installation or mobility. Earlier days, decisions were taken at a centralized location, and they were transmitted to the specific location, which means either the specific location has no freedom to make a decision or it is limited by the resources which restrict the managers to make decisions. With the increase in individual computing resources, storage resources as well as network resources, almost every individual location can take a decision to manage a given situation at least partially. The availability of cloud technologies at a reasonable cost also is making the most systems to behave autonomously. However, there has been a considerable number of issues being reported from many of the autonomous systems, especially in the areas of privacy and security. *Figure 3.31* depicts the simple architecture for Autonomic Computing for marine vehicles.

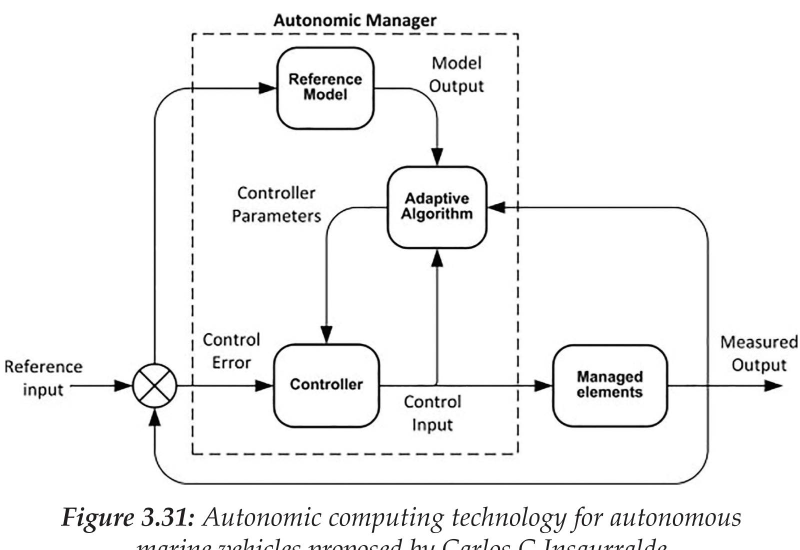


Figure 3.31: *Autonomic computing technology for autonomous marine vehicles proposed by Carlos C.Insaurralde*

Though many research issues were addressed by the research community, System architectures, Human-computer interaction, Privacy, and security are major challenges in Autonomic computing.

IoT research areas

IoT is nothing new but a grouping of technologies. The thought connecting the imaginary world is becoming a reality as everything from home appliances to jet engines are connected to the Internet. IoT sometimes a confusing term due to its nature of accessing devices with each other. Ideally, it is made up of embedded systems that require to collaborate and make intelligent decisions so that it makes meaning of it in the end. With respect to the security of IOT concerned, the following are a few security problems:

1. Insecure cloud interface
2. Insecure software
3. Poor physical security
4. Insecure web interface
5. Insufficient authentication
6. Insecure mobile interface
7. Insufficient security configurability
8. Insecure network services
9. Lack of transport encryptions
10. Privacy concerns

Few potential areas of research are listed in the following sections.

Smart technology

Smart technology allows mobile, databases, web, wireless access, and sensors to acclimatize and meet the requirements of the smart preschoolers in smart contexts. This smartness could make physical/logical applications which can be capable of adapting themselves automatically and alter behavior to suit the environment, senses the things with sensors, thus providing data to analyze and extrapolate from, drawing conclusions from rules, a sample image is shown in *Figure 4.13*. It also is enables self-learning that is using experience to improve anticipating, performance, thinking, and reasoning about what to do next, with the ability to self-determination and self-complacency. Smart technology ranges from smart office, smart home, industrial automation, smart cities, smart agriculture to smart parking, smart highways, to small scale automation at manufacturing plants. Nowadays smart devices are increasing like a double in a year but not limited to these devices; smart speaker, smart home hub, smart light bulbs, smart thermostat, smart security camera, smart switch, smart plug, smart lock, smart smoke detector, smart antenna, smart battery, smart battery charger, smart bomb, smart bookmark, smart bullet, smart camera, smart cell, smart display, smart gun, smart highway, smart mobile, smart label, smart TV, smart mine, smart module, smart personal objects technology, smart retainer, smart tag, smart thermostat, smart toy, smart traffic light, smart transducer, smart weapon, smart whiteboard, and so on.

Developing smart applications are equally important, aligning with hardware limitations, self-troubleshooting, security protocols between devices, and so on.

Wireless sensor networks

Basically, IoT is the network of physical devices, home appliances, vehicles, and other items embedded with electronics, sensors, software, actuators, and connectivity, which enables objects to connect and exchange information within the existing Internet infrastructure. Such sensed data further processed and analyzed for the next action. Advances in computing and network technologies, such as WSNs, forming a global network infrastructure, called the IoT. The main difference is depicted in *Figure 3.32*.

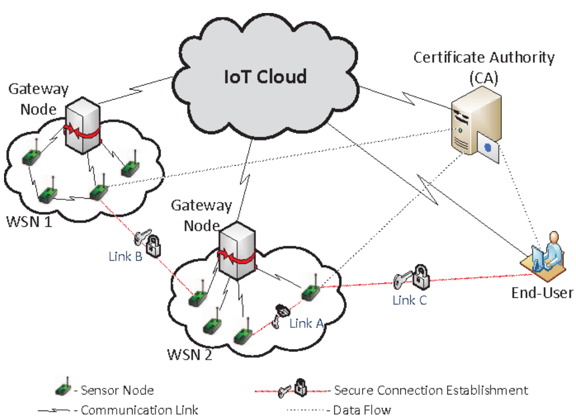


Figure 3.32: *WSN(sense the data) v/s IoT(WSN+ Internet + Software Applications + Cloud Computing + etc.)*

So WSN need not be connected to the Internet; sensor nodes gather data in real-time and send to local devices, whereas IoT is on Internet-connected with other things. Routing is not implemented in IoT, but WSN has it. In IoT, objects may be anything sensors, cameras, humans, systems, and mobiles, and these devices may send their data to the Internet so other devices may use it in their computations.

Various utilities that use the IoT services are mentioned in the *Figure 3.33*.

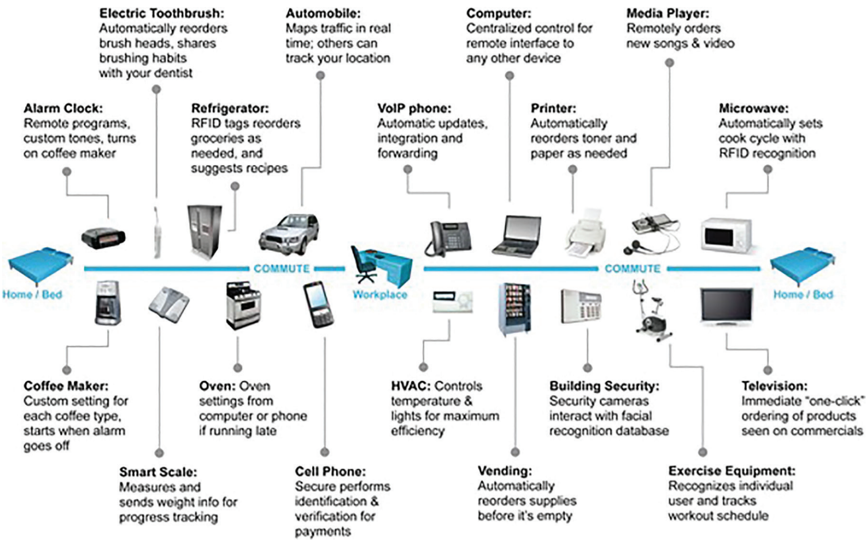


Figure 3.33: *IoT- an ever-growing list of connected devices (Source: the IPSO Alliance)*

The list of IoT devices keeps growing due to the integration of IoT compliance as well as the paradigm shift towards the manufacturing of these devices.

IoTs do communication among WSN homogeneous or heterogeneous objects which pose challenges like architecture, data fusion, security, and identifying useful data. Other issues could be as follows:

1. QoS
2. Topology/Dynamically objects adding
3. Network configuration
4. Resilience
5. User authentication/authorization

6. Self-diagnosis
7. Group detection and hierarchical detection
8. Network redundancy and protocol optimization
9. Accountability
10. Functionality
11. Fault detection and/or recovery
12. Ownership
13. Fault tolerance

Cloud computing

IoT allows billions of objects to be connected and communicate with each other to share data that enhance the quality of our daily lives. On the other side, Cloud computing gives us dynamic, expedient, and scalable network access which makes it attainable to share computing resources, so, this, in turn, enables on-demand data integration from assorted data sources. The huge number of resources available on the Cloud can be highly beneficial for the IoT, while the Cloud can get more publicity to improve its limitations with real-world devices in a more on-demand and distributed fashion, the advantages include, Incentives to new experiments, Elastic and scalable, Environment compatibility, Affordable, Avoiding Downtime or Delay, Efficient growth, Secure, Disaster recovery. The integration of Cloud Computing with the IoT is the most effective way on which to pose many issues such as Security and privacy, Legal / contractual, Economic, Devices (Sensors, Actuators, etc.), Networking and Communications, Data Management, Decision Making, Social and Legal Issues, Human Behavior and Usability, Marketing, Service quality, Inter-operability issues still form significant challenges. Other issues are as follows:

1. **Mischievous objects protection**: Cloud enhanced security across the IoT system since it operates as a mediator and controller between objects.
2. **Access controls for IoT-Cloud**: Outward access to cloud resources should be controlled by access controls to oversee the actions that may be taken on objects, distributing a query, accomplishing some computation, and so on.

3. **Recognizing sensitive data**: Data will condense numerous aspects of the physical environment, including highly personal data about individuals, groups, and companies, and can also have physical significance.
4. **Protected communications**: Privacy to avert eavesdropping and data leakage, and integrity to protect data from venality/ interference.
5. **Cloud architectures**: Private, public, or hybrid, where predominantly sensitive, there may be decisions to prevent data being placed on a public cloud.
6. **In-cloud data fortification**: These apprehensions the cloud provider protecting data within their service, by preventing data trickle during communication, processing, and storing in the cloud.
7. **Encryption by objects**: Objects(users and tenants) could encrypt data in-advance uploading to the cloud to avoid the provider having access to intelligible data; prevent the provider from being enforced to disclose intelligible data to others, make sure protection against the provider leaking data.
8. **Reliability of cloud services**: Belief placed in a cloud service provider is much required to secure service, guarantee it is suitably configured, report issues, and use data only for the wished-for purposes.
9. **Influence of cloud decentralization on security**: The concept of the decentralized cloud increases interesting security deliberation.
10. **Malevolent objects safeguard of provider**: The cloud provider will keep up numerous access, and other controls, to safeguard against precise attacks.

Cloud computing has provided an opportunity for the researchers to develop better utilization of cloud resources, especially by offering the free-tier facilities to develop the solutions.

Big Data

Contemporary information systems are generating a huge amount of data like TBs in day to day activities since digital technologies like different computing (cloud, grid, green, and so on) techniques are increasing, which are connected via the Internet. Nevertheless, the analysis of these enormous information needs many efforts at multiple levels for knowledge mining and decision making. Consequently, Big Data Analytics is a contemporary area of research and development that has become progressively vital. It is exposed to investigate cutting-edge research determinations intended at analyzing IoT information. *Figure 3.34* represents an overview of IoT big data and the knowledge discovery process.

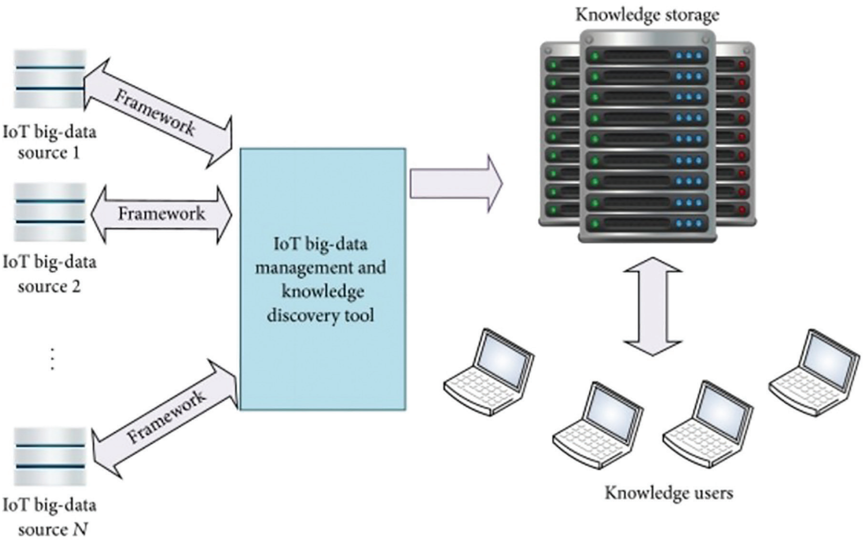


Figure 3.34: *IoT Big-Data Facts Revolution*

Big Data revolution took a leap when Apache released a Hadoop framework with MapReduce. Moreover, as a different approach Apache Spark has added more modules such as stream processing to improve the big data analytics.

Ubiquitous computing

Ubiquitous computing (**UC**) is basically the term for human communication with computers in virtually everything which forces the computer to live out here in the world with folks. In UC, computing is prepared to perform anytime, everywhere. In IoT, physical devices are connected to each other using the Internet. IoT can be made to appear as UC. *Figure 3.35* represents an overview of IoT UC and knowledge discovery architecture.

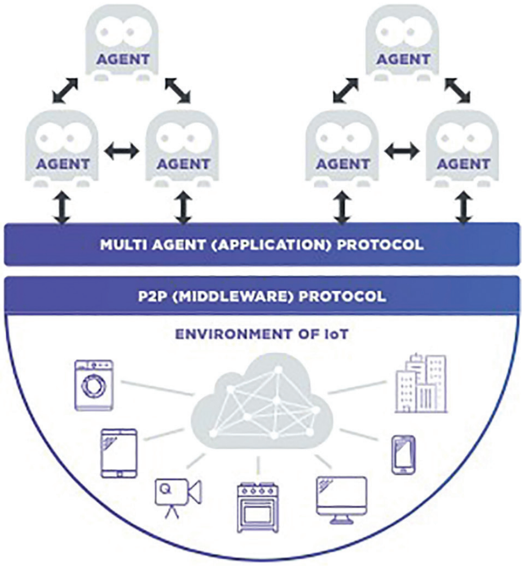


Figure 3.35: *Overview of IoT platform and UC relationship*

A standard integration or middleware protocol can give a trustworthy distributed system model, which is intrinsically scalable over the expected growth of IoT.

Distributed systems

Distributed systems and IoTs represent a vision wherein the Internet encompasses into the real world, taking on daily objects. Physical objects are connected from the virtual world, but can be remotely controlled and can turn as physical access points to Internet services. The physical access points is a geographically distributed system which incorporates such varied technologies as mobile, pervasive, and cloud computing. *Figure 3.36* represents an overview of IoT DS and knowledge discovery architecture.

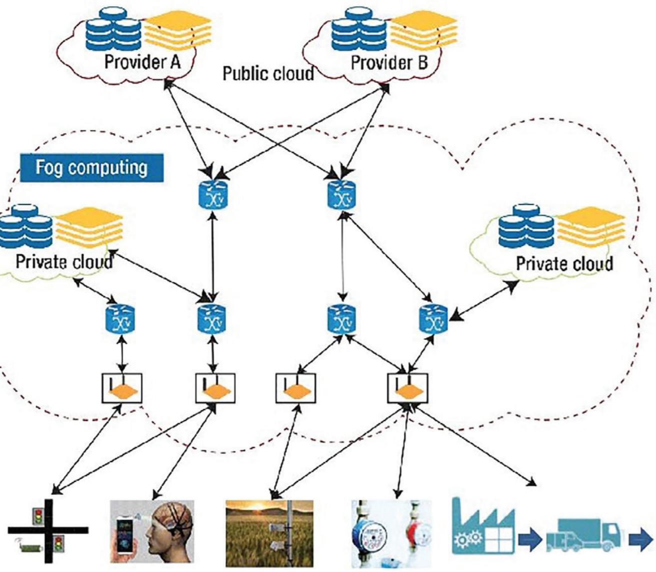


Figure 3.36: *Overview of IoT platform and DC relationship*
(Source: www.icar.cnr.it)

On the cutting-edge connectivity of systems, devices, and services, IoT bank covers a diversity of domains, protocols, and applications. A dispersed system of cooperating smart objects are emerging as a new paradigm for IoT. Smart devices are capable to sense/actuate, store, and interpret data created within themselves and around the adjoining external world where they are located, action on their own, collaborate with each other, and interchange data with other kinds of electronic devices and human. Unified computing has revolutionized various electronic devices with the provision of integrated computing environments. IoT and Distributed Computing need faster communication. IoT platforms have encouraged the researchers of cloud and fog computing to customize the solutions to address specialized issues.

DC has numerous common problems with concurrent and parallel computing, as all these three falls in the methodical computing field. Currently, a large amount of DC technologies coupled with a service-oriented architecture, hardware virtualization, and autonomic and utility computing have directed to cloud computing. Innovative algorithms and techniques must be developed and analyzed to execute multifarious applications on cloud conveniences scalably.

RFID

RFID is habitually seen as a prerequisite for the IoT. RFID is an automatic technology and supports devices or computers to recognize objects, record metadata, or control specific goals through radio waves. Linking RFID reader to the system of the Internet, the readers can recognize, track and monitor the objects attached with tags universally, habitually, and in actual time, if necessary, can be called IoT. RFID technology can be used to shorten actions and advance the effectiveness and efficiency of inventory management. To increase the usage of RFID, it is required to design system architecture for identifying and monitoring the movement of monitored objects. Basically, both are essential to tie for next generations' communication, as shown in *Figure 3.37*.

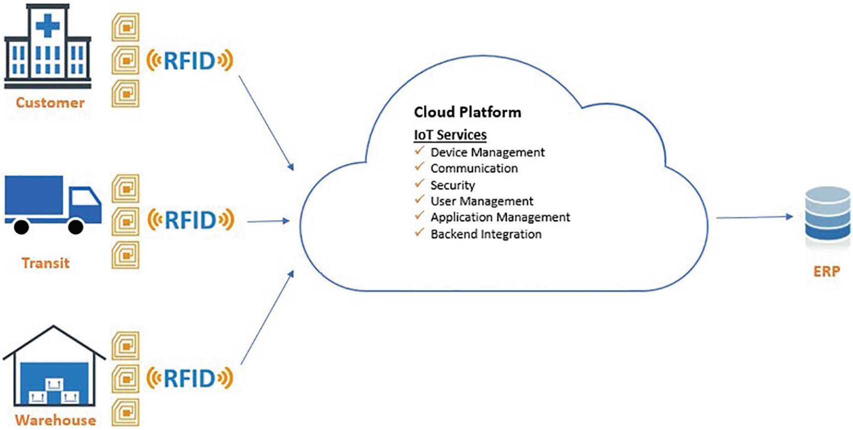


Figure 3.37: *RFID v/s IoT*

The above figure explains the ultilization of IoT and RFID as the key technologies for the detection and identification of monitored objects.

Wireless Sensor Networks

In a broad term,"WSN is a subset of IoT" . Essentially WSN allows you the real-time monitoring of the physical sensing domains such as power grid, healthcare, smart transport, air traffic, and agriculture that can be meritoriously controlled and management over and done with cyberspace. IoT has the ability to connect every possible device to the **WWW** as shown in *Figure 3.38*, and works via cloud-based computing as a service that can pose many issues including security, QoS, efficiency, and so on.

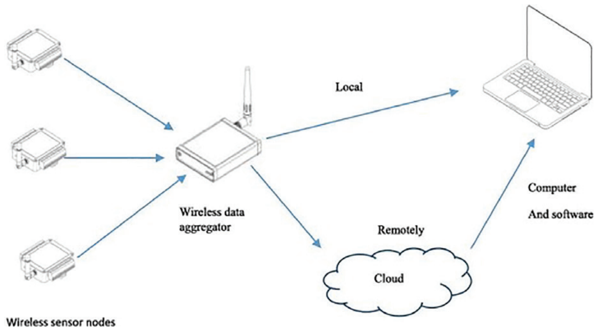


Figure 3.38: *WSN in/as IoT*

WSN is a low- cost, low-power transceivers, compact-size, and open standard stacks, have made promising infrastructure for home/ office and industrial monitoring applications. The primary aim is to sample, gather, and analyze every piece of data around us in order to progress production efficiency and guarantee optimal resource consumption.

Mobile computing

IoT and the WoT (Web of Things) are becoming a reality, as shown in *Figure 3.39*, their inter-link with mobile phone computing is growing.

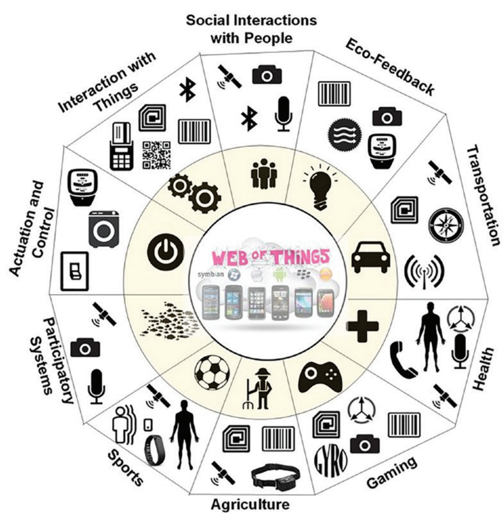


Figure 3.39: *Mobile computing and IoT/WoT: Application categories*

Mobile devices integrated sensors offer cutting-edge services, which when united with web-enabled real-world devices located adjacent the mobile user (e.g., environmental sensors, energy monitors, body area networks, RFID tags, etc.), have the latent of enhancing the overall user perception, awareness, and experience, inspiring more informed choices and superior choices. The industry requires to explore the most significant work performed in the area of mobile phone computing joined with the IoT/WoT. Analyze issues in domains, according to the area of application (that is, sports, gaming, health, agriculture, transportation, and so on), the nature of the interaction (that is, eco-feedback, participatory sensing, actuation, and control) or the communicating actors tangled (that is things, people).

Open issues and research challenges in mobile computing are listed as follows:

1. Crowdsensing
2. Continuous sensing
3. Security
4. Heterogeneity
5. Persuasion
6. Big data analysis
7. The context problem
8. Reliability
9. Search and Discovery
10. Business cases
11. Privacy
12. Personalization
13. Emotions analysis

Mobile computing has become an integrated solution not only in smartphones, and tabs but also have become part of the laptops.

AI (ML/DL)

Clearly, there is an overlap between AI and IoT. AI is about analysis and a decision like simulating intelligent behavior in devices of all kinds, as shown in *Figure 3.40*.

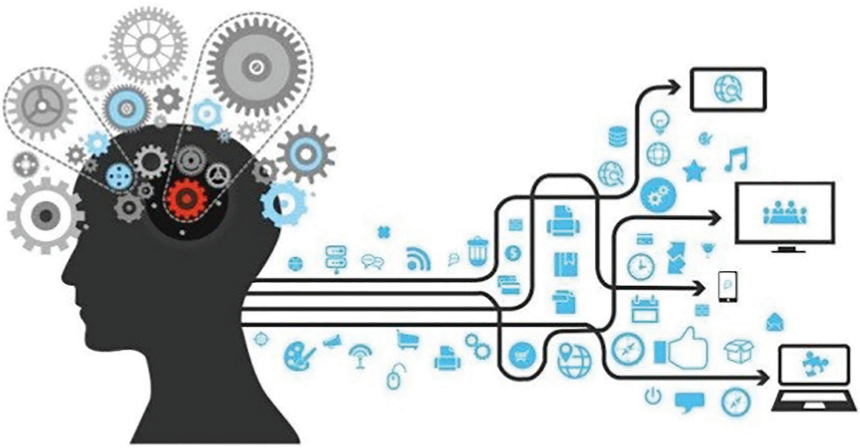


Figure 3.40: *AI in IoT*

IoT is about connectivity and measurement like connecting devices and making use of the data generated from those devices. Preferably, data is generated by linked sensors is pattern matched with ML over time to detect events and used to predict a future event. As IoT devices will produce enormous amounts of information, then AI will be functionally essential to deal with these huge volumes if we're to have any chance of making sense of the information.

IoT and AI combination could be the trigger to really drive smart on many needs. This kind of integration can have issues like privacy, ethics, hacking, mobility challenges, environment pollution, cost, energy efficiency, availability, service quality in multidisciplinary, and so on.

Embedded systems

An embedded system frequently consists of a microcontroller programmed to do a precise job. The IoT is defined as a process in which objects are armed with actuators, sensors, and processors that include hardware board design and development, web APIs, software systems, and protocols, which together create a connected environment of embedded systems as shown in *Figure 3.41*.

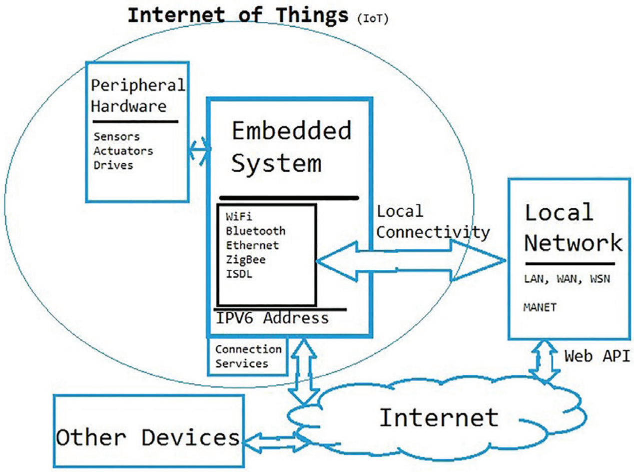


Figure 3.41: *Embedded Systems in IoT*

Embedded system is essentially the study of how to set up a device that is software/hardware or both that is embedded in a bigger system and is typically a real-time system. Embedded systems will also be at the foundation for the deployment of many IoTs solutions, mainly within certain industry verticals and IIoT applications. Designing an embedded IoT hardware system is not easy; few challenges are listed as follows:

1. The security crisis in embedded systems
2. Lack of essential flexibility for running applications over embedded systems
3. Glitches of testing an embedded system design
4. High power dissipation of embedded system design
5. Inadequate functional care of safety-critical embedded systems
6. Constrained by cost and time-to-market
7. Struggle in familiarizing to new environments
8. Recurrent changes in hardware and software facilities
9. Carrying out power awareness operations
10. Verification and Validation issues
11. Glitches in ensuring smooth integration of new services
12. Problems in packaging and integration of small size chip with low weight and reduced power consumption

As IoT is the combination of Embedded Systems and Wireless Sensor Networks with the association of Cloud Computing, it is possible to experience sudden surprises in terms of malfunctioning.

Cyber-Physical Systems (CPS)

IoT enables connecting Things like Objects and Machines to the internet and ultimately to each other, while CPS is the integration of computation, networking, and physical process, as shown in *Figure 3.42*:

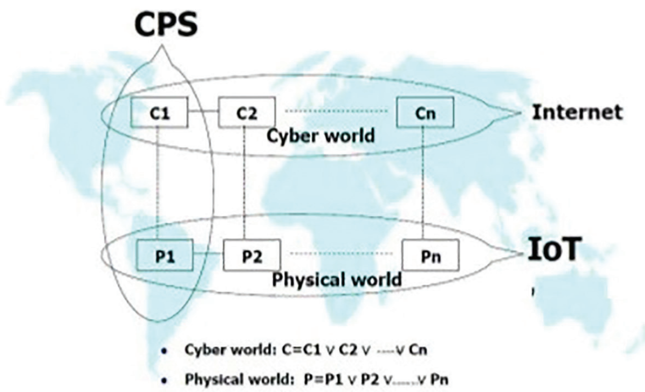


Figure 3.42: *CPS v/s IoT*

Hence, these operations are monitored, coordinated, controlled and integrated by a computing and communication core while IoT is the internetworking of vehicles, physical devices, buildings, and other items—embedded with electronics, sensors, actuators, software, and network connectivity that enable these objects to collect and exchange data through the internet, so we can gather that CPS can be specified just for specific systems like physical and engineered. Few challenges are listed as follows:

1. Industrial espionage/sabotage
2. Production outages due to non-availability of data
3. Industrial broadband structure
4. Data protection and data security
5. Lack of benefit quantification
6. Lack of prioritization by top management

Semantic web

The semantic web is a development of the WWW in which information on web pages is structured and tagged in such a way that it can be read directly by systems. Smart buildings, Smart cities, and e-health are among numerous application domains that are presently shining and will continue to shine from IoT and Web technologies in a predictable imminent, as shown in *Figure 3.43*.

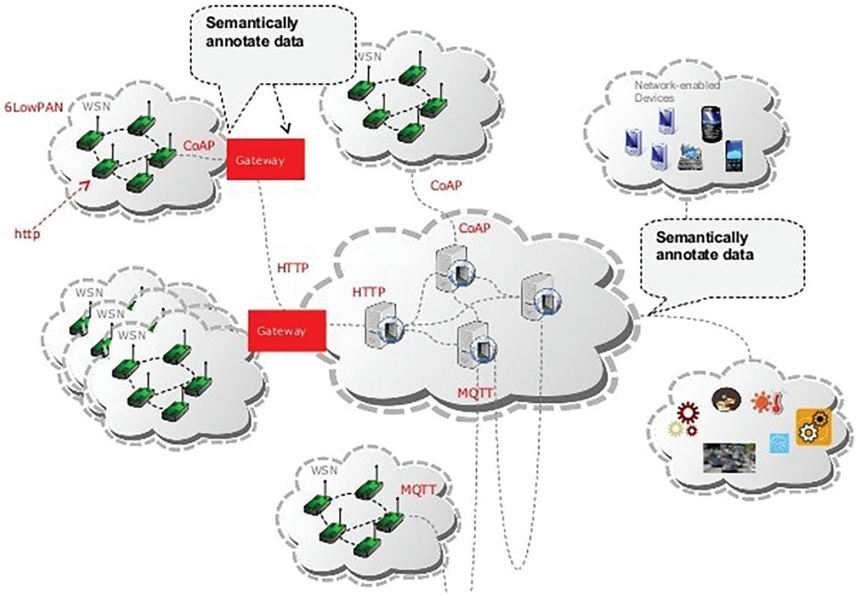


Figure 3.43: *Semantic Web for WoT/IoT*

Likewise, semantic technologies are addressing as follows:

1. Facilitate inter-operability among numerous information processes, including representation, management, and storage of data.
2. Expedite easy integration of data application
3. Alleviate heterogeneity by providing semantic interoperability
4. Deduce and abstract new knowledge to build applications providing smart solutions

Challenges are listed as follows:

1. Standardization and Re-usability
2. Data Confidentiality and Privacy

3. Data Interpretation and Synthesis
4. Data Quality
5. Scalability and Flexibility
6. High-Level Processing

IoT has improvised the concept by developing the accessibility of the devices through the web and smart apps through the gadgets.

Security and reliability challenges

When smart objects are connected or linked for a purpose which means it creates new opportunities for hackers to disrupt services and steal credential/crucial information. Smart devices often play critical roles in data gathering, management, and control, sometimes in life-and-death applications– yet they are vulnerable. Hence, today's smart devices are significantly more vulnerable to attack than desktop systems. IoT is an enabler for the intelligence devices for crucial things such as hospitals, cities, grids, organizations, and buildings. Hence, privacy and security are some of the major issues that prevent the wide embrace of IoTs.

IoT and IIoT (Industrial IoT) clouds

With the advent of IoT, the cloud service providers by offering their resources for every sector, say the research industry, development industry as well as users.

A. IoT
   1. Oracle IoT Cloud - ORACLE Cloud for the Internet of Things.
   2. Google Cloud IoT - Google Cloud Platform IoT solutions.
   3. IBM Watson - IBM cloud for the IoT.
   4. Azure IoT Hub - Microsoft cloud for the IoT.
   5. Bosch IoT Cloud - Highly scalable cloud infrastructure based on Cloud Foundry.
   6. CloudPlugs IoT - An end-to-end Fog Computing Platform for IoT.
   7. Yaler - Relay infrastructure for secure access to embedded systems.

8. Zatar - Zatar is the first ARMmbed standards-based IoT cloud service.
9. Exosite murano - IoT platform by Exosite.
10. Salesforce IoT Cloud - Salesforce cloud for the Internet of Things.
11. Agile IoT Platform - Ayla Networks IoT Platform (with cloud services).
12. Alibaba cloud - A cloud computing solution
13. SAP HANA - SAP cloud for the Internet of Things.
14. Siemens MindSphere - Open IoT ecosystem as PaaS.
15. Xively IoT Cloud - IoT platform.
16. Artik Cloud - Samsung cloud for the IoT.
17. AWS IoT - Amazon cloud for the IoT.

B. Industrial IoT
   1. Thingworx - Industrial IoT cloud.
   2. deviceWISE for Factory - Telit IIoT cloud.
   3. Voice of the Machine - Industrial IoT cloud (by Parker Hannifin, based on Exosite).
   4. Space-Time Insight IIoT - Industrial IoT cloud (formerly go-factory.com).
   5. Autodesk Fusion Connect - No-coding industrial IoT platform.
   6. DataXChange - Cloud manufacturing.
   7. Predix - Industrial IoT cloud (by General Electric).

Collective research areas

AI, IoT, WSN, and Blockchain can accompany each other well and can potentially new height form using technologies. Grouping these technologies working in tandem is not modern, but the convergence would happen faster than ventured. We need to stretch our minds to envision the impact of these three technologies taken together fully. The technologies have to use in creative ways for appropriate solutions. The restriction is not going to be the technology solutions but the creative thinking of the business needs.

All four (AI, IoT, WSN, and Blockchain) technologies are at the peak of inflated expectations as per the Gartner Hype Cycle for emerging technologies, as shown in *Figure 3.44*:

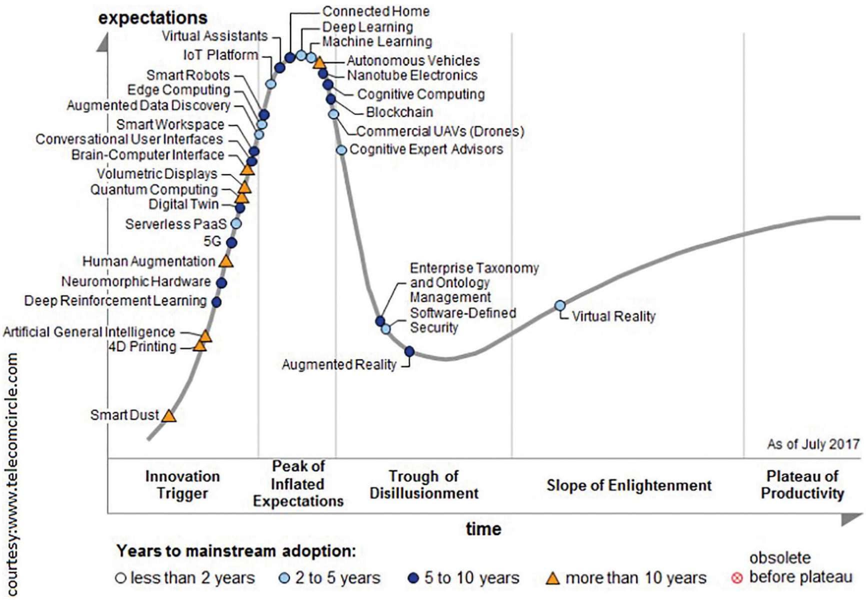


Figure 3.44: *Gartner Hype Cycle-Emerging Technologies*
(Source: https://www.telecomcircle.com/2018/04/iot-blockchain-ai/)

Gartner Hype Cycle has helped many industries as well as the researchers to plan their works towards developing the solutions.

Blockchain, along with WSN+AI+IoT, can increase the Trust, Traceability, Security, and Smart Contracts. *Figure 3.45* is the visual representation of action how four technologies, i.e., WSN, AI, IoT, Blockchain, when you put together.

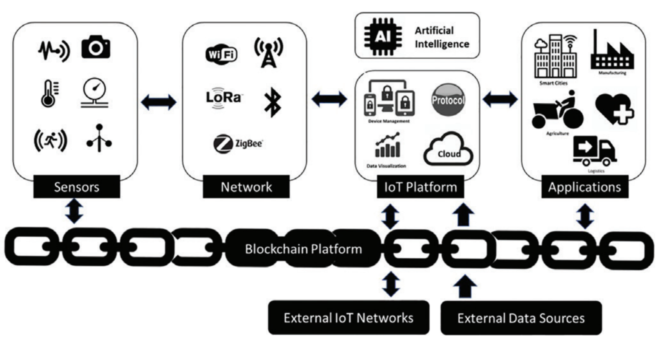


Figure 3.45: *WSN, AI, IoT and Blockchain in Action*
(Source: https://www.telecomcircle.com/2018/04/iot-blockchain-ai/)

AI gets layered over the IoT platform, which ideally contains powerful sensor nodes / devices while the data from external sources circulate through the Blockchain platform, which will increase the efficiency but also help businesses deliver better customer service. Even though the mixing of these technologies together would lead to higher complexity while the privacy issues are more priority. There would be challenges around compatibility due to a lack of protocols and standards once we stitch or tie these technologies.

Top searching topics based on Internet

This section would provide some insights to the readers to understand for which content the users have searched for:

1. IoT
   - (a) IoT Safety/Security
   - (b) Smart City/Campus/Classrooms/Home
   - (c) Monitoring/Remote/Local
   - (d) WoT-Web of Trust
   - (e) Internet of Multimedia Things
   - (f) Activity Detection
   - (g) Data Traffic
   - (h) QoS Management
   - (i) Resource Constraints
   - (j) Data Analysis
   - (k) IoT Applications
   - (l) IoT + Fog + Cloud + AI + WSN Infrastructures
2. AI/ML/DL
   - (a) Deep Learning Methods
   - (b) Hybrid Unsupervised/Supervised ML
   - (c) Self-Optimizing and Self-Programming Computing Systems
   - (d) Multimedia/Text Classification
   - (e) Traffic/Topology/Data Analytics
   - (f) Deep neural network
   - (g) Fault/Error/Exception/Incident/Anomaly/Event Detection
   - (h) Artificial Intelligence Techniques to Signal Processing

(i) Applied Smartness
(j) Integration of IoT and WSN
(k) Bio-Inspired Algorithms
(l) Tracking Algorithms
(m) Retrieval approaches/Dataset Classification/Segmentation
(n) Prediction of Data/Video/Changes
(o) Robotics
(p) Neural network
(q) 5G and Smart Grid

3. Image Processing
   (a) Machine (Deep) Learning Methods for Image Processing
   (b) Image Denoising/Deblurring/Imaging publication/
   (c) E-healthcare/Medical Imaging
   (d) QoS
   (e) Integration of IoT and AI
   (f) Smart Surveillance/Smart Imaging/Smart manipulation
   (g) Face recognition

4. Blockchain
   (a) Blockchain Adoption in Supply Chain Networks/Business/ Applications/BitCoin/Industrial
   (b) Secure data transfer/ email/ notification/ communication/ command etc.
   (c) Blockchain for IoT/AI/Network etc.
   (d) 5G and Smart Grid
   (e) Proof-of-Work Mechanisms
   (f) Blockchain Technology Applied to Smart Cities
   (g) Food/Consumables/Things Safety

5. Other areas
   (a) Data mining
   (b) Cloud computing
   (c) Fluorescent dyes
   (d) Big data
   (e) 5G
   (f) Smart grid
   (g) Antenna

(h) VSLI
(i) Power electronics
(j) Power system
(k) Network security
(l) FPGA
(m) Wireless power transfer
(n) Cybersecurity
(o) Micro-grid

The search trend over the web changes over time. It is based on various factors such as local government announcements, media hype, and so on.

Summary

In this chapter, an extensive content has been provided for a comprehensive understanding of contemporary technologies for beginner-level researchers.

After reading this chapter, users must have understood the insights of each technology, interconnection between each of the technologies. It will help them to understand and plan to focus their research.

The next chapter is intended to continue the interest of the researchers towards developing the solutions, if not simulating the solutions by using the simulators.

Questions

1. What are the various issues to be addressed when network scalability is the primary concern?
2. Why does a WSN need a cluster? Which are the WSN parameters that help to decide the size of a WSN cluster?
3. Is the Quality of Service the same for WSN and IoT? If not, how do they differ?
4. List the types of possible attacks on a WSN. Which attack is the most damaging, and why?
5. For which problems Deep Learning is most appropriate? State a problem that you have come across which needs Deep Learning to be implemented. Justify your answer.

6. What is the difference between IoT and IIoT? What are the additional features needed to distinguish IoT and IIoT?

Do some research

Study and understand Recommender Systems. Play half-a-dozen of videos on YouTube related to one specific topic or a person. List the top five contact who use Smartphones, whom you frequently contact using your Smartphone. Observe which videos are recommended to you in the seventh instance. Enquire with those shortlisted five contacts, for which video was recommended for each of them. Do you find any similarities or differences in the recommendation? Develop your theory upon your observations.

CHAPTER 4
Simulators of WSN, AI, and IoT

Introduction

Simulators have played a key role in the researchers' life to develop a prototype before developing an actual solution. This chapter provides a piece of good information about various simulators, the description of each simulator, and the source to access the simulator.

Structure

- Introduction
- WSN Simulators
- AI Simulators
- IoT Simulators
- Summary

Objectives

After reading this chapter, the reader will be able to understand:

- The components of the simulator
- Proprietary simulators versus open-source simulators
- Various simulators which would help the students and researchers to work on.

Introduction

Simulation is the imitation of the actions of real-world research problems or systems over time. Typically, there is some type of system that has loads of inputs, applies some mathematical procedures to these inputs, and delivers back output in the form of data that can be evaluated or results of research.

WSN simulators

This section briefs about simulations steps and few popular simulators which are easily available on the web either freely/paid.

Basics of simulation

A WSN simulator consists of various modules, namely protocols, events, environment, node, medium, transceiver, and applications.

Simulators for WSN are required because running the real networks is costly and time-consuming, and simulators provide an easy way to test new applications and protocols of WSN using virtual setup. Examples of WSN simulators include NS-2, TOSSIM, EmStar, OMNeT++, J-Sim, ATEMU, Avrora, and so on.

What is the difference between simulators and emulators?

The simulator tries to duplicate the behavior of the device, whereas the emulator tries to duplicate the inner workings of the device. A simulator is a software that duplicates some processor in almost all the possible ways, whereas an emulator is hardware that duplicates the features and functions of a real system so that it can behave like the actual system.

Example of the simulator: Write a new program that draws the calculator's display and keys, and when the user presses a key, the programs do what it supposed to do.

The process for the simulation would be more easy and meaningful when the initials steps are defined properly, that is., defining the objectives, planning them to create the ease in modeling the system and data.

The key features and limitations of each simulator/emulators are highlighted in *Table 4.1* and *Table 4.2*:

Simulator	Prog. Language or Platform	Key Features	Limitations
OMNeT++	C++	It is an extensible, modular, component-based simulator. It supports realistic channel, power consumption library, and radio models, a key element for accurate early-phase WSN simulation.	The number of protocols is less, and there could be compatibility problems as individual researching groups develop the models separately.
NS-2	C++, TCL	Open source, easy to add new protocols. A large number of protocols available publicly. Availability of a visualization tool.	Supports only two wireless MAC protocols, 802.11, and a single-hop TDMA protocol.
OPNET	C/C++	OPNET supports Fast discrete event simulation engine, Lot of component library with source code, Object-oriented modeling, Hierarchical modeling environment, Scalable wireless simulations support, 32- bit and 64-bit graphical user interface etc.	The simulation requires a lot of processing power and can be very time-consuming, particularly for a network with a large number of transmitters and receivers.

GloMoSim	Parsec	Parallel simulation capability. It is tailored specifically for wireless networks. Availability of a visualization tool.	Effectively limited to IP networks because of low-level design assumptions. Unavailability of new protocols.
TOSSIM	nesC	The high degree of accuracy or running the application source code unchanged. Availability of a visualization tool.	Compilation steps lose the fine-grained timing and interrupt the properties of the code.
ATEMU	C	Helps to simulate multiple sensor nodes at the same time, and each sensor node can run different programs, it has a large library of a wide range of hard devices, it provides a very high level of detail emulation in WSNs.	The simulation time is much longer than other simulation tools, and it has fewer functions to simulate routing and clustering problems.
UWSim	C++	Publicly available and designed solely for UWSN.	Supports only a limited number of functionalities and calls for extension.
Avrora	Java	Can handle networks having up to 10,000 nodes. Enables validation of time-dependent properties of the large-scale networks.	Fails to model clock drift. 50% slower than TOSSIM. It cannot model mobility.
Castalia	C++	Physical process modeling, sensing device bias and noise, node clock drift, and several MAC and routing protocols implemented. Highly tunable MAC protocol and a flexible parametric physical process model.	Not a sensor-specific platform. Not useful if one would like to test code compiled for a specific sensor node platform.

Table 4.1: *Key features and limitations of some popular WSN simulators*

Simulator	Prog. Language or Platform	Key Features	Limitations
SENS	C++	Platform-independent Users can assemble application-specific environment. Defines an environment as a grid of interchangeable tiles.	Not accurately simulate a MAC protocol. Provides support for sensors, actuators, and physical phenomena only for sound.
Shawn	Java	Not limited to the implementation of distributed protocols, it can simulate vast networks.	Detailed simulations of issues such as radio propagation properties or low-layer issues are not well considered.
SENSE	C++	Balanced consideration of modeling methodology and simulation efficiency. Memory- efficient, fast, extensible, and reusable.	Not accurate evaluation of WSN research. Lacks a comprehensive set of models Absence of a visualization tool.
COOJA	Java/C	Concerning both simulated hardware and software. Larger-scale behavior protocols and algorithms can be observed.	Not extremely efficient. Supports a limited number of simultaneous node types. Making extensive and time-dependent simulations difficult.
EmStar	Linux	May be run on a diverse set of execution platforms. Combination of simulator and emulator. EmStar's use of the component-based model allows for fair scalability.	Only run code for the types of nodes. It does not support parallel simulations. Not as efficient and fast as other frameworks.

J-Sim	Java	Provides support for energy modeling, with the exception of radio energy consumption Support mobile wireless networks and sensor networks. Component-oriented architecture.	Low efficiency of the simulation. The only MAC protocol provided for wireless networks is 802.11. Unnecessary run-time overhead.
(J)Prowler	Matlab/ Java	Probabilistic wireless sensor network simulators. (J)Prowler provides an accurate radio model.	It provides only one MAC protocol, the default MAC protocol of TinyOS.
VisualSense	Ptolemy II	Provides an accurate and extensible radio model as well as a sound model that is accurate enough to use for localization.	Does not provide any protocols above the wireless medium, or any sensor or physical phenomena other than sound.

Table 4.2: *Key features and limitations of some popular WSN simulators(cont...)*

Example for the emulator: Get a calculator's firmware, then write a program that loads the firmware and interprets it the same way the microprocessor does in the calculator.

Programming for WSN is a bit a challenging task in the real setup; hence it would be better if it simulated through WSN simulators, which has two basic features; reproducible experimentation, and dynamic environment modeling.

What is the difference between discrete-event simulations and trace-driven simulation?

Discrete-event simulation is widely used in WSNs because it can easily simulate lots of jobs running on a variety of sensor nodes. This simulation can list pending events, which can be simulated by routines, input routines, output routines, initial routines, trace routines, debugging environment, and dynamic memory management.

Trace-driven simulation is commonly used in real systems since its results have more credibility and provide a more accurate workload; however, high-level detail information increases the complexity of the simulation; workloads may change, and thus the representativeness of the simulation needs to be suspicious.

What is the difference between synchronous simulation and asynchronous simulation?

Synchronous simulation is based on rounds, and at the beginning of each round, the simulators increment the overall time by one unit. Then, it moves the nodes according to their mobility models and updates the connections according to the connectivity model. Similarly, the framework iterates over the set of nodes and performs these steps for each node.

Normally, any simulation consists of several steps / procedures which are followed one by one, as shown in self-explanatory *Figure 4.1*.

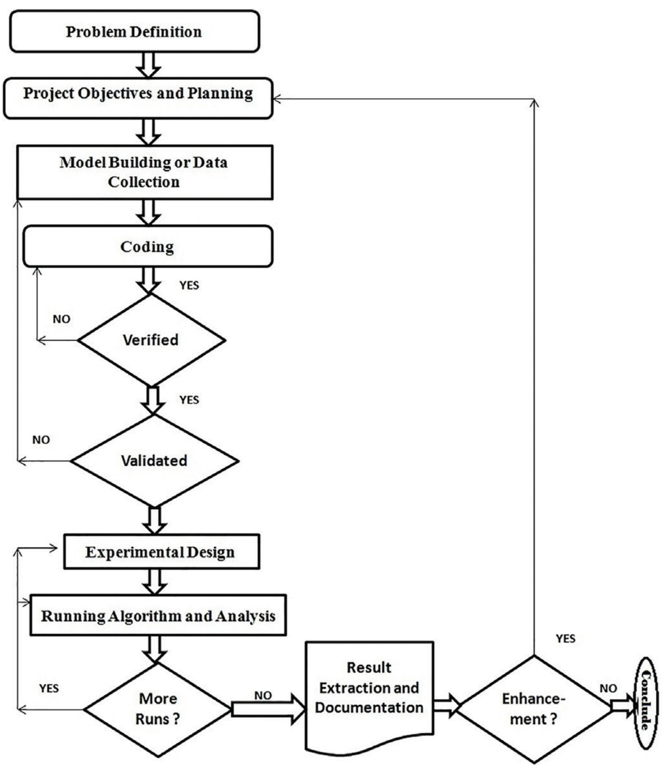


***Figure 4.1:** Procedure of simulation*

Asynchronous simulation is a purely event-based simulation that holds a list of message events and timer events, which is sorted by the time when these events should happen, for example., the arrival of a message, execution of timer-handler. The simulator frequently picks the most recent event and executes it. The asynchronous simulation model runs much faster than the synchronous mode.

Few simulation tools

This section describes a few main-stream simulation tools used for WSNs:

1. **OMNeT++**: OMNeT++ is a discrete event network simulator built in C++. OMNeT++ is open-source software available for academic institutions or research organizations. This simulator supports the module programming model. Users can run the OMNeT++ simulator on Linux Operating Systems, Unix-like system, and Windows. OMNeT++ is a popular non-specific network simulator, which can be used in both wired and wireless area. Most of frameworks and simulation models in OMNeT++ are open source.

   OMNeT++ provides a component architecture for models. Components (modules) are programmed in C++, then assembled into larger components and models using a high-level language (NED). OMNeT++ is not a simulator in itself but rather a simulation framework. Instead of containing explicit and hard-wired support for computer networks or other areas, it provides the infrastructure for writing such simulations. Specific application areas are catered by various simulation models and frameworks; most of them are open source.

   Website to download OMNeT++: http://www.omnetpp.org/

2. **J-Sim**: It is a real-time process-based and component-based simulation environment developed entirely in Java. It supports many protocols, including a WSN simulation framework with a very detailed model of WSNs, and implementation of localization, routing, and data diffusion WSN algorithms. JSim models are easily reusable and interchangeable, offering the maximum elasticity, including the GUI library for animation, tracing and debugging support, and a script interface. As JSim claims that,

the scalability of a number of wireless nodes is around 500 with two orders of magnitude better memory consumption but a 41% worse execution time.

Website to download J-Sim: https://sites.google.com/site/jsimofficial/

3. **NS2**: NS2 is a discrete event simulator that provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks on the Unix environment. We can use NS2 to simulate WSN in terms of invoking network traffic consistency to the patterns expected for sensor networks. NS2 works at packet level provide substantial support to simulate a bunch of protocols like TCP, UDP, FTP, HTTP, and DSR. It uses TCL as its scripting language and C++ used for protocol simulations, byte manipulation, packet processing, algorithm implementation, and so on.

   Website to download NS2: http://nsnam.isi.edu/nsnam/index.php/User

4. **TOSSIM**: It is an emulator particularly designed for WSN running on TinyOS; TOSSIM is a free tool, and it best for embedded operating system devices. TOSSIM can run on Linux Operating Systems or on Cygwin on Windows. TOSSIM supports two programming interfaces: Python and C++. Basically, Python allows you to interact with a running simulation dynamically, where C++ can help to overcome the performance of the simulation. TOSSIM currently does not support acquiring energy measurements.

   Website to download TOSSIM: http://www.tinyos.net

5. **GloMoSim**: GloMoSim is developed for wireless networks built with Parsec. Parsec is a simulation language derived from C, that adds semantics for creating simulation entities and message communication parallelly on different architectures. Considering the advantages of parallelization, it has been shown to scale up to 10,000 nodes; hence scalability is high. Many proposals for WSN protocols have been tested with it, and it is worth to simulate proposed WSN protocols.

   Website to download GloMoSim: http://pcl.cs.ucla.edu/projects/glomosim/

6. **ATEMU**: ATEMU is an emulator for AVR processor-based systems. It does low-level emulation of the MEMSIC Mica2 sensor platform, whoever the program is customizable enough to be extended to support different hardware platforms used in heterogeneous network simulations. The simulator is binary compatible with the MICA2 sensor node, emulating the processor, radio interface, timers, LEDs, and other devices, making the platform able to run TinyOS. In this process, the CPU instructions are decoded and executed according to the Atmel ATmega 128L microcontroller specification. ATEMU comes with XATDB, a graphical debugger User Interface.

   Website to download ATEMU: http://www.hynet.umd.edu/research/atemu/

7. **EmSim**: EmStar is a software framework to simulate WSN applications on special platforms called microservers. The EmStar environment contains a Linux microkernel extension, libraries, services, and tools. This simulation has a separate EmStar process tree corresponds to each node in the web, the extensions offered by EmStar cooperate with EmSim where every simulated node runs an EmStar stack and is connected through a simulated radio channel model as it is not a discrete event but a time-driven simulator.

   Website to download EmSim: http://www.cvs.cens.ucla.edu/emstar/

8. **Avrora**: Avrora is a simulating and analyzing framework developed for MEMSIC Mica2 and MicaZ sensor platforms. Avrora supports applications written using the Atmel and GNU assembler syntaxes, where each node has its own separate thread. It has a set of monitoring and profiling utilities that provides debugging via breakpoints and timeouts.

   Website to download Avrora: http://compilers.cs.ucla.edu/avrora/

9. **MSPSim**: MSPSim is a Java-based emulator of MSP430 WSN platforms; it supports the loading of IHEX and ELF firmware files with additional tools like monitoring stack, setting breakpoints, and profiling. Hence MSPSim simulates the program and displays a visual representation of the whole sensor board.

MSPSim is available with Contiki OS and can be used in cross-level simulations conducted with the COOJA platform.

Website to download MSPSim: http://www.sics.se/project/mspsim/

10. **Freemote Emulator:** Freemote Emulator is a Java-based emulator providing a lightweight emulation tool for emerging Java-based Motes, which runs experiments in real-time mixing real and emulated nodes. Freemote Emulator is a part of the Freemote Environment with Freemote Testbed. System architecture defines layers with templates like Physical, Data Link (MAC), Routing, and Application, which helps developers to write code quickly for real and emulated nodes as well as predefined scenarios.

    Website to download Freemote Emulator: http://www.assembla.com/wiki/show/freemote/

11. **SensorSim**: SensorSim uses NS-2 as a base layer for providing additional functionalities for modeling WSNs but adds unnecessary complexity. The main features include sensing channel and sensor models, energy and communication protocol models, scenario generation, and integrates hybrid simulations.

    Help website: https://github.com/NavPy/SensorSim

Apart from the above simulators, still, there are many open-source tools available on the Internet. This section listed a few popular simulators used for WSN. Briefly explained about OMNeT++, J-Sim, NS2, TOSSIM, GloMoSim, ATEMU, EmSim, Avrora, MSPSim, and Freemote Emulator simulators.

AI simulators

The possibility of access to a real-time environment is not easy for every researcher to conduct the research through a variety of experiments. Reasons could range from the safety regulations of the researcher, restricted access to the device, the sensitivity of the data that the organization does maintain, can be the reliability of the work that the researchers want to carry out in the real-time environment, etc.

Many times, setting up the configuration as required by the researchers may become impossible or even could result in an expensive affair.

Hence, the simulators are the saviors for the researchers at the beginner-level as well as at the intermediate-level. Researchers can perform the experiments the way they want to. With a little training, it is easy to understand the simulator.

Fundamentally, the simulator is a software environment that mimics the original environment. For example, a researcher wants to see how his/her idea to automate the fitting unit of an automobile company and wants to see how it works. This task needs the researcher to access the resources of a complete setup of the specific automobile unit. In this case, the researcher may have to perform many experiments beginning from identifying the screw specifications till the arm movements. Many of the attempts during this experiment may result in failure, which further results in wastage of physical material to compromising the production time in the automobile unit. Eventually, the researchers find it very tough to conduct their research without having the the fundamental idea of the hazards that they may face during these kinds of experiments.

Simulators offer great relief for such researchers through the experience of almost a real-time environment. Researchers team can perform many tasks ranging from the design until the testing of their work. However, one should understand that there is no such simulator which can give the complete experience of the real-time environment. But, a minimum of 90% of the real-time environment can be found in the simulators. There are simulators with limited functionality as well, such as training a flight pilot who is a fresh-recruit, testing a small car's functionality on the rough roads, and so on.

Similarly, the researchers who took Artificial Intelligence as the business logic for their work can find a good number of simulators to carry out their experiments and derive a comprehensive result. AI is applicable wherever the application of human intelligence becomes a time-taking aspect or if the problem space is too complex to resolve. With the proper configuration of the environment, one can derive a better solution through AI methods. Many industries have almost completely adopted AI as the supporting business logic for quick decisions and better results. Adopting AI has become considerably increasing, especially in healthcare, automobile, mining, warfare, etc. In the following sections, the brief information of a variety of simulators has been presented to give an idea for the researchers who are about to start their research or already started but searching for the solution in this direction.

Brain simulator

Not all the researchers are good at mathematics or even in programming. Furthermore, the lack of such knowledge should not stop the research of the people who are good at generating wonderful ideas. Brain Simulator is a boon for such researchers, especially those who want to design an AI brain. The fundamental question would be, Why does someone need an AI brain. AI brain is required in such an environment where human intervention is not possible at a faster pace. These AI brains are required in the games or game simulators, flight simulators, warfare simulators, etc. This simulator has numerous modules such as working memory, image recognition, prediction, motion behavior generator, and so on. One can modify these modules or create them as per their requirements. GUI is also easy to work with, as shown in *Figure 4.2*:

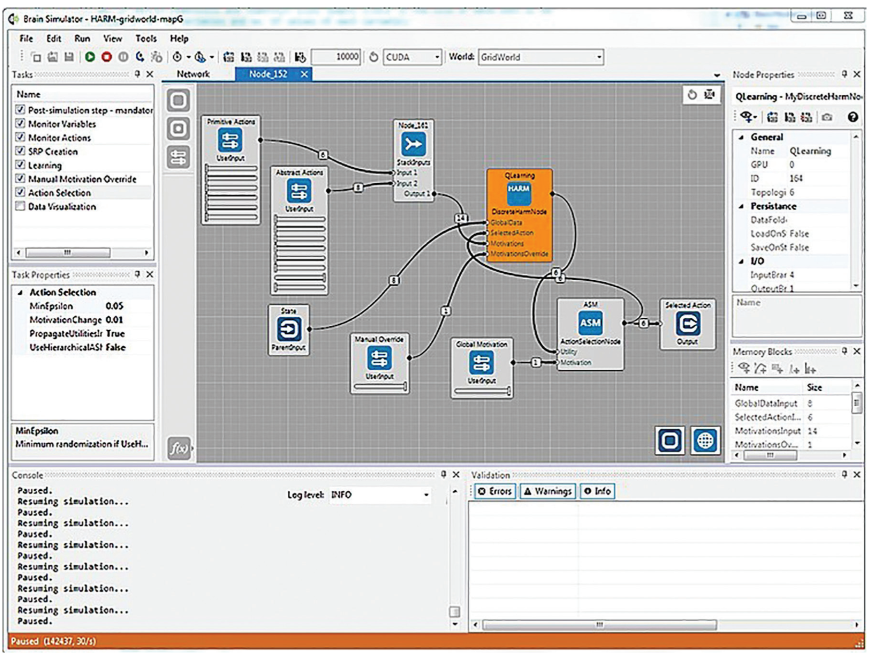


Figure 4.2: *Brain simulator's User Interface*
(Source: https://www.goodai.com/brain-simulator)

Brain Simulator can be used on various computer OSes such as Windows, Linux, Mac. However, the simulator requires an nVIDIA graphics card (hardware) with CUDA support (firmware). CUDA is available for free to download, and installation is also easy. The only requirement for the researcher is to take a little training on how to configure the Brain Simulator to the CUDA tool. In the near future, these steps may also become automated with a single click installation. If the researcher feels the usage of a graphics card is temporary or expensive, a cloud-based and cluster-based CPU/GPU facility is offered by the organization. For the Brain simulator, AI agents are designed such that they operate on sensor input in the simulated environment.

For more information on download and configuration instructions, refer weblink: https://www.goodai.com/brain-simulator/

ISAAC sim

Robotics is one of the research areas in which AI is spreading its wings as with gaining popularity in the areas of Autonomous computing, especially Autonomous vehicles. Robots have already been installed in the restaurants for the tasks ranging from receiving the customers until serving the orders to the dining tables. Though the accuracy needs to be improved considerably, researchers who are into this field are contributing their potential workers to improve the functionality. Few automobile companies such as Volvo are finding no barriers to produce their products. In 2018, Volvo presented its Volvo S90 as HR90, which is equipped with AI to conduct interviews for human technicians. If one has an idea in the area of AI-powered robotics, they can make use of nVIDIA's ISAAC Sim simulator to create and deploy such devices. As embedded computing is an important aspect, in this case, ISAAC Sim is supported by ISAAC SDK, which works for perception, navigation, and manipulation of the environment around the robots, as shown in *Figure 4.3:*

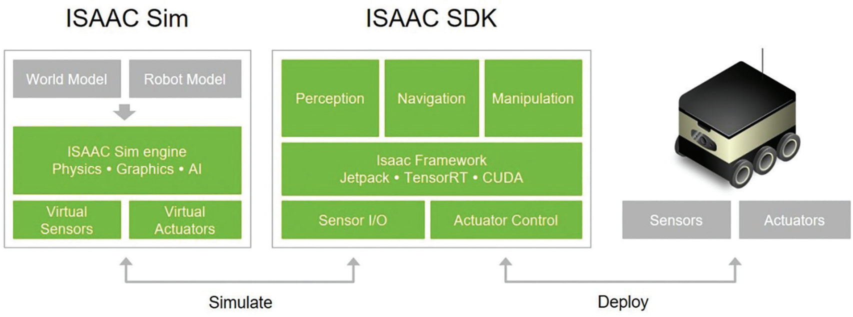


Figure 4.3: *ISAAC Sim interaction with ISAAC SDK (Source: https://developer.nvidia.com/isaac-sdk)*

Testing of hardware-in-the-loop can be done with NVIDIA Jetson AGX Xavier. As the simulator is completely a virtual environment, the ISAAC SDK helps the ISAAC Sim for a better understanding of Sensor protocols and Actuator controls. Ultimately, the goal of the ISAAC Sim is to give an opportunity to the Robotics researchers to produce production-quality work with the support of high-performance GPU- accelerated algorithms.

To download the SDK and to know more about the documentation, the web link is: https://developer.nvidia.com/isaac-sdk

Couger

Customers and users of Robots do expect a great performance from them. The performance of the robots is subjected to the availability of information within them as well as the brain, which is installed by the robot manufacturers. Robot brain performance depends on the factors of data that it has, the knowledge that is programmed with task planners, communication support, information processing, and so on.

Once the robot is manufactured and sold it to the customers, it would be the responsibility of the customer to keep feeding the data and the responsibility of the robot support team to keep updating the knowledge. All of these tasks become painful.

Cloud robotics work in a way that the robots would experience the property of light-weight in terms of data, knowledge, task planner, and so on. **Couger** is a Japanese company that offers Cloud Robotics by integrating Artificial Intelligence and Robotics. A robot would be connected to one of the Cloud platforms to support the aspects mentioned above. These would make the customer as well as the support team to keep improving the performance of the robot through the periodical updates received from the cloud. However, the updates that the robots do receive would be based on the options chosen by the customer. Accordingly, cloud robotics would work on the data, task planner, communication among robots, information processing, and so on, with the support of the Deep Learning technologies that are developed for the purpose. The technologies that Couger has used to develop their Cloud Robotics are the Robot Operating System (ROS), and Deep Convolution Neural Network (DCNN) over Intel Joule hardware.

To find more on Couger and its experience, the web link is: https://couger.co.jp/project/detail03.html.

Anylogic

Anylogic simulation environment provides a suite of industry-specific tools as a combination package. Fundamentally anylogic platform offers various libraries such as Material Handling Library, Road traffic library, Rail library, Pedestrian library, etc. A general presentation of the availability of anylogic libraries is shown in Figure 4.4.

Figure 4.4: *Anylogic Simulation (Source: https://www.anylogic.com)*

Anylogic is a multimethod modeling environment through which the researchers can develop their models using any combination of the three methods: Discrete events, Agent-based, and System Dynamics. For a better understanding of the results, this simulation tool provides the animation of the model and the visualization of the performance through the charts. One can make their models more interactive and can also save their simulations into the dashboards. As mentioned above, the libraries are more industry-specific, so the researchers can feel their developed work almost matching the industry standards.

The exhaustive features of this wonderful simulation tool are listed as follows:

(a) Multi-method modeling environment
(b) Animation and visualization
(c) Industry-specific libraries
(d) A professional agent-based simulation tool
(e) GIS maps integration
(f) Simulation in the cloud
(g) Rich experiment framework
(h) Data interoperability
(i) Model export and integration
(j) Support in model building
(k) Extensible and customizable platform

To find various versions of anylogic subscription and help guide the web link is: https://www.anylogic.com/downloads/

Cozmo SDK

Those AI researchers in the specialization of IoT, Computer Vision, and Human-computer interaction can make the best use of this simulator. Because of its lucid combination of character, hardware, and software, Cozmo SDK becomes a unique simulation platform. Anki has developed Cozmo as the smartest AI-powered robot with a cute look. For the developers, Anki has released Cozmo SDK for its AI-based IoT, HCI products such as Karate Cozmo. However, Cozmo can be integrated with Oracle Cloud and Calypso.

Though the Cozmo robot is a commercial product, one can create the applications from the beginner-level to the researcher-level.

(a) Sandbox version for the beginner-level

(b) Constructor version for the intermediate-level

(c) Python-SDK for the Advanced-level or for the researchers

As the Python-SDK is a fully open-source, it gives the freedom for the developers and the researchers to implement their model. Once the Cozmo robot is purchased, Anki allows access to all the code and SDK resources, as shown in *Figure 4.5*:

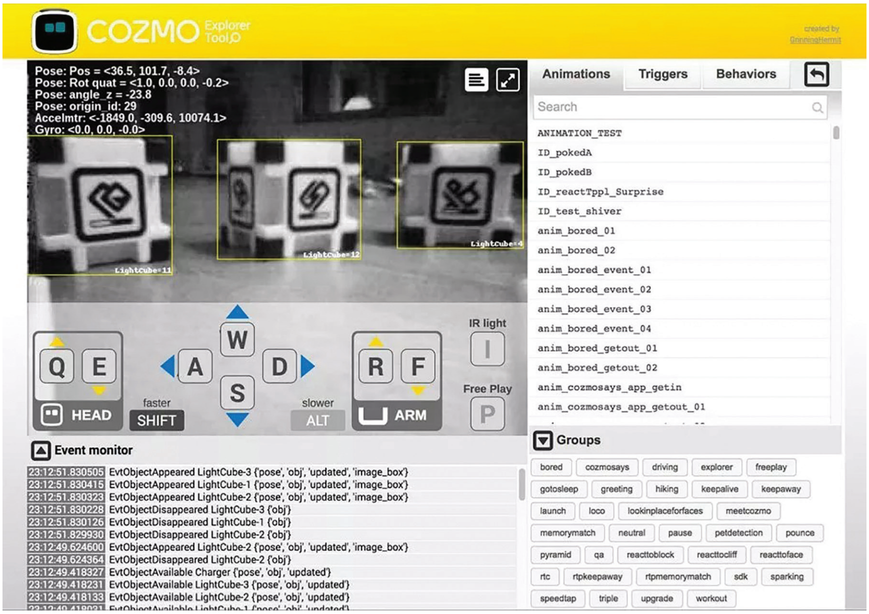


Figure 4.5: *The Cozmo Explorer Tool*
(Source: https://developer.anki.com/blog/learn/tutorial/getting-started-with-the-cozmo-sdk/)

A good number of third-party libraries such as Google Assistant, Social networking apps allow the developer to strengthen the Cozmo robot's capabilities in a number of ways.

A developer can find the supporting features for Cosmo SDK and other features at: https://developer.anki.com/

Tensorflow

One of the Open source software libraries that Google has developed and used for their applications is **TensorFlowTM**. The purpose of developing TensorFlowTM is to conduct research in the areas of ML and DNN. However, the system is useful in many other domains too. The fundamental concept on which TensorFlowTM works is the numerical computations. The method used data flow graphs: Nodes and Edges. Nodes are used to represent the mathematical operations, whereas the edges are used to represent the tensors or multidimensional data arrays. These tensors are communicated between the nodes, that is, mathematical operations. The architecture is so flexible that the computations can be deployed to one or more computational units in a desktop (CPUs / GPUs) with one Application Program Interface (API). The same architecture can be used to do the same in the server or the mobile device.

Apart from the libraries and APIs, TensorFlowTM offers TensorBoard as part of the package for the machine learning experiment's tooling and visualization, refer *Figure 4.6*:

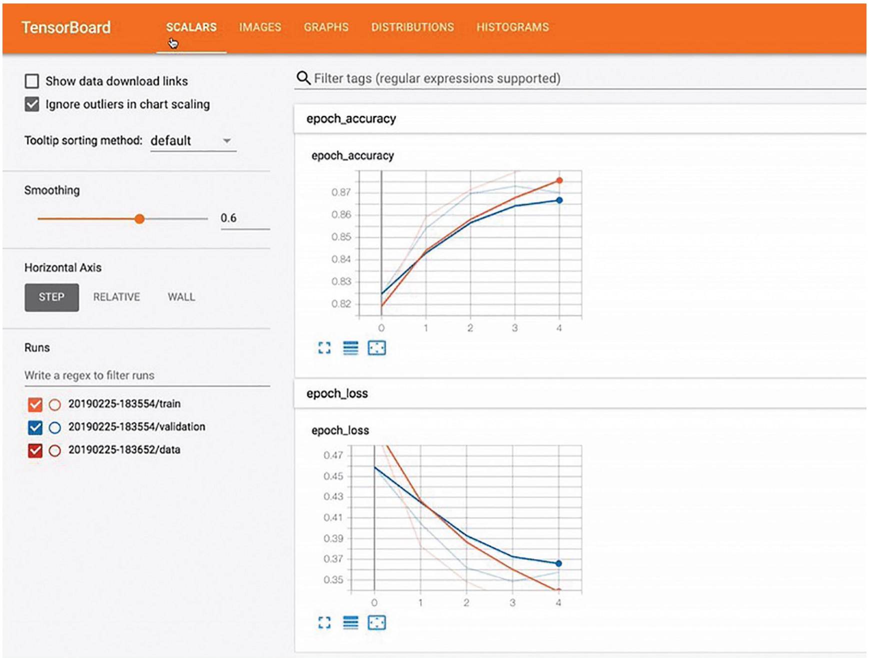


Figure 4.6: *TensorBoard (Source: https://www.tensorflow.org/tensorboard)*

Other tools as part of TensorFlowTM are:

(a) CoLab stands for Collaboratory, which allows TensorFlow Code to be executed in the local browser with no setup required.
(b) What-If Tool, is very useful to understand, probe, debug and check the fairness of the machine learning models that the researchers or developers do develop
(c) ML Perf is a machine learning benchmark tool to measure the performance of machine learning cloud platforms, hardware accelerators as well as software frameworks.
(d) XLA stands for Accelerated Linear Algebra, which is a compiler for linear algebra used to optimize the computations in TensorFlow.
(e) TensorFlow Playground, to work with Neural Networks in the browser.
(f) TensorFlow Research Cloud, a very useful program through which researchers can apply for the access of a cluster of even a size more than 1000TPUs.

One can find more solutions for ML problems and download instructions of Tensorflow at https://www.tensorflow.org/

Keras

Keras is a Python DL library that is found as a high-level neural network library API. As the library is developed using Python, it can be run on TensorFlow as well. Having the features of Modularity, User-friendliness, and extensibility Keras can be used at ease for fast prototyping. Model is Keras's core data structure, refer to *Figure 4.7*.

One of the significant features of Keras is powerful image classification, and models can be built using very small data. There are two types of Keras models: the Sequential model, and the Model class used with the functional API. Each model has numerous methods and attributes, as well. The fundamental building blocks of Keras models are Keras layers. By using a wide range of layer functions, layers are created.

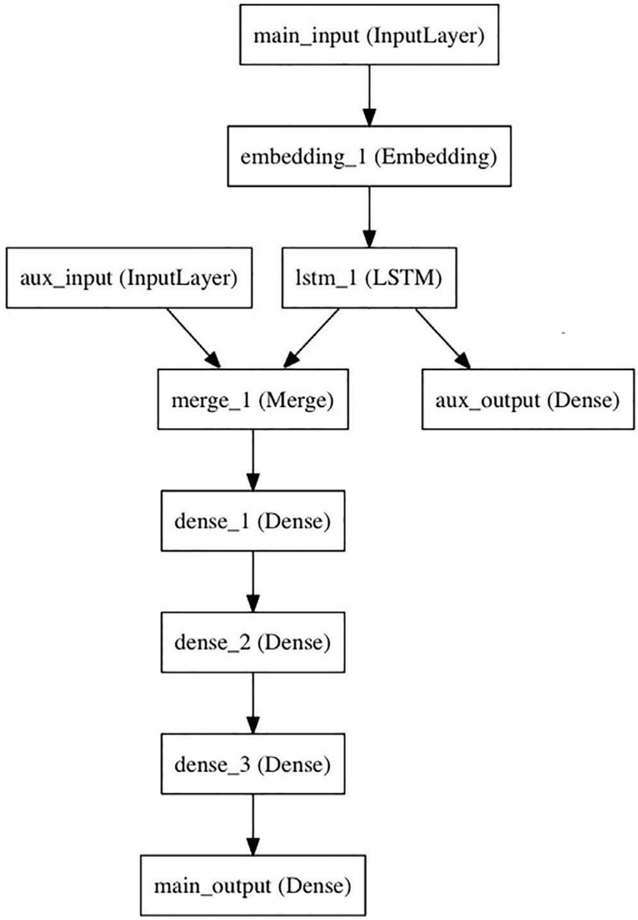


Figure 4.7: *One of the Keras's Multi-input and Multi-output models (Source: https://keras.io/getting-started/functional-api-guide/)*

Various layers that Keras provide are:

(a) Core Layers, which consist of Dense, Activation, Dropout, Flatten, Input, Reshape, Permute, RepeatVector, Lambda, ActivityRegularization, Masking, SpatialDropout1D, Spatial-Dropout2D, Spatial- Dropout3D.

(b) Convolution Layers which consist of Conv1D, Conv2D, Conv3D, SeparableConv1D, SeparableConv2D, DepthwiseConv2D, Conv2Dtranspose, Conv3Dtranspose, Cropping1D, Cropping2D, UpSampling1D, Up- Sampling2D, UpSampling3D, ZeroPadding1D, ZeroPadding2D, Ze- roPadding3D.

(c) Pooling Layers which consist of MaxPooling1D, MaxPooling2D, Max- Pooling3D, AveragePooling1D, AveragePooling2D, AveragePooling3D, GlobalMaxPooling1D, GlobalAveragePooling1D, GlobalMaxPooling2D, GlobalAveragePooling2D, GlobalMaxPooling3D, GlobalAveragePooling3D.

(d) Locally-connected Layers which consist of LocallyConnected1D, Lo- callyConnected2D

(e) Recurrent Layers, which consist of RNN, SimpleRNN, GRU, LSTM, ConvLSTM2D, ConvLSTM2Dcell, SimpleRNNCell, GRUCell, LSTM- Cell, CuDNNGRU, CuDNNLSTM.

(f) Embedding Layers

(g) Merge Layers, which consist of Add, Subtract, Multiply, Average, Maximum, Minimum, Concatenate, Dot.

(h) Advanced Activation Layers which consist of Rectified Linear Unit (ReLU), Leaky Rectified Linear Unit (LeakyReLU), Parametric Rectified Linear Unit (PreLU), Exponential Linear Unit (ELU), ThresholdeddReLU, Softmax,

(i) Normalization Layers consist of the BatchNormalization layer.

(j) Noise Layers consist of GaussianNoise, GaussianDropout, Al- phaDropout.

(k) Layer wrappers consist of TimeDistributed, Bidirectional.

(l) Own layers shall be written for all those custom operations with trainable weights, whereas the above layers can be written for stateless custom operations.

Prerequisites to download Keras and supporting documentation can be found from the web link is: https://keras.io/

Machine Learning Addict–MLaddict

The **MLaddict** is the collection of four interactive learning tools that are developed for various machine learning algorithms. The four simulators are:

(a) Linear regression simulator is to understand the way linear regression works when used gradient descent. Five steps in this simulator are the Initialization of parameters, Calculation of hypothesis for every data point, Calculation of cost function, Calculation of partial derivatives of the cost function w.r.t. parameters, Updating the parameters.

(b) Neural Network Simulator is devised to understand the working of artificial neural networks. The simulator produces the results in 3 phases: Initialization, Forward pass, and Backpropagation pass with a total of 11 steps.

(c) Elman Recurrent Neural Network Simulator is a simple RNN, which produces the results in 3 phases: Initialization, Forward pass, and Backpropagation pass with a total of 12 steps refer to *Figure 4.8*.

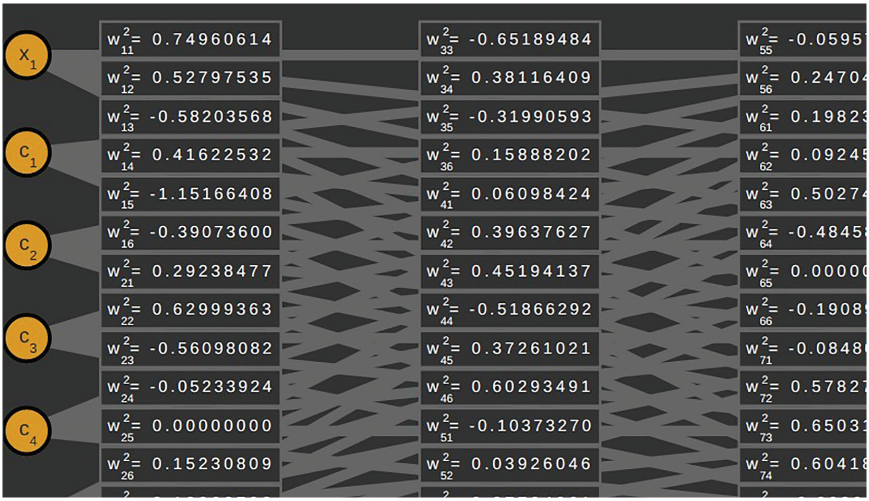


Figure 4.8: *An instance of Elman Recurrent Neural Network Simulator (Source: https://www.mladdict.com/elman-recurrent-neural-network-simulator)*

(d) Q-Learning Simulator portrays the results as a simple 4x3 grid based on the Agent and Episode model.

All the four simulators can be accessed through the weblink: https://www.mladdict.com/

RapidMiner

RapidMiner tool, suits best for the group of researchers or developers who are working on analytics. This tool takes the assistance of machine learning, data preparation, and predictive models. Workflow of RapidMiner tool is as shown in *Figure 4.9*:

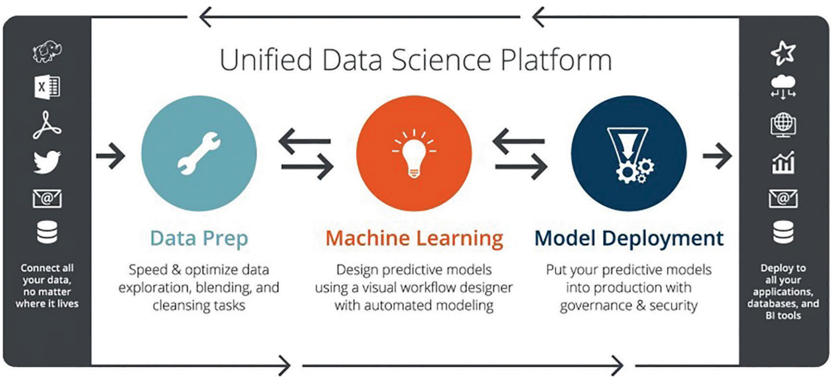


Figure 4.9: *Workflow in RapidMiner (Source: https://rapidminer.com)*

The software tool consists of three modules:

(a) RapidMiner Studio for the visualization of workflow, especially for data scientists.
(b) RapidMiner Server, which facilitates the activities of Model management, Team collaboration, and deployment.
(c) RapidMiner Radoop is a code-free machine learning tool for Hadoop and Spark.

Modeling through the RapidMiner supports seven popular methods:

(a) K-Means clustering
(b) Principal Component Analysis
(c) Correlation and Covariance Matrix
(d) Naive Bayes
(e) Logistic Regression
(f) Decision Tree
(g) Split Validation: evaluate model performance

With a careful understanding of the tool, one can create and validate correct machine learning models. Researchers are also facilitated with RapidMiner Auto Model, which uses automated machine learning and best practices so that they can build predictive models.

To start working with RapidMiner and to find more information about it, one can visit: https://rapidminer.com/

PyTorch

PyTorch is one of the open-source deep learning platforms, which gives the flexibility to researchers and developers from the prototyping stage to production and deployment. Key Features of PyTorch is shown in *Figure 4.10:*

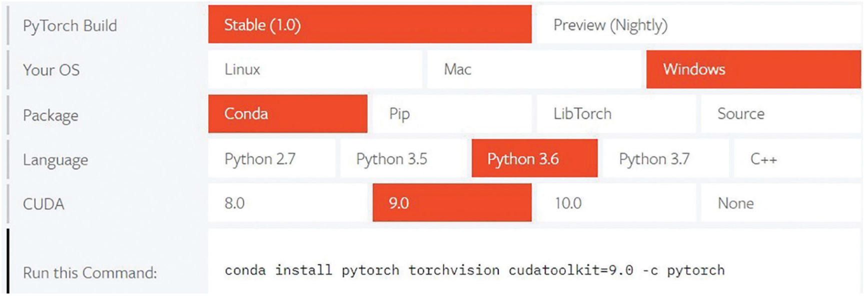


Figure 4.10: *A complete stack of PyTorch (Source: https://pytorch.org/)*

Pytorch functionalities include:

(a) Distributed Training
(b) Hybrid Front-end
(c) Python-First
(d) Native ONNX support
(e) C++ Frontend

It has a great ecosystem that contains libraries and tools built upon PyTorch to support AI development and accelerate it.

(a) AllenNLP, Deep learning for Natural Language Processing (NLP).
(b) ELF, for game research, to permit developers and researchers who can train and test their gaming algorithms.
(c) Fastai, an open-source library that can simplify the training of accurate neural networks based on best practices such as deep learning.
(d) Flair, another library which is built upon PyTorch for Natural Language Processing.
(e) Glow, designed for hardware accelerators and is a machine learning compiler as well as the execution engine.
(f) Horovod, a distributed deep learning training framework for Py- Torch, Keras, MXNet, and TensorFlow.

The ecosystem for PyTorch and the supporting features can be found at: https://pytorch.org/

DL4J

DL4J stands for **Deep Learning For Java**. Deeplearning4j is written in Java, so it is highly compatible with any JVM language, such as Clojure, Scala, or Kotlin. C, C++, and CUDA are used as the primitive computations, whereas Keras would be used as the Python API. This open-source project for deep learning in Java and Scala and is workable over the Eclipse platform, so Eclipse Deeplearning4j. As DL4J is also integrated with Apache Spark and Hadoop, as shown in *Figure 4.11*:

Figure 4.11: *User Interface of DL4J Training*
(Source: https://github.com/deeplearning4j/deeplearning4j)

The distributed deep-learning library facilitates the business environments with AI on distributed CPUs and GPUs.

Guide for DL4J, APIs, examples can be found at https://deeplearning4j.org/

AIBrain

Another company in the area of developing the AI brain is AIBrain. To improve the quality of living, AIBrain has developed various products such as:

(a) TYCHE: Intelligent Robot Companion for Kids
(b) SMILE: SEL Skills Training System for Kids
(c) dAIsy: English Learning Ai Companion
(d) ATHENA: AI Host Robot

Apart from the above four products, AIBrain has developed a simulation game, FUTURABLE, as shown in *Figure 4.12*:

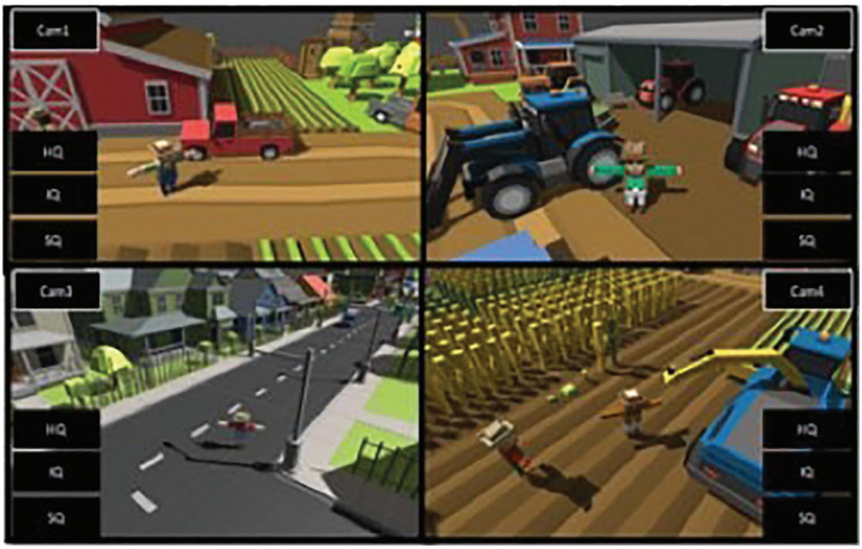


Figure 4.12: *FUTURABLE simulation game scenario*
(Source: https://aibrain.com/products/futurable/)

This simulation game comes in two categories: Life simulation and Business simulation. Life simulation results in a way that what kind of life we can expect with the various changes that are happening around the world through disruptive AI technology. One can foresee or forecast by accelerating the future by 365 times faster. All this can be done before the kind of life as it happens, but keeping the present situations and trends as the major information. FUTURABLE AI uses mathematical modeling using Monte Carlo, Probabilistic reasoning, and planner based on AI, Machine Learning, Deep Learning. Solution for Intelligent agent problems is developed using a BDI planner.

For Life Simulation and Business Simulation, information can be had from the following link: https://futurable.ai/

Section *AI simulators*, has provided the preliminary idea over the AI simulators, which will also provide the fundamental idea about which simulator would be more suitable for their work.

IoT simulators

In the present industry, almost every device is being built to be connected via the internet for the benefit of the user. Furthermore, the connected device collects the data, sends it to the application to which the user is connected/registered for the better experience. For example, when a user is using a smartwatch to keep track of his daily health activities, all the data such as how much distance the user has walked, for how much of time the user has used treadmill, and so on, would be calculated and sent to the application installed in the mobile phone. The analytics tool, which is part of the application, would inform the user whether the user has reached the target or not.

In the above example, the mention was only on the health; however, smartwatches are devised to help the user in many ways. Not only smartwatches, but the IoT devices are spread across in many industrial applications, especially in the Aviation, Automobile, Hotels, and so on. They are helping the stakeholders in a potential way. To build such devices and the assisted applications, the team needs great research. To help such research teams, many industries have developed great platforms, few are focused on specific issues, and few are into multi-dimensional. An exhaustive list of the components for the various IoT devices has been mentioned in *Figure 4.13*:

Every component mentioned in *Figure 4.13* has its own potential to build an integrated device for the specific use-case.

Those who would want to apply their knowledge either for an alternative or for the enhancement can consider the respective platform, as mentioned in the list of IoT platforms. Based on the use-case, each platform would prepare an architecture to develop the solution(s). The architecture for predictive maintenance is depicted in *Figure 4.14*. Maintenance is equally important.

Industry Use Case	**Components Used**					
Industrial Sensors	Vibration Sensor	Temperature Sensor	Pressure Sensor	Humidity Sensor	RFID	Camera
Motion Sensors	Accelerometer	Gyroscope	Tilt Sensor	Piezoelectric Sensor	Distance Sensor	GPS Tracker
Industrial Automation	Programmable Logic Controller	Data History				
Infrastructure	Micro-controller	Memory	Communication device			
Power Supply	Battery	Electricity Network				
Consumer Product Contact	Button	Switch	Touch Sensor	Hall-effect Sensor	Fingerprint detector	Flexibility Sensor
Sound	Buzzer	Microphone	Speaker	Sound Modules		
Lighting	Light Emitting Diode (LED)	Light Sensor				
Displays	Dot Matrix	Screens				
Mechanical	Potentiometer	Motor	Vibration Motor	Weight Sensor		

Figure 4.13: *Components of IoT Devices*

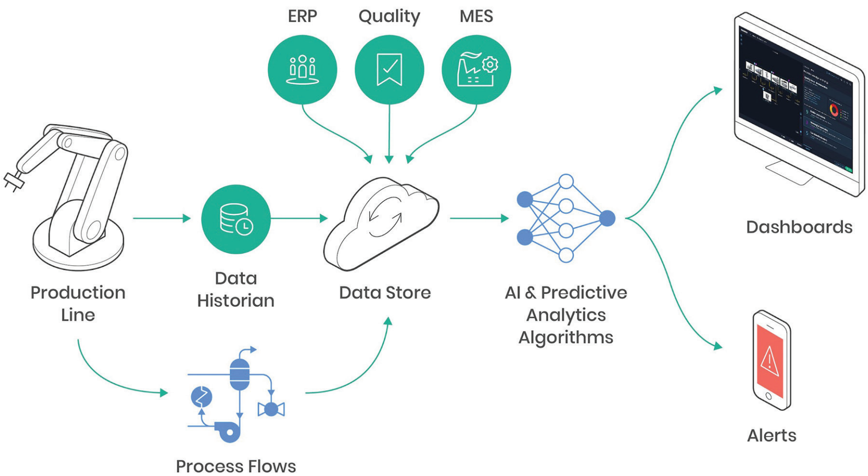


Figure 4.14: *Architecture for the Predictive Maintenance (Source: https://www.seebo.com/predictive-maintenance/)*

1. **BevyWise IoT**: BevyWise IoT simulator helps the researchers who are working on lightweight messaging for small sensors and mobile devices. Message Queuing Telemetry Transport (MQTT) is the protocol for such messaging, which is optimized for high-latency and unreliable networks.

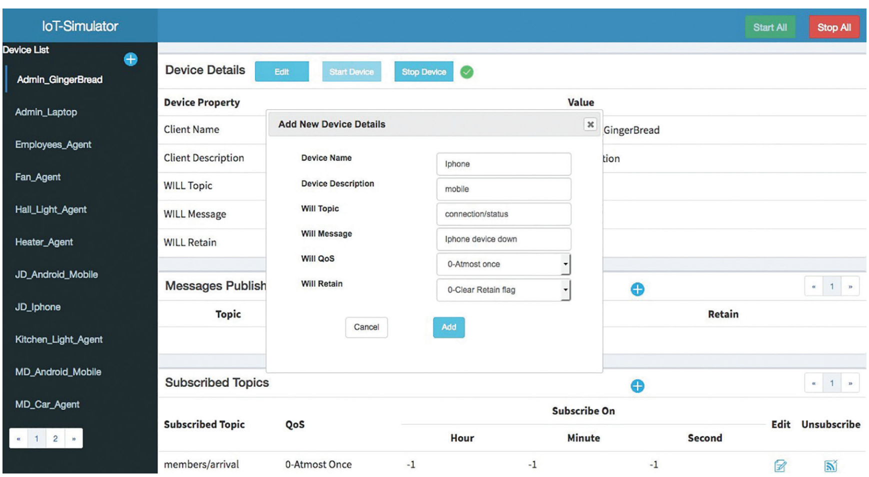


Figure 4.15: *User Interface of BevyWise MQTT simulator*

MQTT is a protocol that basically works on the concept of publishing- subscribe-based messaging which works on top of the TCP/IP. BevyWise IoT simulator is devised to test the cloud and on-premise MQTT Application for functional and load testing. BevyWise is supported by Windows, Ubuntu Linux, Mac operating systems with MySQL as the database. A simple and decent GUI of the BevyWise MQTT simulator is shown in *Figure 4.15*.

For more information about the simulator and to download the simulator, you may visit this link: https://www.bevywise.com/iot-simulator .

MATLAB: Though proprietary MATLAB is a very well-known platform developed by Mathworks for various computing paradigms such as Signal Processing, Image Processing, and Computer Vision, Control Systems, Aerospace, Autonomous Systems, and so on. MATLAB^R and Simulink^R have devised the IoT platform in such a way that the developer can design, prototype, and deploy IoT applications for the use-cases in predictive maintenance, operations optimization, supervisory control, and so on. A sample UI is shown in *Figure 4.16*:

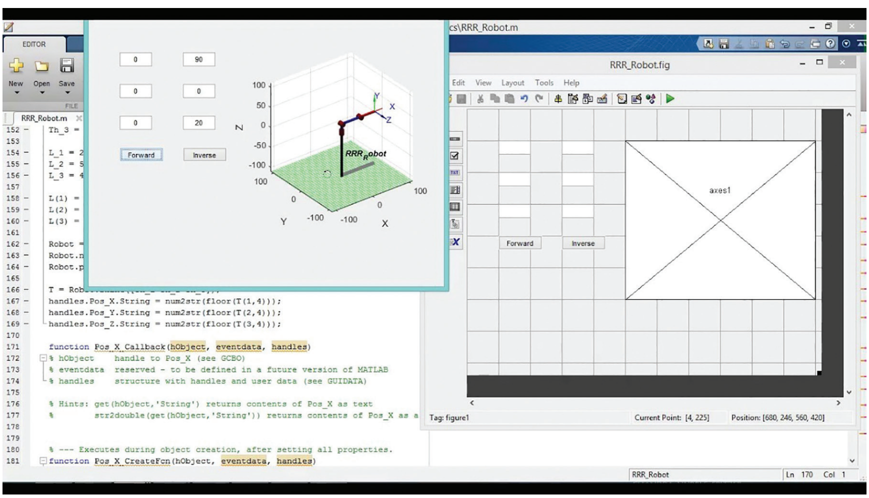


Figure 4.16: *MATLAB GUI for Robot Arm Simulation*

MATLAB^R and Simulink^R IoT platform have very organized modules/functions for each phase, such as:

(a) For preprocessing the streaming and archived data, the support of REST, MQTT, and OPC UA protocols is provided.

(b) Built-in functions are available to design custom IoT analytics and algorithms.

(c) A beautiful platform to develop data-driven and physics-based models.

(d) By automatically generating C/C++, HDL, PLC, GPU, .NET, or JavaR based software components developer of an IoT solution can easily deploy it on their own device or on the cloud.

(e) For prototyping of small-scale production applications and for the visualization of live data, hassle-free ThingSpeakTM can be used.

For more information about the MATLABR and SimulinkR IoT simulation, visit the link:

https://www.mathworks.com/solutions/internet-of-things.html and for more on research using MATLAB visit the link: https://www.mathworks.com/academia/research.html

2. **NetSim**: In the area of networks modeling and simulation, NetSim is already playing a key role in helping the industry with its Pro version and help the academicians and researchers with the Academic versions. Due to its strong presence in the network's applications, NetSim has extended its simulator to address the IoT scenario and applications based on IoT.

   One of the scenarios of the IoT network using NetSim is shown in *Figure 4.17*:

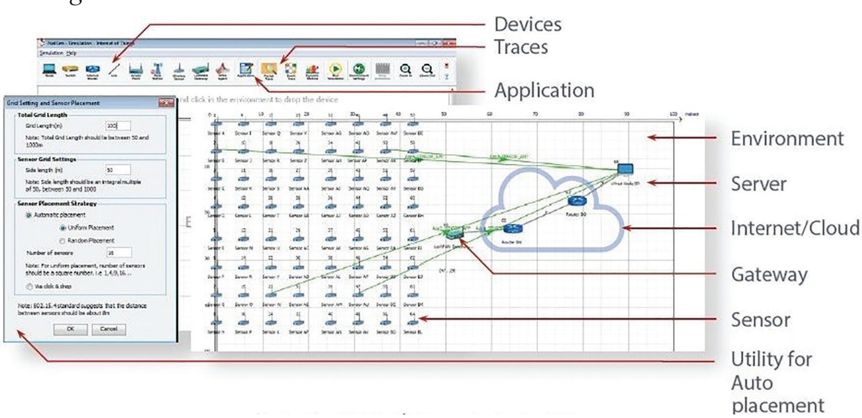


Figure 4.17: *IoT Network Scenario in NetSim*

NetSim also depicts the larger varieties of devices that are addressed, especially the messages been communicated. NetSim is already being used in various research activities such as:

(a) Energy harvesting in IoT
(b) Clustering algorithms for Reducing Energy Consumption
(c) Applications of Machine Learning to IoT
(d) Route Optimization in RPL Based IoT networks
(e) Attacks in IoT networks
(f) Localization techniques

A beta version of Sensor Emulation is available from NetSim. For more information on NetSim IoT simulation and NetSim for Academics, https://www.tetcos.com/netsim-iot.html and https://www.tetcos.com/netsim-acad.html can be visited respectively.

3. **ANSYS**: Another familiar organization that is helping the engineers and researchers by developing the tools and frameworks for various solutions. As soon as ANSYS identified the need to develop IoT solutions for the most challenging industries.

   A sample of simulating drones for deliveries with ANSYS is shown in *Figure 4.18*:

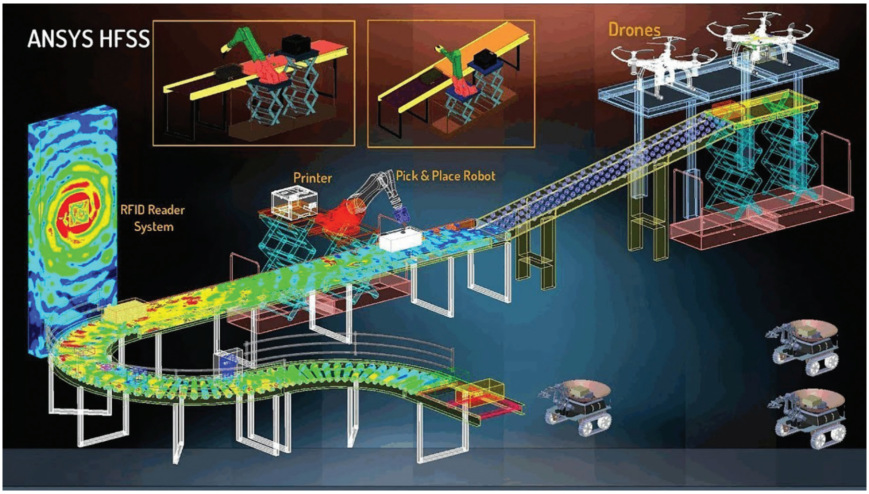


Figure 4.18: *Simulating Drones for Deliveries with ANSYS*

The simulation solutions for which ANSYS has addressed are:
(a) Connected soldier
(b) Wearable and medical devices
(c) Drones
(d) Connected cars
(e) Industrial Equipment and Asset Management

(f) Virtual System Prototyping
(g) Embedded Software Development
(h) Designing Devices for Harsh Environments
(i) Power Management
(j) Sensors and MEMS Design
(k) Antenna Design and Placement

Chip Package System DesignMore information about ANSYS IoT simulations can be had from the following link: https://www.ansys.com/Campaigns/internet-of-things.

Academicians and researchers can find the tools for their research from the following link: https://www.ansys.com/en-in/academic to download their free software.

4. **Oracle Integrated Cloud (OCL):** Oracle has developed its IoT platform through its well-established cloud services, as shown in *Figure 4.19*:

Figure 4.19: *Oracle's IoT Cloud Service*

With the help of the MQTT client module and Publish-and-Subscribe paradigm, the IoT services are integrated to have communication among the various IoT-based devices and applications. Oracle IoT platform works on four comprehensive modules, each with the specific activities:

(a) Connect
   i. Digital Twin
   ii. High-speed Messaging
   iii. Sensors and Gateways

(b) Analyze
   i. Stream Processing or Event Processing

   ii. Contextualization
   iii. Ad-Hoc Exploration
(c) Integrate
   i. Digital Thread
   ii. REST APIs
   iii. Command and Control
(d) Learn
   i. Machine Learning
   ii. Predictive Twin
   iii. Recommendations

Though the service is a proprietary version, one can try it out from https://cloud.oracle.com/en US/IoT, and more information can be had from the following link: https://docs.oracle.com/en/cloud/paas/iot-cloud/index.html.

5. **AWS IoT Core**: A managed cloud service from Amazon Web Services is AWS IoT Core, which facilitates connecting the IoT devices through its console, as shown in *Figure 4.20*:

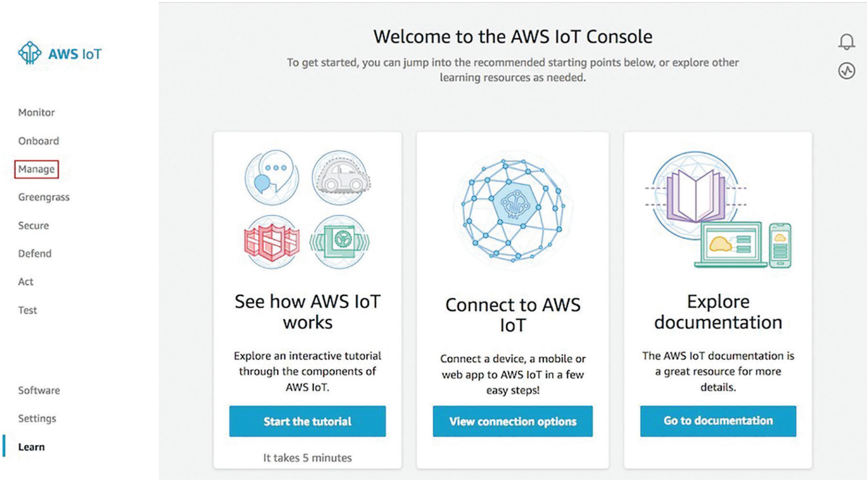


Figure 4.20: *GUI instance of Registering an IoT device on AWS IoT Console*

Scalability and **Communication** are important aspects to work with IoT devices. AWS IoT allows a huge number of devices with more than billion messages to be communicated among the IoT devices. Furthermore, the security and reliability among the communication of IoT devices are ensured. AWS IoT Core works with the support of many AWS services such as Amazon S3, Amazon DynamoDB, AWS Lambda, and so on. The process that it offers the users through AWS IoT is:

(a) Connecting the devices and managing them
(b) Securing the device connections as well as data
(c) Processing the device's data and applying actions accordingly
(d) Ability to read the device state at any time and set it

To start working on AWS IoT Core for free refer the following link: https://aws.amazon.com/iot-core is the URL to visit.

6. **IBM IoT Cloud (IBM Watson)**: Cloud service from IBM for IBM Watson IoT allows the users to communicate to the IoT devices and consume the data from them to store and process.

   You ask a question, Watson answers in Natural Language as depicted in the following *Figure 4.21*:

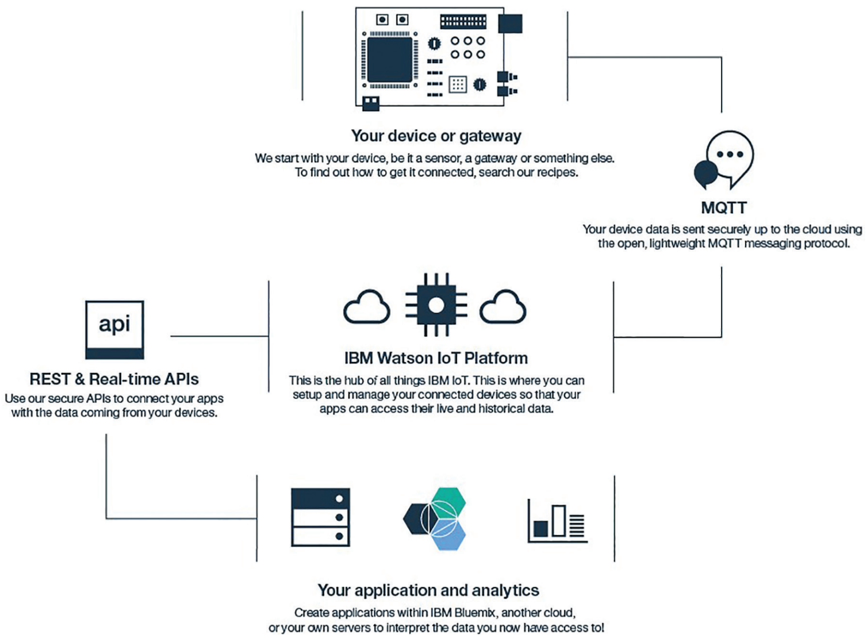


Figure 4.21: *IBM's IoT Overview*

Main features of the IBM IoT Cloud are as follows:

(a) Register the devices and connecting them with a great security
(b) Store the data, configure the transformation actions, integrate with the device platforms for the information management

(c) With the help of Dashboards, analytics and rules are provided to monitor the real-time data of the devices

(d) To provide risk and secure management, IBM works with secure-by-design control capabilities.

IBM offers a free of access service for IoT with 500 devices be registered, 500 application bindings, and for a maximum of 200MB of data be exchanged and analyzed. For a researcher and academician, these services are sufficient to work with. All these services can be accessed through https://www.ibm.com/in-en/cloud/get-started/iot-platform .

7. **Microsoft Azure IoT**: Microsoft Azure IoT increases the speed of the device communication and minimized the cost and complexity through the variety of solutions and technologies.

   Well-defined IoT system is depicted in the following *Figure 4.22:*

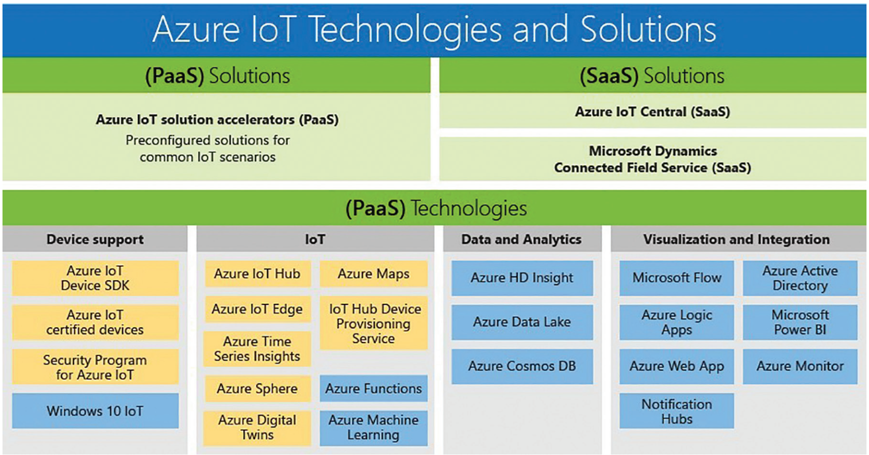


Figure 4.22: *Microsoft Azure IoT Technologies and Solutions*

The developer can configure any device on any OS platform by the Openness feature that Azure IoT offers. In addition to this, devices and data operations are scalable across many regions because of the support of Azure Cloud's secure and scalable services. Azure IoT offers its solutions across many services such as IoT solution Accelerators for PaaS, Azure IoT Central for SaaS, IoT Hub, and IoT Edge for PaaS.

For more details on Azure facilities and to build an Azure IoT, developers can access the Azure IoT solutions through: https://azure.microsoft.com/en-us/free/ .

8. **Google Cloud**: The overview diagram of Google Cloud IoT Core (Figure 4.23) depicts the various functionary modules that it provides for the IoT solution providers. It is evident that any IoT solution has to take the messaging service, especially MQTT, to provide communication across multiple IoT devices. The two main components of Google Cloud IoT are device manager and protocol bridge. The device manager permits various IoT devices to be connected securely and be managed through the Cloud IoT Core console. Protocol Bridge makes sure that the communication among the connection endpoints is guaranteed, which further takes care of load balancing.

   Google Cloud IoT Core is as shown in the following *Figure 4.23*:

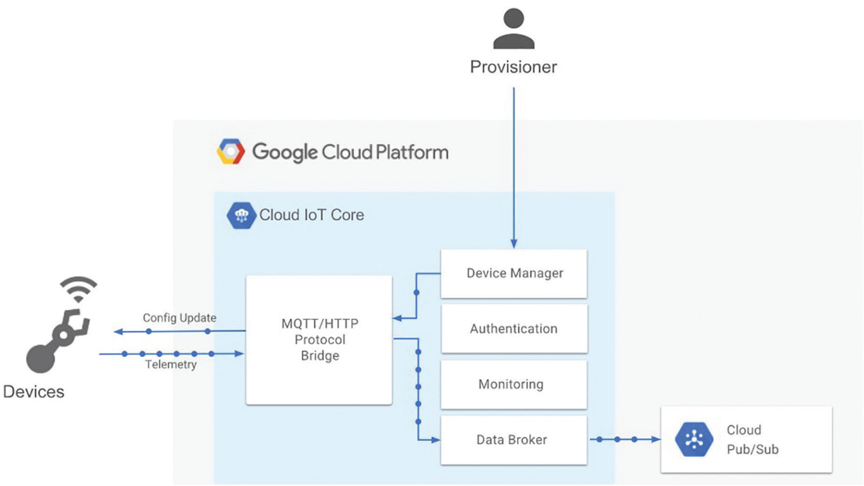


***Figure 4.23:** Google Cloud IoT Core Overview*

   In the initial stage, if the developers would want to observe the devices, their functionary and configurability, they can find the Cloud IoT ready-made kits at https://cloud.google.com/solutions/iot/kit/ and acquire a cloud account for IoT solution development one can visit https://cloud.google.com/iot-core/ .

9. **iFogSim**: One of the pioneers of Cloud Computing and its solutions, Dr. Rajkumar Buyya and his team, has proposed and developed iFogSim (architecture is shown in *Figure 4.24*) for Fog Computing to address the issues in the IoT solutions such as decrease the latency and network congestion. As part of their work, they have developed Sense-Process- Actuate Model and

Stream-Processing model. The simulated services available in iFogSim are as follows:

(a) Monitoring service

(b) Resource management service

One of the limitations of iFogSim is it does not address the low-level network issues such as interference management between densely colocated devices, so the developers and the users need to abstract these low-level issues to high-level attributes such as latency or bandwidth of the connection between IoT devices and gateways.

Cloud computing turned into Fog Computing which is shown in the following *Figure 4.24*:

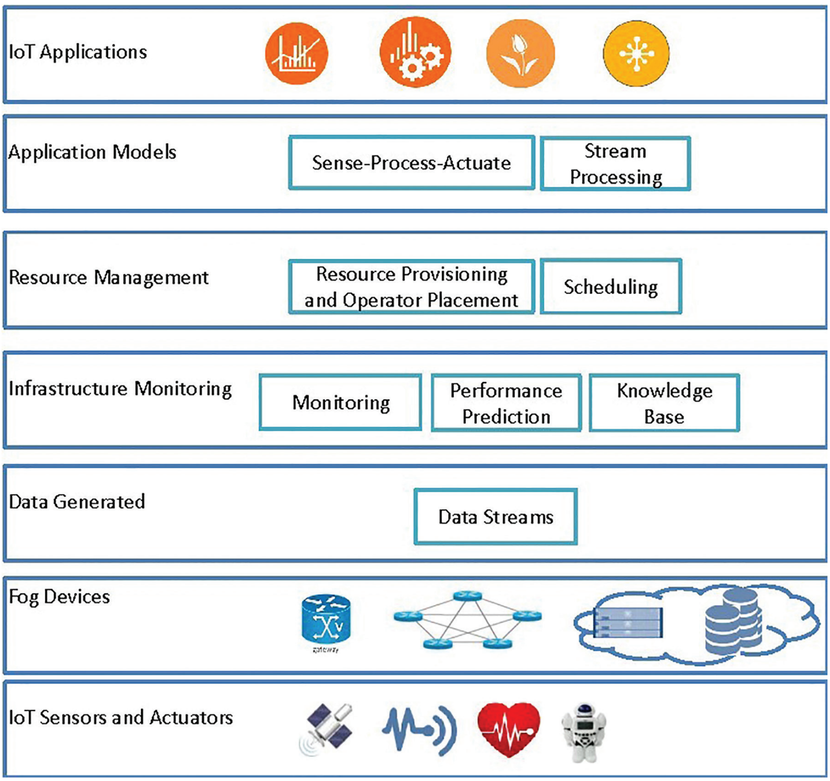


***Figure 4.24:** Fog Computing Architecture (Proposed by Dr. Rajkumar Buyya)*

To know more about the iFogSim, one can read his article through http://www.buyya.com/papers/iFogSim.pdf, and the toolkit can be downloaded from the link: https://github.com/Cloudslab/iFogSim.

10. **Jumper Virtual Lab**: Unlike the tools we have discussed, JumperVirtual Lab is the hardware modeling framework that is powered by Artificial Intelligence. The input for this framework is hardware data sheets by which the framework powers the Natural Language Processing to build a behavioral simulation model for the hardware.

    An instance of Running a Mbed OS 5 application in Jumper is shown in *Figure 4.25*:

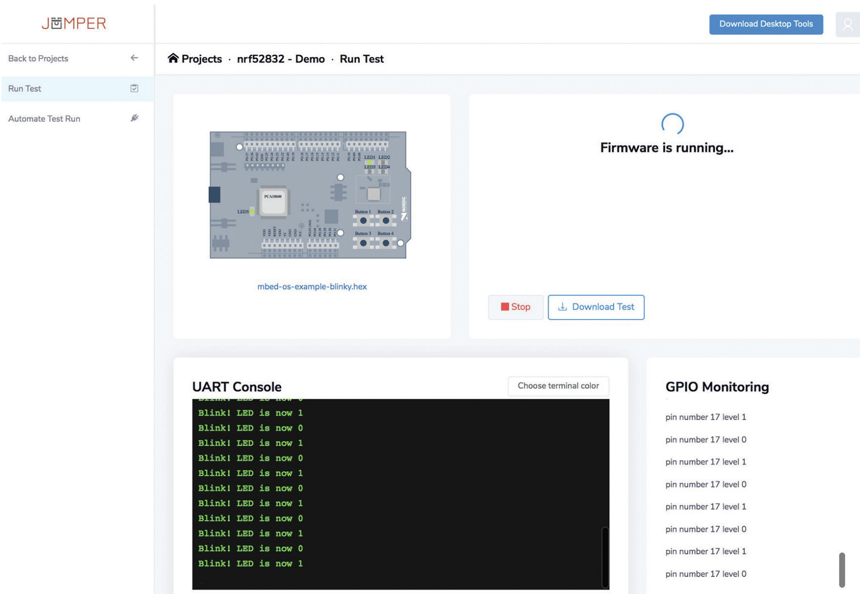


Figure 4.25: *An instance of Running a Mbed OS 5 application in Jumper*

Main features of the Jumper Virtual Lab are mentioned as follows:

(a) Behavioral Model Creation

(b) Model Verification

(c) Adaptive Learning Algorithms

More information about Jumper Virtual Lab and to start working with it, one can visit: https://jumper.io/hardware-simulation-modeling-powered-by-ai .

11. **MMIC IoT Simulator**: With the growing demand to develop the solutions for the Smart Cities, Gambit Communications has developed a simulator for the researchers to work upon the issues concerned. MMIC IoT Simulator lets the developers create a virtual lab that allows them to configure thousands of sensors

and IoT devices. The main components that MMIC IoT Simulator supports are MQTT Simulator, HTTP/REST Simulator, CoAP Simulator, Modbus Simulator, and MMIC Shell with the support of the major platforms such as Windows, Linux, and Amazon Cloud.

One can find the download link and the information about MMIC IoT Simulator from the link: https://www.gambitcomm.com/site/iotsimulator.php.

12. **CupCarbon U-One**: CupCarbon U-One is the open-source Network Simulator for Wireless Sensor Networks and the Internet of Things based on the application layer of the nodes. With a rich and professional JavaFX framework, it provides the users to develop Intelligent Mobility solutions by using Senscript as a scripting language. Radio modules such as ZigBee, 802.15.4, LoRa, and Wifi are supported by U-One. In addition to these features, Serialization and Deserialization are also supported between Radio and Microcontroller. One of the limitations of the CupCarbon U-One simulator is the inability to simulate all protocol layers for the reason of the complexity of urban networks. To download the free simulator, the source code of CupCarbon U-One, one can visit http://www.cupcarbon.com/ .

13. **Simplesoft**: To create a test environment for the numerous sensors and gateways, SimpleIoTSimulatorTM from SimpleSoft provides an easy to use the environment around. Few of the important IoT protocols that the SimpleIoTSimulatorTM supports are: CoAP, MQTT, MQTT-SN, MQTT-Broker, http/s client, HTTP/s server, Modbus over TCP, BAC- net/IP server, and so on The limitation of the SimpleIoTSimulatorTM is it supports only one Operating System, that is, 64-bit RedHat Enterprise Linux. More information can be had about SimpleIoTSimulatorTM from https://www.smplsft.com/SimpleIoTSimulator.html

Summary

We have discussed major simulators of WSN, AI, and IoT, which are currently available online; however, every year, adding more and more simulators into the research community.

Apart from existing simulators, the researcher can develop his/her own or can customize open source tools according to his/her needs. There are chances of having known/unknown bugs in the simulators; hence researcher should be extra cautious on the same as your entire work will be based on simulation works.

In the next chapter, we will discuss Blockchain applications for Wireless Sensor Networks, Artificial Intelligence, and the Internet of Things.

Questions

1. What is the importance of the simulator? How would it help the students and researchers?
2. Which simulators are more helpful other than those listed in this chapter? Why?
3. What are the similarities and differences between the simulator and emulator?
4. List the advantages and disadvantages of opensource simulators? How can you convert the disadvantage of the opensource simulators into a new simulator?

Do some research

Scilab is one of the powerful Free and Opensource packages to perform various functions. Answer for the following:

1. For which proprietary package Scilab is a strong alternative?
2. List the toolboxes which are part of Scilab.
3. Find the difference between the programming complexity between Scilab and the proprietary package, which you have found as an answer for “a”. To find the difference, consider the case, Plot a 3D surface function.
4. What knowledge you have gained after performing all the above activities.

CHAPTER 5
BlockChain for WSN, AI, and IoT

Introduction

In the era of data explosion from various sources, privacy and security have become a great concern. There are more connected devices that share information among themselves for specific purposes. Though Blockchain is not the recent development, its applications have gained great success due to the successful implementation of cryptocurrency. Readers would learn about various Blockchain simulators and Software Development Kits.

Structure

- Introduction
- Blockchain Simulators / SDKs

Objectives

After reading this chapter, the reader would be able to:

- Understand the blockchain simulators and SDKs
- Explore through the functionalities of blockchain simulators

Introduction

A **blockchain** is an increasing list of blocks that are linked using cryptography. Individually block comprises a cryptographic hash of the preceding block, a timestamp, and transaction data (usually denoted as a Merkle tree). A blockchain is designed to resistant against modification of the information, which is usually managed by a peer-to-peer network collectively obeying a protocol for inter-node communication and endorsing new blocks.

Blockchain simulators/SDKs

With the wide publicity of Bitcoin and Ethereum, the techno world has realized the importance of Blockchain implementation for the regular industry solutions, especially to authorize the transactions in a secure way. Every solution provider has used their own consensus algorithms such as Proof of Work (PoW), Proof of Stake (PoS), Proof of Elapsed Time (PoET), etc., based on the problem and corresponding solution. A simple workflow of Blockchain transaction is depicted in *Figure 5.1*:

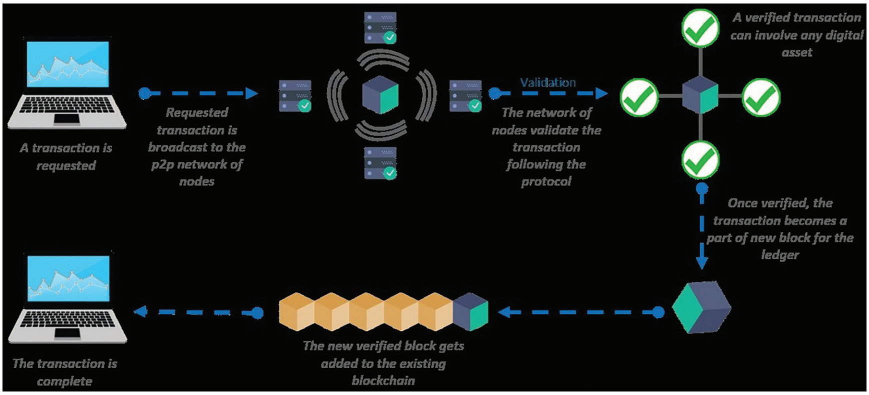


Figure 5.1: *A simple workflow of Blockchain transaction: http://gruaseconomicas.cl*

In further discussions, we will provide brief information on blockchain platforms or SDKs.

1. **Ethereum Blockchain platform**: It is a decentralized platform to run Smart contract code such as Solidity. This blockchain platform is governed by Ethereum developers. Mode of operation in

Ethereum blockchain is permissionless (both public and private) by using **Proof-of-Work** (**PoW**) based mining at the ledger level. A generic blockchain (Ethereum) network is shown in *Figure 5.2*:

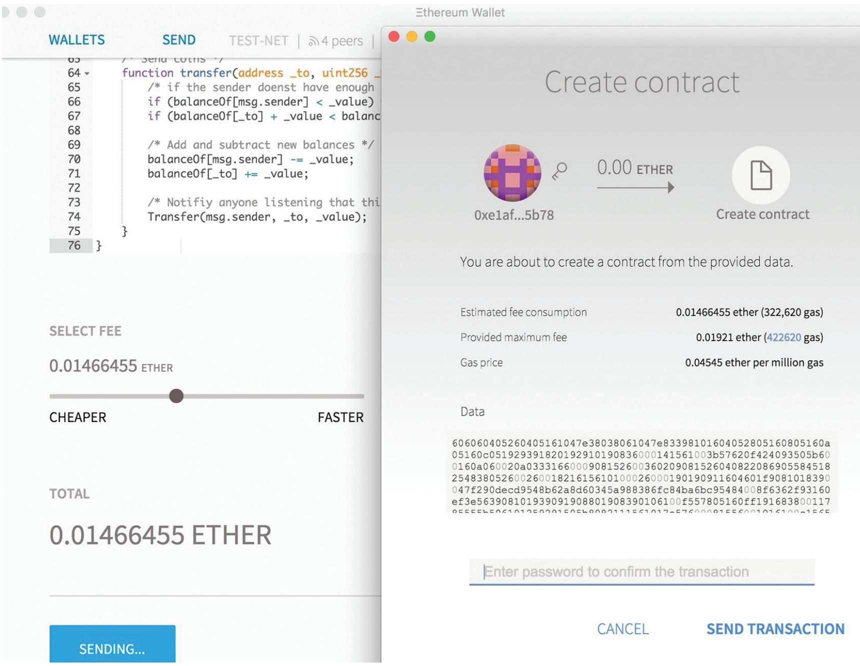


Figure 5.2: *An instance of Ethereum Wallet*

To know more about Ethereum Blockchain platform and to start working with it, visit the weblink: https://www.ethereum.org/ .

2. **Hyperledger Fabric**: IBM has developed its blockchain platform to develop, deploy the transparent, interoperable, reliable blockchains for enterprises. It is an open-source and open governance platform that consists of innovative capabilities. The key features of the Hyperledger Fabric are:
   (a) Permissioned network
   (b) Confidential transactions
   (c) Pluggable architecture
   (d) Easy to Get Started

   IBM Blockchain is being implemented for the solutions in the industries such as IBM Food TrustTM to connect growers, processors, distributors, and connected units; Tradelens for supply chain platform; we.trade for trade and finance across thirteen European banks. An illustration of the typical architecture of a peer node serving several blockchain applications is shown in *Figure 5.3*:

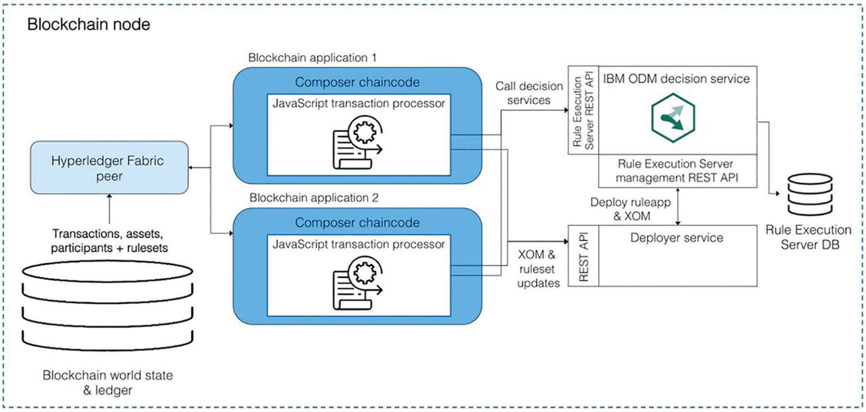


Figure 5.3: *A typical architecture of a peer node serving several blockchain applications*

For more information on IBM Blockchain and to download the free beta version visit the website: https://www.ibm.com/blockchain/platform.

3. **Geth**: Geth stands for the Ethereum platform, which uses the Go programming language. It is a generic blockchain platform which is governed by Ethereum developers using Smart contract code such as Solidity. Mode of operation in Geth is permissionless (both public and private) by using PoW (Proof-of-Work) based mining at the ledger level. A generic blockchain network is shown in Figure 5.4:

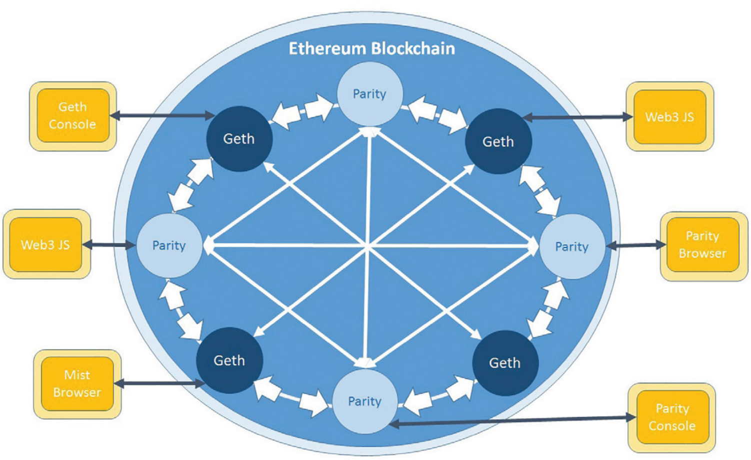


Figure 5.4: *A generic Ethereum Blockchain Network*

Three interfaces that the Geth works on are Javascript Console, JSON-RPC Server, and Command-line options.

To download and understand the installation requirements, the web link is: https://github.com/ethereum/go-ethereum/wiki/geth.

4. **Microsoft Azure Blockchain Workbench**: To help the developer community of the blockchain, Microsoft has developed its version called Azure Blockchain Workbench. It has developed many solution templates to simplify deploying the components while creating the blockchain applications. Repository of Azure Blockchain development kit consists of Connect, Integrate, Accelerators, and DevOps for Smart Contracts. The instance during the application registration in Azure Active Directoryis shown in *Figure 5.5:*

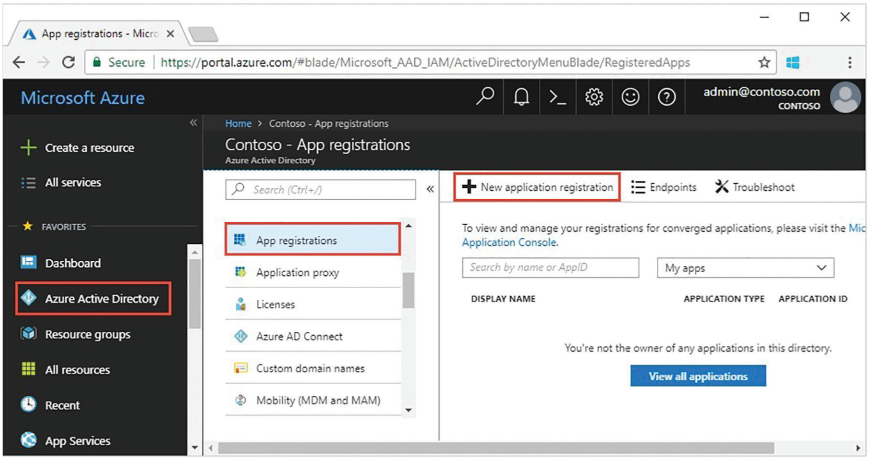


Figure 5.5: *Application registration in Azure Active Directory (AAD)*

To know more about Azure Blockchain Workbench, the web link is: https://azure.microsoft.com/en-in/solutions/blockchain.

5. **Blockchain on AWS (Amazon Managed Blockchain)**: Amazon ing the successful cloud services provider, it has spread its services to offer Blockchain platforms. Though the platform is not a single solution, it has addressed most of the customer and developer needs. AWS blockchain solutions have the capabilities of ledgers with centralized ownership and blockchain networks with decentralized ownership. These capabilities have the properties of centralized, immutable, verifiable, transparent,

and removing intermediaries. Amazon Managed Blockchain provides an environment for the solution developers to create a network, invite the members to participate, adding the nodes, and deploying the application. Is it automatic:

6. **MultiChain**: For those developers having a decent knowledge of developing own blockchains and deploying them for the specific usage, MultiChain is one of the blockchain development platforms. It facilitates rapid deployment, unlimited assets, creating multiple key-valued data streams. Furthermore, MultiChain is a developer-friendly platform offering customizability and flexible security. To understand the MultiChain requirements, download and install, the web link is https://www.multichain.com/download-install/.

7. **Oracle blockchain for developers**: There are many use cases that the enterprises are addressing towards developing the solutions. With the evolution and exponential increase in usage of the cloud service, almost all the major service providers are offering the solutions and development platforms over their cloud services. One such solution provider is Oracle, which has also started offering blockchain development platforms over its cloud. For about 3,500 hours, a developer can use an account for free of cost but on terms and conditions. To know more about the key features, various use cases, cloud account access, the web link is https://developer.oracle.com/Blockchain.

Summary

This chapter summarizes the simulators and SDKs pertained to blockchain in the areas of WSN, AI, and IoT. However, the readers are suggested to spend some time to understand the documentation of the opensource platforms for them to work better on the platforms.

From this chapter, readers would have gained a preliminary understanding of the blockchain applications towards the trending concepts.

In the next chapter, we will learn about research areas which are at present that would further lead to future developments.

Questions

1. What makes Blockchain significant from other security algorithms?
2. Is Blockchain applicable only for Cryptocurrency? What is those feature which made Blockchain-Cryptocurrency combination so famous?
3. What is the purpose of Active Directory in Microsoft implementation of Blockchain using Azure? List the components of the Azure Active Directory.

Do some research

1. Observe *Figure 5.5* and *Figure 5.6* carefully. Prepare your own theory for which functions they are? Identify the same scenario and functions that are implemented in AWS Managed Blockchain.
2. From the available sources, understand the IoT architecture. Prepare a list of IoT functions for which the application of Blockchain is not possible.

CHAPTER 6
What is Next?

Introduction

In this chapter, the reader is provided with various research areas, which are currently trending as well as future areas of research. This chapter will help all those readers who are research-inclined.

Structure

- Introduction
- Present Research Areas in Race
- Future Research Areas

Objectives

After reading this chapter, the reader will be able to understand:

- Various current research areas
- Research areas that are predicted to be found in the near future

Introduction

Technology is not standing water, it is non-constant, and in fact, it changes its face, pace, race withholding its base over a period! Hence, days are very nearer where WSN, AI, and IoT are treated as old fashion technologies! If so, then what is next? Predicting what is next is really a tough guess because of the fact affected by many flowing things such as competition, economy, politics, situation, laws, social values, education, commercial, etc. However, the below section tries to highlight a few predictable areas of research in Computer Science.

Present research areas in race

This section will try to highlight a few research areas which are in the hot race, and it takes a while to reach maturity, however not later than 2050.

Blockchain for one-stop security

One of the buzzwords which have attracted the world in recent times is Blockchain. Fundamentally, Blockchain manages the database of continuously growing resources in a distributed mode. The two main elements of the Blockchain are Blocks and Transaction. Public Blockchain and Private Blockchain are the two types. Though the world is seeing this concept in the area of crypto-currency, this concept can conveniently be applied in various areas of technology, especially, in the trading, certificate management, smartphones, healthcare, regular governance, finance, security, etc. Providing security for various applications is challenging as well as an essential task. So, Blockchain's implementation in the area of security is gaining much popularity as well as the demand. Though there are other methodologies that can be implemented, Blockchain has its own uniqueness due to its property to keep the databases in the distributed/decentralized environment. This makes the availability of the data to the global participants easy, and also the updates will never be lost in contrary to the centralized environment. In the centralized environment, when an update is lost at the point of transaction, it is permanently lost, but in a distributed environment, it's not as a copy would be available across a subset of the locations.

Blockchain applications in cybersecurity and data security

In the world of connected devices and online transactions, cybersecurity is the essential implementation to a greater extent. No organization would ignore the possibility of cyber threats or cybercrime. Blockchain, with its distributed nature, would successfully address the cyber-attacks such as **Denial of Service** (**DoS**), Man in the middle attack, Phishing, SQL Injection, Cross-site scripting attacks, and so on. DoS attacks are originated when the access to services are blocked by the hackers, which can easily be resolved through Blockchain by keeping the services in the distributed locations along with the authentication.

Blockchain authentication is not at a single-step, but it has to be done by many participants in the network. It may initiate a thought in the reader's mind that authentication at multiple locations might lead to delay of services. Instead of being attacked, a bit of delay is welcome, and there is a number of implementations that will take care of the speed of execution of authentication modules at the distributed locations, which further guarantees are loading of services at the native location at the same speed. However, the speed of loading the services, as well as the strength of the security depends on the way the implementation is requested by the client organizations. Though the implementation is a bit a costly affair, it guarantees the strength.

Blockchain applications in Security of IoT

IoT is another area of recent technologies that have emerged into the market for better human living standards. As most of the devices are equipped with network protocols to be connected with other devices or software, there is a great need for network security. But the network security varies for IoT applications with regular security solutions. Devices that are used for the IoT applications are Sensors, Actuators, and so on, so the communication from and to the IoT devices would vary both in terms of content as well as protocols. Oscar Novo has proposed an architecture for IoT in his paper Blockchain Meets IoT:

An Architecture for Scalable Access Management in IoT, is shown in *Figure 6.1*.

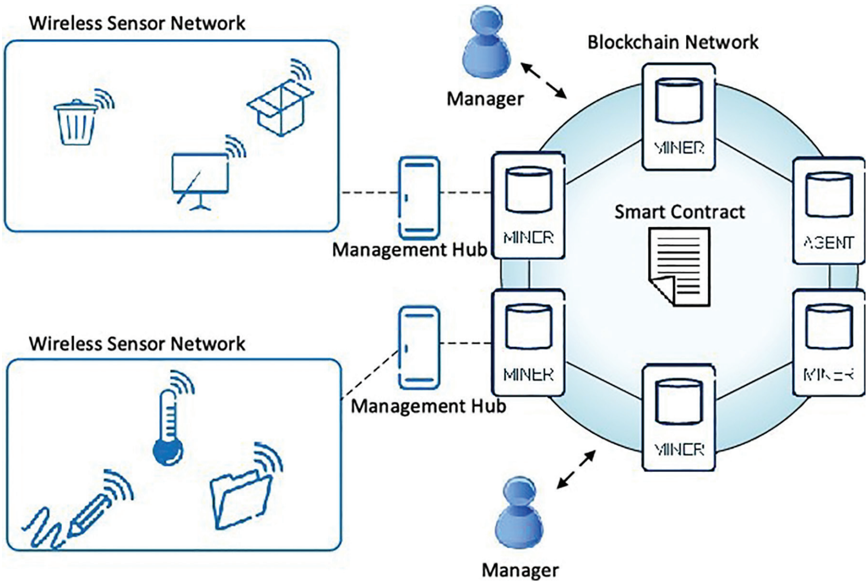


Figure 6.1: *Architecture for Scalable Access Management in IoT*

A separate set of protocols have been developed for IoT, so a variation of security implementations. Non-IP Sensor, Mutual authentication, Crypto algorithms with shorter keys, Embedded Sensors are few of the IoT security issues where the community needs the solutions from the industries.

Blockchain platforms for the developers

To build and deploy the next-generation distributed Blockchain applications, many organizations have released software development platforms across the world. Oracle Autonomous Blockchain Cloud Service for a comprehensive distributed ledgers among the cloud platforms; Etherum for smart contracts and cryptocurrency; Mastercard Blockchain for the secure digital transfer applications; Hyperledger to develop distributed ledgers as shown in *Figure 6.2*:

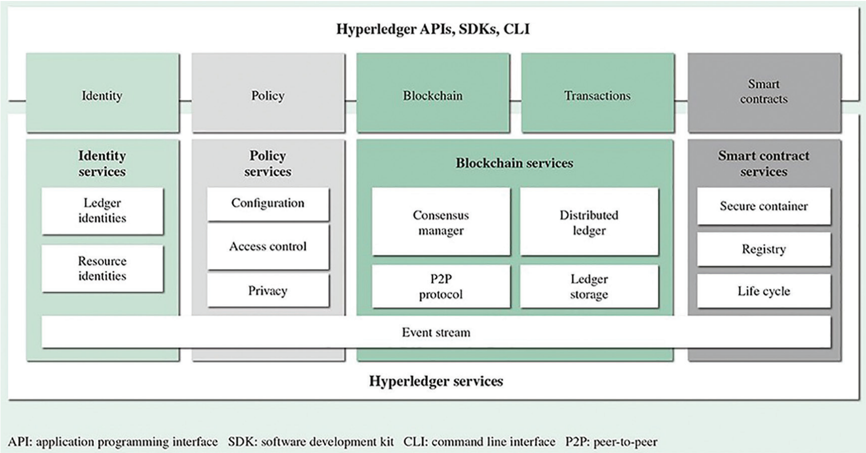


Figure 6.2: *Platform architecture developed by Hyperledger*

SAP Leonardo to facilitate IoT applications with machine learning; IBM Blockchain to develop the trust and accountability in the transactions history; Amazon Managed Blockchain for a fully scalable managed services; Azure Blockchain Workbench for a low-risk, low-cost, fail-fast platforms, etc. are the popular platforms for different needs of the solutions using Blockchain.

Human organ producing

Those humans who are doing good with their health are blessed. This statement does not mean the other group is cursed. If the health issues are not so complex, they can be dealt with the regular doctor consultation and proper treatment. But if the issues are complex to the extent that the person needs transplantation of the complex and essential organs such as heart, liver, kidney, then there are connected issues with the process. Before the transplantation donors and acceptors must be diagnosed for the compatibility, especially the blood type. Furthermore, few more diagnoses are required after it is found the blood type is compatible. After all these steps, surgery and post-surgery care are more vital. Even with the availability of advanced technologies in medicine and treatment, there are failure cases, including donors. More deaths are reported because of the non-availability of the donors, moreover the incompatibility with the available donor. To solve such issues, there is a lot of study and research going into medicine with the computational devices and algorithms to produce organs that are at its high compatibility. Three top techniques to reproduce the organs are as follows:

1. **Electrospinning**: A technique involved with producing nanofibers with one-hundredth the width of a human hair is assembled into a custom organ anatomy.
2. **Decellularization**: Decellularization is the procedure to isolate the extracellular matrix of a tissue from its inhabiting cells, leaving an ECM anatomy of the original tissue. This tissue can further be used in artificial organs and for tissue regeneration.
3. **3D printing**: Printing the organ with high precision and accuracy when compared with the original organ. Though the process of 3D printing in medical engineering is in its infancy stage, within a decade, it might result in produce the organ which functions as the original organ does. 3D printing of the human liver is depicted in *Figure 6.3*:

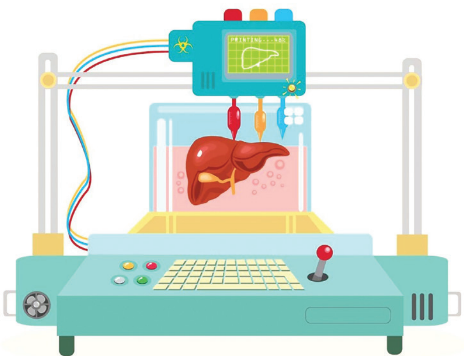


Figure 6.3: *Depiction of 3D printing of Human Liver*

When considered reproducing the organs through 3D printing, there is a lot of potential in the specific areas of printing such as human embryonic stem cells, blood vessels, and heart tissue, skin, damaged heart, cartilage, and bone, to conduct the study of cancer of printed cells and printing other organs.

Infinite aging for human

Don't be confused with the word 'infinite' with the word 'limitless' when it is connected with the age of the human. Infinite aging may even deal with the concept of developing drugs for anti-aging. In 2014 Founders of Human Longevity Inc., an American biologist and technologist Craig Venter, Peter Diamandis, who is also the founder of the X Prize Foundation, has announced this concept. They claimed that they are not intended to develop the drugs for anti-aging. However, the concept deals with the computing research by creating a very large database of 1 million human genome sequences by 2020, which includes the genome sequences of supercentenarians. Most of the Biotechnology concepts are related to genetic analysis, which plays an important role such as a study of genes, identification of modifiable elements in the genes, ways to modify the genes, imparting the modified genes, study of side effects after imparting the modified genes into the human. These are all the research issues for which computing devices and software programming are the potential to derive the desired results.

A research work proposed by Csaba Kerepesi, B´alint Dar´oczy, A´d´am Sturm, Tibor Vellai and Andr´as Benczu´r in the research paper Prediction and characterization of human aging-related proteins by using machine learning is shown in the *Figure 6.4*,

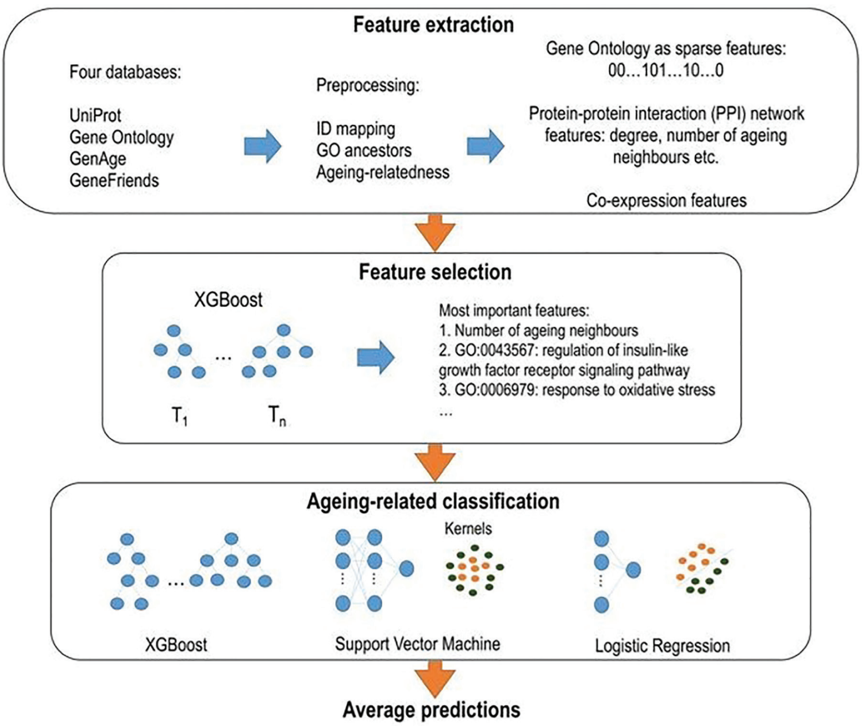


Figure 6.4: *Overview of the study methods as the main ingredients through the classification method*

The above figure depicts the overview of the study methods through one of the classification methods. This kind of research would encourage scientists, which in turn ignites the ideas among the researchers.

Cure deadliest disease coronary artery disease

Among the top deadliest diseases among humans, Coronary Artery Disease (CAD) is placed at the top. The reason for CAD occupying the top place is, 10% of the deaths occurred due to CAD was within a minute of time when it hit at its effect. Risk factors which cause CAD include:

1. High cholesterol
2. Overweight
3. Being diabetic
4. High Blood pressure
5. Family History
6. Smoking the tobacco
7. Overconsumption of alcohol (which also causes liver cirrhosis and neuro-related issues)

Though all these relate to the medicine and pharmacy-related areas, ubiquitous computing makes the solutions to be available for the doctors to suggest. The latest solutions that the doctors started suggesting are smart gadgets such as to track the blood pressure, pulse rate, etc. Any abrupt change in these parameters would alert the patient and the family person who is connected to the gadget. This will facilitate the affected person to be able to attend the doctor for the appropriate treatment. Minimal intervention surgeries are also increasing, thanks to the researchers and developers to develop such equipment and software tools with a high-precision. Though medical supervision is an essential part to reduce the risk of CAD, other methods are also suggested, such as follows:

1. Tracking the consumption of proper medicines
2. Tracking the healthy activities such as physical exercises, smoking, diet, weight control
3. Tracking the health after Catheter-Based Therapies

4. Tracking the health after Coronary Artery Bypass Graft (CABG) surgery In each of the computer and computing of the case, research plays a vital role to achieve the accuracy through the high-precision both at the diagnosis and treatment.

Single, compatible device for all IoT tools

Realization of the Internet of Things (IoT) has become possible because of the availability of high-speed internet to the regular household, especially to smartphone users. Before we address the research and development for the single, compatible device for all IoT tools, let us look into various devices which are already available in the market. The list of most common IoT devices available in the market is shown in *Figure 6.5*.

Coffee maker	Indoor camera	Intelligent yoga mat
Smart Alarm clock	Smart Thermostat	Voice controller
Outdoor camera	Portable Wi-Fi video camera	Smart Air Quality Monitor
Smart navigation system	Smart Irrigation Controller	Smartband as Activity Tracker
Intelligent oven	Smart thermometer	Smart Video Doorbell
Blood Pressure Monitor	Smart lock	Garden sensor
Smart baby monitoring	Sprinkler Controller	Automatic pet feeder
Garage door automation	Precision cooker	Smart Vent

Figure 6.5: *List of most common IoT devices available in the market*

The issue which we need to understand is the manufacturers are concentrating on only a few devices accompanying with the smart controllers through the smartphone or tablet device. At the start, it offers a pleasant feeling to use the devices with individual smart apps. As a function of time, users feel annoyed to operate each device with a separate app.

From such feeling comes the idea of a single device for all such tools. IoT is not only for home automation but also for other devices that are compatible and offer great convenience in day-to-day life. However, we should ignore the issue of human laziness as a result of the automation of all devices. When considered the issues related to the compatibility of all the IoT devices to be brought to one single platform, the following are essential:

1. Registration of each IoT device
2. Authorization or authentication of each IoT device
3. Configuration of IoT devices
4. Provisioning of IoT device
5. Monitoring and diagnosing the IoT device
6. Troubleshooting the IoT devices

Irrespective of the manufacturers of each of the IoT devices, the device which should contain all the apps must be able to configure them without any problem. To deal with such issues, the industry needs device management protocols, networking protocols, and so on.

Travel human at the speed of light

The speed of light in the vacuum is 2,99,792 kilometers per second or 1,86,282 miles per second. Can a human really be able to travel with such speed? Hypothetically, nothing can travel at light speed. It would be a wonderful event if it really happens, in the present time. But, it might not be so wonderful and may become a common event in the near future due to a lot of research is being done to achieve the goal. What stops a human from achieving this goal? We need specialized vehicles that can accelerate fast and achieve light speed within a shorter time. This event makes the machine surface experience a lot of air friction, which would result in fire and further related events. Humans sitting in such vehicles during the journey also experience a weird situation such as the mass of the human in the journey becomes infinite.

A rough calculation says travel of fourth earth years is equal to a trip of two weeks. This otherwise means that when human life is experiencing four years of aging, the human traveled for the same duration would experience aging by two weeks. However, all these are theoretical calculations. To understand the true possibilities, limitations, effects during the travel, dealing through the weird experiences after such a journey, etc. are the research issues using high-performance scientific computing resources. Whether the travel for humans at the speed of light becomes a reality in the very near future, a proof of concept can be computed with the help of the principles of Physics and computer simulations. However, a theory contrary to this concept is slower speed of light. Few games are developed to experience the ability to see things in the past as against the travel of light.

Zero in-flight failure crash or zero casualties

To save the journey time and for the convenience people choose airplanes. But, the mode of journey by air is most unstable as the environment does not support for safety. There are various phases from the time just before the flight till landing: Standing/Taxiing, Take-off, Enroute, Maneuvering, Approach, Landing. These accidents or fatalities do include for both the business flights and private flights. Most of the recent flight crashes were involved in crash landing into the seas and oceans. In each accident, there was a minor percentage of flight passengers escaped the death. The most valuable part is saving human life, be it the pilot, flight attendants, or the passengers. Damage is not only for human life, but other industries also go into losses such as flight insurance, life insurance, penalties levied on poor maintenance (if any), and so on. From *Figure 6.6*, it can be inferred that from the year 1972 till 2018, hundreds of lives were lost during the plane crashes:

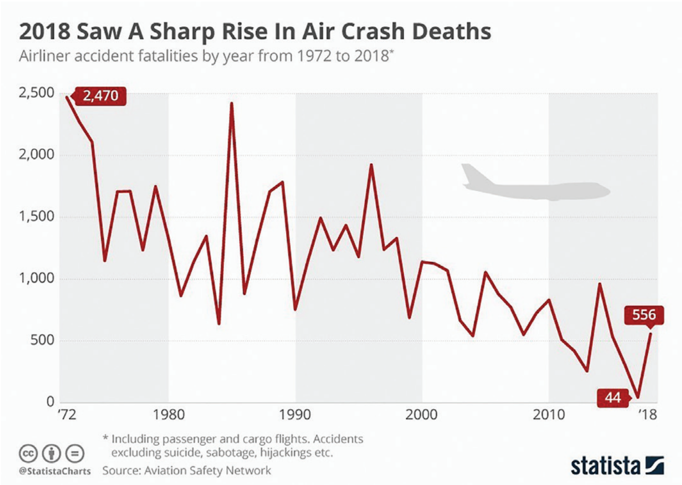


Figure 6.6: Statistics of Air Crash Deaths from 1972 to 2018

These can be avoided by analyzing the issues at various phases, as mentioned earlier. With the availability of flight-generated data, realtime data analytics, it is quite possible to avoid most of the accidents, thereby saving precious lives in addition to avoiding huge losses been experienced by insurance companies, Aeroplane manufacturing industries. At each phase of flight, developing new equipment for the safety of passengers would further generate revenue by manufacturing safety equipment.

Earthquake and natural calamities

Earthquakes are natural disasters that no one can stop. However, one can minimize the effect of damage that can be caused by earthquakes and the aftershocks. Reasons for the earthquakes are volcanic eruptions, geological faults, and tectonic movements, manmade, such as testing of nuclear bombs. Among all the reasons the earthquakes due to tectonic movements cause major destruction. Side effects of the earthquakes are:

1. **Ground shaking**: This is the most common effect when an earthquake is caused due to any of the above reasons. Because of this effect and depending on the strength, many of the buildings, high rise structures, dams, and so on would collapse abruptly, which further causes loss of life.
2. **Ground rupture**: Though there were minor reports of loss of life due to this ground rupture, there would be huge losses for public transport such as railway lines, roads; pipelines installed underground; tunnels dug, etc.
3. **Landslides**: If the landslides occur near human occupancies, then depending upon the strength of the slide, a loss of life could be heavy. If the earthquake occurs in the snowy mountains, avalanches could be the side effects during which the skiers, researchers, security forces must be very careful.
4. **Tsunamis**: Tsunamis are the side effects of the stronger earthquakes that occur in the seas or oceans. A strong tidal wave of seismic sea waves would result in a strong flow of water into the surroundings of the seas or oceans. Much of the coastal regions have become residential areas for various reasons; considerable loss of human life would be the result. In addition, if there are

any hazardous installations around the coastal regions, such as nuclear factories, then the loss would be huge.

5. **Liquefaction**: When the groundwater erupts and causes the soil to lose its strength, during the earthquake, it results in Liquefaction.
6. **Fire**: Fire is the common cause in the areas where natural gas mains are installed and are broken during the earthquake. A sudden eruption of gas and any small fire around due to electric lines or any other sources would result in the strong fire, which would create heavy damage.

If a researcher can carefully study the cause and effect of the earthquakes, they can propose the solutions through which damage can be avoided. Building earthquake residences is one of the examples of the solutions which are already built-in Japan, initially. Though earthquake is not evil, the damage is so sudden, and impact on revenue loss is so huge. So, a lot of further revenue investments make the governments postpone other plans. Prevention of loss of life, preventive steps to reduce damage to the structures, constructing the structures which would reduce the impact of tsunamis, and so on are the potential research areas that can be suggested by applying computer software simulations.

Layers of security

The security field is developing insignificance because of expanding dependence on computer systems, the Internet, and wireless networks, for example, Bluetooth and Wi-Fi, and because of the development of "smart" gadgets, including smartphones, televisions and the different small gadgets that establish the IoT. We would express our future security level in *Figure 6.7*.

Layer -1 :	User Level like Password, thumb impression etc.
Layer -2 :	Application Level like Encryption, Firewall etc.
Layer -3 :	Device Level like Machine Authentication etc.
Layer -4 :	Networking Level like Antivirus, Access Control etc.
Layer -5 :	AI Security Level like Hacking, Cyber, Fraud etc.
Layer -6 :	Security for AI Level like Defense Against AI Security Attacks etc.
Layer -7 :	Security Defense Level like end-to-end security etc.
Layer –N:	N-Security Level etc.

Figure 6.7: *Layers of Security*

Because of its intricacy, both as far as legislative issues and innovation, it is additionally one of the real difficulties of the contemporary world.

Learn/study anything in overnight!

This is similar to Whole Brain Emulation (WBE) or Mind /Brain-Upload/Copying /Transfer. Mind transferring may possibly be cultivated by both of two strategies: Copy-and-exchange or slow substitution of neurons. Mind transferring would be accomplished by examining and mapping the notable highlights of a natural cerebrum, and afterward by duplicating, exchanging, and putting away that data state into a computer system or another computational gadget.

BCIs read electrical signals or other manifestations of brain activity and translate them into a digital form that computers can understand, process, and convert into actions of some kind, such as moving a cursor or turning on a TV. BCI can help people with the inabilities to control computers, wheelchairs, televisions, or other devices with brain activity. Electroencephalograph (EEG) is attached to the scalp. The electrodes can read brain signals. The electrodes measure minute differences in the voltage between neurons, as shown in *Figure 6.8*.

Figure 6.8: *BCI working*

The signal is then amplified and filtered. This whole process can be reversed to achieve excellent brain training where an end-user will enable us to learn anything, including the difficult subject, is a while!

Smart kitchen

The best brilliant kitchen gadgets are currently commonplace in the IoT transformation, with an entire host of cool associated embellishments and apparatuses available for anyone running from keen stoves to forks and plates to appetite. Smartness just not limited to cooking, but it covers human health, calories, habits, disease assessment, guest food assessment, alarming food controls, and so on.

Smart pricing and paying for all

Now we are paying bills separately for many things like utility bills-power/water bill, internet bill, food bill, online buying, agriculture-related, business-related and many more, future will enhance with a single level pricing and paying which will save our time, energy and money with the help of IoT.

Auto agriculture

With the help of IoT, we can automate many things in the agriculture sector, as shown in *Figure 6.9*.

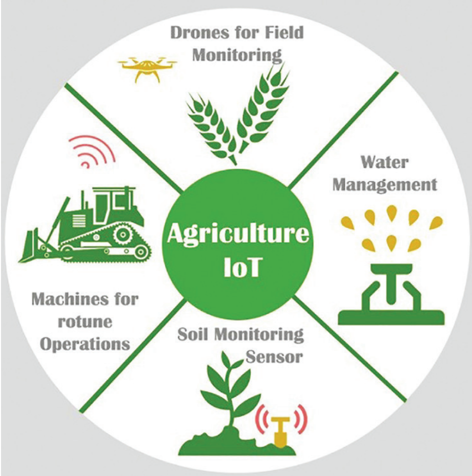


Figure 6.9: *IoTs applications in agriculture*

There are many ways IoT can improve agriculture by data collection through smart agriculture sensors, drones, for example, soil quality, weather conditions, crop's growth progress, or cattle health.

Increase in Virtual Assistant (AI assistant) usage

This is a digital assistant, is an application program that understands natural language voice commands and performs tasks for the end-user. Tasks that are performed by the virtual assistant are shown in the *Figure 6.10*:

Figure 6.10: *Few of VA's tasks*

Many tasks, like shown in the above figure, have historically performed by a personal assistant or secretary, include taking dictation, looking up phone numbers, reading text or email messages aloud, scheduling, placing phone calls, and reminding the end-user about appointments. Popular VA presently includes Amazon Alexa, Apple's Siri, Google Now, and Microsoft's Cortana – the digital assistant built into Windows Phone 8.1 and Windows 10.

Self-driving/running devices

IoT/AI/WSN technology can help many devices to run on their own, and this topic is already a hot research area hence not discussing much here.

Instant, efficient medical diagnosis

It is the process of determining which disease or condition explains a person's symptoms and signs based on samples. Currently, this is a bit time consuming and money consuming too, and sometimes this goes for multiple tests due to inefficiency in the data, these kinds of issues will be resolved using smart devices like AI-based IoTs and report will be displayed on smartphones like shown in *Figure 6.11*.

***Figure 6.11:** Medical apps*

Such medical apps ensure that the consumer's wellness is kept at primary position. This objective further ensures that the relevant is communicated to the respective people or devices for further assistance.

Smart space exploration

This is the discovery and exploration of celestial structures in outer space by means of evolving and growing space technology. Example-shown in *Figure 6.12*.

***Figure 6.12:** Smart space exploration*

With the help of AI, WSN, and IoTs, space technology will reach a new level in the coming days like using Robots in the space and train it's mind instantly in the space remotely from earth's scientists, so it is as good as a human is landed there !

Auto military or border management

Similar to Automated Border Control system (ABC) or eGates but applying thoughts at international border level with a smart setup including Flights/- Ship/Driving vehicles.

Self-medication

AI will be utilized to break down information to feature botches in treatments, work process wasteful aspects, keeping away from superfluous patient hospitalization. AI may appear sci-fi; however, sooner rather than later, we will see an upset in human services in both wellbeing help and medication management.

Future research areas

This section will try to highlight a few research areas which are not in a race or just started, and it takes a lot of time to improve or to reach a peak!

Body parts as a unique ID

Already the world has known to generate unique IDs out of few parts of the human body like Iris, Ear, Lip print, Tongue, Voice, Toe print, Teeth, Retina, and Gait. In future other parts of the body are evaluated for unique identification at-least with a combination if not a single part.

Inter brain cell network

Neural circuits interconnect to one another to form large scale brain networks, till now this is developed to a peak level, now it's time to shift the paradigm to work on interbrain networking as shown in *Figure 6.13*:

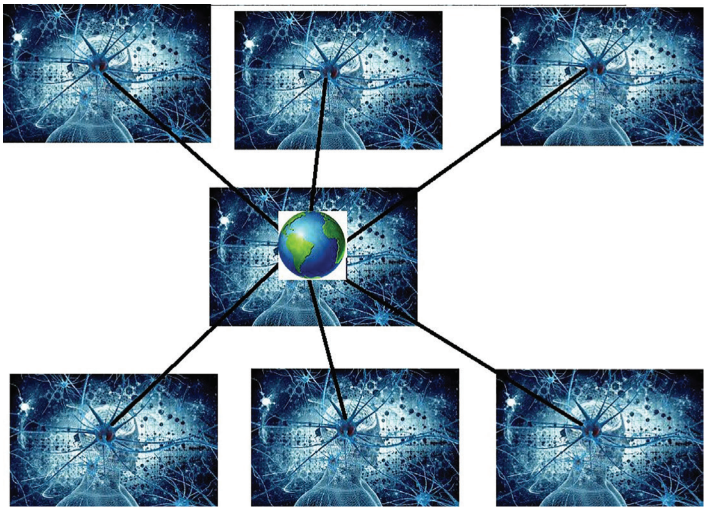


Figure 6.13: *Sample of interbrain cell network*

It looks like it is really tough research, but nothing is impossible.

Enable gadgets action with empty hands

This is something looks like a magic but with help of our body and it's temperature, neurons communications, variations inside body, and/or minimal tiny devices (which is almost like integrated part of human!); this kind of assessment can lead us to a new era where human can roam anywhere without any gadgets/IoTs or with almost negligible tiny-devices. A scenario of palm working as keypad is shown in the *Figure 6.14*:

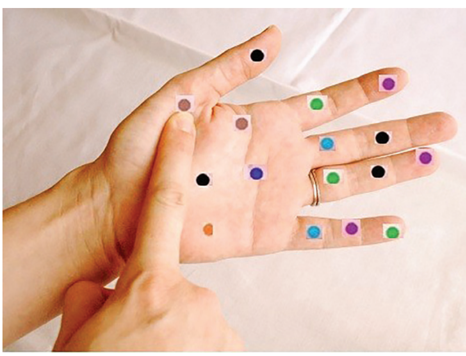


Figure 6.14: *Example of enabling gadgets action with empty hands*

Say, using our palm/volar (which is the central region of the anterior part of the hand), can act as a keypad as shown in *Figure 6.14* for few commands which can be routed through neuron networks and actions will be performed.

AI for finding a true love

Finding a compatible Lover or Wife is really a challenging task for ages; as time goes into the relationship, the definition of compatibility is diluted, and reasons would be ego, misunderstanding, lack of give-and-take policy, responsibility-taking, sharing thoughts...N (not limited!). Even many sites talk about matching compatible parameters; however, all those data pointers are fed/manipulated by us directly/indirectly. Now, AI is landing to solve those issues, as shown in *Figure 6.15* !

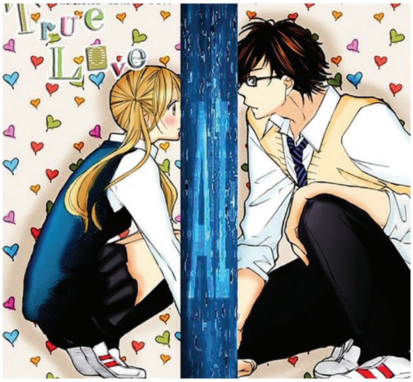


Figure 6.15: *AI for finding a true love*

We can extract behavioral parameters from gadgets which are used by him/her, what is tasting and food cooking based on how many times he/she enters into the kitchen of own/hotel with the help of IoTs, how many times the mood swings in a day/week/month based on what issues can be assessed by temperature/sound/BP/ Conversation etc. Maybe we can get the Android Apps help for such things in the coming days.

Internet of Everything (IoE)

It would not be a surprise if we get IoE for what we can assume. As in previous decades, IoE will rely in the future on the idea that internet connections are not limited to laptops, desktops, and some tablets. Instead, machines tended to become smarter with better data access and expanded network capabilities. By this process, we mean the process of carrying out an activity, such as the production process, the market strategy, and so on. Using the IoE, we can create information to guide decision-making at every stage of the business. Many data sources open up new types of information that can be used to convert qualitative information into numbers. For example, linking employee output based on changes in the work environment variable.

Land in any planet with VA

Computer and Computing around AI can put us in a big change over space technology with the help of the VA. Virtual Assistants usually work from home and as a freelancer (not as a W2 employee). While virtual assistants can do what they really need, many do things that fascinate themselves with the virtual world.

Here are some examples of the types of jobs that tend to work well for virtual assistants:

- Online administrative functions
- Email and calendar organization
- Scheduling
- Transcription
- Event planning
- Writing and editing
- Organizing files
- Booking travel

Virtual Assistant Lifestyle takes a long time, and each show can be different, but usually, you get the benefits of a Virtual Assistant. Virtual assistants can usually work from home and set their own hours - at home - with their spouse.

AI for self-coding/decoding

This is already an in-progress area; however, it will be extended to ethical hacking, personalized Apps, and so on. Artificial intelligence has evolved over the years, as has computer technology, hardware, memory, and processor speed. As computers accelerate, more computation can be done, increasing the power required to compute the processing of many artificial intelligence algorithms.

Writing a new Artificial Intelligence program is enabled by one of the tools, SketchAdapter. Made from tens of thousands of program programs, SketchAdapt learns to compose small, high-level programs, while the algorithms let you find the right subprograms to complete the details. Unlike similar automatic program writing methods, SketchAdapter knows when to switch from statistics mapping to a less efficient but more versatile symbolic reasoning mode to fill in the blanks.

Cartoons behavior into reality

Maybe this could be possible with the help of the VA. In the next couple of years, virtual reality applications are likely to become more sophisticated with the emergence of more powerful devices capable of developing high-quality visuals. There is also a growing awareness of how we can effectively communicate and navigate the virtual environment, leading to more intuitive methods of exploring and interacting with virtual space. Here are the immediate consequences of the immersive virtual reality experience, amplified by the power of AI.

Can we trace God/Devil/Aliens?

Computer technology can answer to these dilemmas. It is considered that every living thing in the Universe are source of some electromagnetic signals. Though those signals are weak, the devices are available in the market to capture such weak signals and interpret the data that is being communicated. In the process those weak signals can be interpreted to find the God thing or Evil thing along with the alien thing.

Robots as pets/friend/spouse

Nowadays, people are more compatible with pets than their spouses, and in the coming days, it will be enhanced to the next level to create more comfort level like Robots of their own kind of as shown in *Figure 6.16*!

Figure 6.16: *Robots as pets/friend/spouse*

Can astrology be replaced?

Astrology may be replaced with improvements in AI. It is claimed by a few researchers that astrology is one of the applications of data science. From ancient times, continuous research has produced many theories. Among them, few have stood strong till today, but many of them have vanished due to the proof that they are misinterpretations. This clearly shows that unless there is voluminous data, a scientist cannot infer a theory. Moreover, the same theory has to be validated, which needs data science. Hence, there is more scope for research in Astrology. It is obvious that working with Astrology is endless.

IA v/s AI v/s AI: Meta-AI

Intelligence Assessment (**IA**) v/s **Artificial Intelligence** (**AI**) makes a system like human thinking and apply on him back what that is thinking like search, pattern recognition, image processing, machine learning, deep learning, and so on. This is called AI in Infinite Loop, where everybody will have AI to create security breaches and prevent others from the attack on his stuff and so on ! This is really a challenging one and endless unless politically or technically cut this loop. However, Only AI can predict about AI.

AI makes you laughter

In the future, we tune AI systems to produce smile on your face like you feed i/p: ”Joke with these words : Rain and Wife” and immediately you will receive a formed laughing message like- ”Due to heavy rain, I am stuck at home with my wife Please HELP !”.

If immatured, make matured!

AI can help to solve/fill the gap of maturity, including growing babies and idiots by training their attitudes/mind, and so on. In psychology, maturity is the ability to respond to the environment aware of the correct time and location to behave and knowing when to act, according to the circumstances and the culture of the society one lives in.

If the researchers could develop machines that can understand the psychology of humans, then those machines can help humans think better than they were. Through the idea sounds good, the process involves interpreting many psychological aspects such as mentality, emotions, and so on. However, in the future, this idea would be realized to make human life more comfortable.

Summary

This chapter has introduced various concepts to the reader, especially the current research areas and the possible areas for future research. Readers would benefit from this chapter to plan their research based on the topics that are tossed with more reachability.

Hopefully, after reading through this chapter, readers have understood the research that can be applied towards various concepts ranging from machines to human psychology.

In the next chapter, we will discuss the state of the AI and IoT by 2050.

Questions

1. What is scalability? How does it affect the pre-defined architecture for any system?

2. What is interoperability? How does it affect the integration of IoT with Blockchain?
3. What is Hyperledger? What are the functions of Hyperledger?
4. List Hyperledger APIs and services in the case of the healthcare system.
5. What are the requirements for creating an infinite aging system? Is it really possible to achieve infinite aging?

Do some research

1. Observe all the appliances for which IoT can be applied. Identify the requirements for each of the IoT devices and their application. Now evaluate the possibility of drawing all the IoT applications onto one device. Develop a 10 to 15-line document that explains the feasibility of such a device.
2. Consider *Figure 6.7*. Though it explains the security requirement at each of the layers, the system seems overloaded with overhead that would be added at each layer. Evaluate the system to reduce the overhead by combining at least one layer with its adjacent layer. This removal should guarantee the performance enhancement.

CHAPTER 7
The state of AI, and IoT by 2050

Introduction

In the previous chapter, we have studied various concepts that are very pervasive and most prominent. Every technology shall evolve to address the issues that are predicted for the near future. However, it is vague to really estimate what is near the future. Hence, this chapter is dedicated to understanding the status of Artificial Intelligence and the Internet of Things by the year 2050. After reading this chapter, the reader can understand in what way their research can be planned.

Structure

- Healthcare
- Agriculture
- Education
- Governance
- Climate and Weather
- Transportation

- Manufacturing
- Defense
- Business services
- Oil, Gas and Mining
- Insurance
- Sports
- Energy
- Fashion
- Advertising
- Construction
- Media and Entertainment
- Legal
- Gaming

Objectives

After reading this chapter, the reader will be able to understand:

- Which areas are most vital for predicting its status in the near future?
- How each of the services would directly or indirectly affect the global business?
- What would be the direction for the improvements that would astonish the society?

Artificial Intelligence (**AI**) has produced fruitful and encouraging results by which the thought process is revolutionized in almost every industrial sector. It has become possible with the trust that AI has created amongst the investors, designers, developers, and importantly the users.

Healthcare

The power of artificial intelligence resonates in many areas. But its impact on healthcare is really changing lives. With its ability to mimic human cognitive functions, AI is creating a paradigm shift in the healthcare industry.

This transformation technology is turning the health industry in many ways. Technology From technology development to clinical research, AI has helped improve outcomes for patients with lower costs. In addition, the introduction of this technology in healthcare provides easy, accessible, and effective access.

For the same reasons, the public and private sectors have invested heavily in the healthcare sector. According to one study, investments will reach $ 6.6 billion by 2021. Accenture reports are even more amazing. According to their analysis, AI applications could save $ 150 billion in AI healthcare by 2026.

AI with Big Data in Healthcare

Recent advances in artificial intelligence have fueled debate on whether artificial intelligence will replace doctors in the future. The idea of replacing human doctors may seem absurd, but AI can help human doctors make better decisions. In some areas of health care, such as radiology, this can completely replace people's judgment.

Big Data has successfully used artificial intelligence in healthcare. Big data analysis has grown rapidly, and many health care data are available. Using this data, powerful AI techniques can unlock clinically relevant information hidden in large amounts of data. It helps to make better clinical decisions.

Why AI in Healthcare?

The ability of artificial intelligence to use advanced algorithms and learn functions from huge data is truly amazing. By using these algorithms, we can better understand the clinical practice. Artificial Intelligence has self-correcting and learning capabilities that help the system gain better accuracy based on the feedback it receives. As a result, it improves over time. These AI systems can help doctors in many ways. Because they are equipped with a lot of information, they can help make decisions in the clinic. In addition, diagnostic and therapeutic errors can be curtailed. One of the sample evolutions is shown in the *Figure* 7.1:

Figure 7.1: *Evolution in Healthcare*
(Source: https://syntheticsmarts.com/changing-marketplace-healthcare-ai-will-shape-future/)

Moreover, large amounts of data are available for artificial intelligence systems. By gathering useful information, they can predict health risks. Artificial intelligence is great and powerful. We cannot question its effectiveness. This will have a huge impact on the healthcare industry. The following facts explain why:

Hospital errors are one of the leading causes of patient death. Artificial intelligence can eliminate these shortcomings and eliminate them. Every year, worldwide, about 43 million people die from medical errors, which AI can easily prevent. In the healthcare sector, almost 86% of errors are preventable. By 2050, the healthcare market for AI treatment will grow by more than 70%.

Applications of AI in Healthcare

The AI healthcare industry is developing for the better experience of both the patient and doctor. From early detection to advanced diagnosis, AI benefits humanity. In some areas, it is already being used, and there are areas where we can see the introduction of AI in the near future. In specialized care, including pharmacy, radiology, and pathology, AI plays an important role.

Virtual assistant for personal health

In the current era, most people have access to a smartphone. They have their own virtual assistant on their mobile devices. Advanced

AI algorithms such as Cortana, Google Assistant, and Siri are already acting as assistants. When combined with healthcare applications, they bring immense value to clients.

Healthcare applications serve as personal health assistants. They can also be used to provide drug warnings and to interact with people. AI can help as a personal assistant to help patients when clinical staff is unavailable.

AI improves sleep quality

A good night's sleep has been very important for good physical and mental health. It has been reported from various studies and observations that the People who sleep better at night are happier, healthier, and more productive during the day. As a result, medical imaging analysis becomes more accurate and effective. This reduces the risk of error. IBM Watson is a concrete example. In the field of oncology, Memorial Sloan Kettering (MSK) can provide physicians with evidence-based treatment options for cancer patients.

Precise medicine

Genetics is a branch of molecular biology that deals with gene structure, evolution, functions, and mapping. It searches for links to diseases from information derived from DNA. When linked to AI, it is possible to detect cancer and some vascular diseases at a very early stage. In addition, it can solve patients' health problems due to their genes. In addition, AI helps to reconcile medical details, reducing the risk of malfunctions.

Health care bots

Artificial intelligence technology is also gaining ground in customer service. Very soon, the world will see health robots. Patients can communicate with these AI robots on a website through a chat window or by phone. Medical robots are used to schedule appointments with a patient's healthcare service provider. These robots help patients with medication. They can also improve customer service by providing 24/7 support.

These are some of the great things that AI can do. But it is not limited to this. Innovations that push the boundaries of healthcare are the best possible solutions to save time, money, and efficiency.

Agriculture

Imagine a future where there are no farmers on the farm. A place where farmers can monitor crop welfare or animal movement without leaving the farm. With the advent of Artificial Intelligence (AI) technology and population growth, agriculture is slowly transforming into groups. By 2050 it is estimated that AI and AI-assisted devices will take care of the agriculture, which would further guarantee the best yield, both in terms of quantity and quality of the crop yield.

Innovative new solutions, some based on robotics and AI, are transforming what we know about agriculture, making it less labor-intensive and more efficient. Lawrence Enderu, a professor at the Jomo Kenyatta University of Agriculture and Technology (JKUAT) School of Computer Science and Technology, described the challenges we face in managing farms to adapt to new technologies. "The reality of climate change is that in many places rain has become unreliable, there are pests, conflicts between humans and wildlife, and it is forcing them to adopt new ways of thinking and acting, To adapt to natural technology," he said.

Although AI is still the latest technology, it has already created mobile technologies. Phone cameras can now detect the captured image and adjust the camera settings accordingly. AI systems are widely used in organizations such as health and agriculture, and Kenyan farmers have the potential to address some of the challenges of climate change, pests and weeds, and crops.

In agriculture, the main applications of drone technology related to climate change include crop monitoring, crop size, and energy estimation, crop tracking, recipe card production, spraying, agricultural infrastructure testing, and high-resolution mapping. In addition, it includes personal sector inquiry, crop loss assessment, and legal expertise in claims. In Kenya and Mozambique, for example, expansion tools use low-cost drones to help farmers identify pests and diseases affecting their crops and make informed decisions to improve efficiency and effectiveness. A visualization of analytics connected to the farming is shown in the Figure 7.2

Figure 7.2: *Role of analytics in the farming sector*
(Source: https://www.business-standard.com/article/technology/towards-farms-of-the-future-how-ai-is-revolutionising-agriculture-in-india-119032001121_1.html)

The Third Eye project was launched in 2017 in the Marimba, Gitongo, and Kibirichia region of Merim County in collaboration with the Dutch Development Agency (SNV), Jomo Kenyatta Agricultural Technology University (JKUAT). It uses RGB cameras and infrared cameras installed on drones to monitor and diagnose plants for pests and diseases, water stress, and nutritional deficiencies. Additional staff is trained in the use of drones and in capturing, analyzing, and displaying results to farmers. Many of them without technology is unable to determine whether their plants are malnourished, underwater pressure, or harmful to crops.

It detects these subtle crop changes before they are visible to the human eye, preventing early intervention and loss to farmers. "The drone is equipped with a sensor that uses the same wavelength, the same device as the satellite, so we can more accurately capture satellite data," said Banci Matti, director and founder of the Research Center and JKUAT water resources. "Small farmers are being affected by armyworms, because lately there is a way to monitor them and identify affected areas," he added.

Interventions such as the Third Eye project form the direction of agriculture uses such readily available technology. The Ministry of Agriculture of various countries is able to protect farmers from the risk of the pests invasion in recent years.

In the 2018 AU High Level Group Report on New Technologies titled Drones on the Horizon: Changing African Agriculture, the AU said that technology could help farmers increase their resources and provide rich, timely, and detailed data. “The use of drones on large and medium-sized farms as well as the use of drones in joint efforts will increase agricultural productivity and return on investment while improving environmental sustainability,” the report said.

Although the use of this technology is limited to small farms in much of Africa, other developed countries such as the United States and the United Kingdom have used it even more in the use of this technology. Experts in the UK are currently testing advanced technologies, such as cow collars, which control the robotic milking system. The collars are equipped with repeaters that connect to the milking machines when they are ready for milking and milking.

In the United States, artificial intelligence experts at Carnegie Mellon University are working with farm managers and crop scientists to improve plant breeding and crop management practices using AI technology. The team has developed a terrestrial robot equipped with a camera and laser scanner capable of predicting the expected operation of the factory.

Professor Enderu, a professor at JKUAT, said similar technology was being introduced at the university. “Depending on the image you get, you can determine the yield of corn,” he says. However, there is a difference between what is available in research institutes and what is available to the consumer. Technological costs such as drones are not available outside government and research institutes. “Buying drones is expensive, and the biggest challenge is to get internal funding from the government and the research institute’s efforts, but we understand that external partners are interested and see the potential,” said Dr. Enderu.

The industry is striving hard to make it easier for the consumer community to make it easy to buy and use the drone technology, and it will surpass the human intervention to the maximum levels, by 2050.

Education

Science fiction writers, futurists, and filmmakers have foreseen dramatic (and sometimes catastrophic) changes that will occur with the advent of general artificial intelligence. So far, Amnesty International has not made such stupid waves, and in many ways, silence is present in many aspects of our daily lives. Smart sensors that help us accurately capture auto-positioning features, including the occasionally alarming personal assistants on smartphones, the kind of artificial intelligence that is around us all the time.

While we are still unable to create autonomous robots like Pepper Popular Odyssey and Star Wars, we have used artificial intelligence technology in smart and often significant applications, even if they did not interfere so well with Mobile devices in our daily life. Education is a place where artificial intelligence is ready to make a big difference (and in some cases).

While we may not see humanoid robots playing the role of teachers in the next decade, several projects are already using computers to help students and teachers gain more educational experience. These tools would follow them and will shape and define future educational experiences.

Artificial Intelligence automates basic educational activities such as rating

In college, it can be frustrating to evaluate homework and tests for large lectures, even if the assistant professors are separated from each other. Even in the lower grades, teachers often find that assessment requires a lot of time and effort to communicate with students, prepare for the lesson, or try to improve.

AI may never replace human classification, but it's pretty close. It is now possible for teachers to automate scoring for almost any type of exam. By 2050 it is expected that most of the universities would adopt to prepare the questions and question papers using AI instead of the human teachers. Though it makes people raise their eyebrows for the efficiency of this technology, it would be realized. Today, pilot grading software is still in its infancy and not exactly the same, although it will be improved (in the coming years, allowing teachers to focus more on classroom activities and student interaction rather than on grading.

The educational software is tailored to the needs of the students

From kindergarten through high school, one of the key ways to influence the teaching of artificial intelligence is to use higher levels of personalized learning. Some of them are already happening in the growing number of training programs, games, and custom software. These systems meet the needs of students, place too much emphasis on certain topics, repeat things that students do not know, and usually help students work at their own pace. One of the learning modes through AI assisted devices, is shown in the *Figure 7.3*.

Figure 7.3: *AI helps to educate the needy (Source: https://becominghuman.ai/millennials-ai-education-in-2018-thoughts-on-the-future-3eda76d9f047)*

This kind of tailored education can be a machine-driven solution to help students at different levels work together in the classroom, while teachers facilitate learning and provide help and assistance as needed. Adaptive learning has already had a significant impact on education (especially through programs such as Hana Academy), and as AI evolves over the next couple of decades, such Adaptive Programs will improve and evolve.

IT may indicate areas where courses need to be improved

Teachers are not always aware of shortcomings in courses and teaching materials that may mislead students about particular topics. Artificial intelligence is one way to solve this problem. Coursera, the largest provider of open online courses, is already implementing this. When a large number of students submit an incorrect homework answer, the system notifies the teacher and provides a personalized message stating the correct answer.

This type of system makes it possible to fill the gaps in interpretation in the course and ensures that students from the same conceptual framework. Instead of waiting for the teacher to return, students receive instant feedback that helps them understand the concept and remember exactly how to do it next time.

Students may receive additional support from AI tutors

While it is clear that human tutors can at least provide most of these machines, these programs can teach students the basics, but they are not yet ideal for helping them develop a high level of thinking and creativity and are still needed to make teachers' lives easier. This should not exclude the possibility that AI teachers will do such things in the future. Given the rapid pace of technological development in recent decades, advanced training systems may not be a dream come true.

AI-based programs can provide useful information to students and faculty

Not only does AI help teachers and students design tailor-made courses based on their needs, but it also provides feedback on the success of the entire course. Some schools, especially those that offer online offerings, use AI systems to track student progress and alert faculty members to performance issues. These types of AI systems allow students to get the help they need and identify areas where teachers can improve the teaching of students with special needs. However, RN programs at these schools do not offer individual courses. Some students work to develop systems to help them choose their major based on areas of success and difficulty. Students do not have to consult; it is a new world chosen by future students.

It changes the way we find and process information

We rarely see AI systems that affect the information we experience every day. Google delivers results to customers based on their location, Amazon makes recommendations based on previous purchases, Siri meets your needs and your guidance, and almost all web ads are tailored to your interests and preferences and purchase.

Intelligent systems of this kind play an important role in interacting with information in our personal and professional lives and can also change the way we find and use information in schools and universities. Over the past decades, AI-based systems have already become many ways to handle the latest and most advanced information and technology, and future students may have different R&D experiences, fact-findings compared to today's students.

It can change the role of teachers

Teachers will always play a role in education, but what is this role, and what role can it play in the form of intelligent computer systems due to new technologies? As mentioned earlier, artificial intelligence can take on tasks such as assessment, help students improve their learning, and can even be an alternative to real-world teaching. However, AI is compatible with many other aspects of teaching. Artificial Intelligence systems can be programmed to provide knowledge, serve as a workplace for students, ask questions and find information, or even replace faculty members with the most basic course materials. However, in most cases, the AI changes the role of the teacher to the coordinator.

Teachers replace few courses, assist students in difficulty, and provide them with interaction and people experiences. In many ways, technology is already changing in the classroom, especially in online schools, or changing the classroom model.

AI makes learning by testing less daunting

Trial and error are an important part of learning, but many students distort the idea of failure or ignorance. Some do not like being promoted to peers or in positions of authority, such as a teacher. A smart computer system designed to help students learn a simple way of trial and error management. Artificial Intelligence can give students the opportunity to experiment and learn in a judgment-less environment, especially if AI tutors can provide developmental solutions. In fact, AI is the right format to support this type of training, as AI systems often learn by trial and error.

AI-related data can transform the way schools find, teach and support students

Intelligent data collection powered by intelligent computer systems is already changing the way colleges treat current and future students. Whether attracting students or helping them choose the best courses, intelligent computer systems help shape every part of the academic experience according to the student's needs and goals.

Data mining systems have already played an important role in the current high-end landscape, but artificial intelligence can still transform higher education. Some schools already have programs that provide students with AI-led training, which will facilitate the transition from high school to college. Who knows, but the college selection process ultimately resembles Amazon or Netflix with a system that advises students on the best institutions and programs.

AI can change where students learn, who teaches them, and how they acquire basic skills

This may require major changes in the years to come. In fact, artificial intelligence has the potential to radically change almost everything we bring to education by 2050.

With artificial intelligence systems, software, and support, students can learn from anywhere in the world. They can sometimes replace teachers (for better or worse) with these types of programs, replacing some classroom teaching. AI-based education programs already help students master basic skills, but as these programs and developers learn more, they offer students a much wider range of services.

Governance

Over the course of seven months, The Future Society has collected data on AI management from thousands of members and collaborators worldwide. These data culminate in a report published in 2018 entitled "Global Citizens' Debate on Regulating the Growth of Artificial Intelligence." The report provides information on current concerns about AI as well as what needs to be done to ensure a safe future as technology advances. Artificial Intelligence is full of information, views, and ideas ranging from manic media reports on autonomous vehicles to science fiction films and TV shows that capture the robots. In these conversations, it is easy to go biased or even confused, and it is difficult to know which voices to follow. The Future Society report explores many stories about artificial intelligence, gathering seven key types of information about machine learning. The major objectives of the AI assisted digital governance is shown in the Figure 7.4.

Figure 7.4: *AI assistance for better governance (Source: http://csreports.aspeninstitute.org/Roundtable-on-Artificial-Intelligence/2017/report/ details/0263/AI-2016)*

The new concept of AI currently lacks a consistent or simple definition of AI and should change in the future course. With the rapid evolution and development of artificial intelligence technology, it has become difficult to maintain a clear and consistent definition of artificial intelligence. Progress requires a clear definition of AI to enforce regulation and reduce risk. The society of the future has come up with a workable definition that describes artificial intelligence as “big data-driven, machine-learning centric, complex sociotechnical systems powered by supercomputing.” While this basic definition is complex, it ensures that all parties are on the same page when discussing AI and making decisions. So far, AI is widely developed and is considered a parody of the human being. Anthropomorphized robots and smartphones that speak to us as humans perpetuate the notion that artificial intelligence must mimic human qualities. What if we use AI outside human simulation? How can AI assess human abilities and work in ways that human beings cannot? For example, AI is the ability to simultaneously analyze large and complex data that the human brain cannot. As these technologies evolve, our concept and relationship with AI will also change. In the coming years, we will witness a process of changing social norms and values along with emerging technologies. As our perception of this technology changes, it is important to create a universal definition and standard for AI classification.

Different AI assumptions

Confidence is key to AI success. People have instinctive reactions to AI because this technology raises ethical issues regarding workforce renewal, personal data collection, etc. But in the end, you can’t rule without trusting AI. One of the recommendations for building trust with Amnesty International is to set up a global ethics committee to act as a “watchdog” to ensure that companies comply with ethical principles. Such a committee would require the cooperation of all governments and organizations around the world, but it would be a necessary step to steer the development of AI and enable people to have confidence in new technologies.

Applying blockchain to ethical AI and Governance

As blockchain technology was developed along with AI, we began to realize that these technologies are mutually supportive. The blockchain acts as a "digital ledger" for storing data and recording transactions. The essence of this technology is that it is decentralized and highly secure - featured that can mitigate some AI risks, such as data collection and secure data transfer. The nature of blockchain transactions encourages users to securely share or exchange personal data. After all, the development of machine learning requires a lot of personal data, and people are right in fear of sharing it. Blockchain is a way to overcome this obstacle and transfer data securely.

Researchers expressed the hope that the coming generations and future utopians could use AI to address broader social issues such as poverty, climate change, and disease. Amnesty International is able to provide goods and services at a cheaper cost, including legal and medical services, by improving access to marginalized communities. Some have argued that it helps society to be more cooperative and balanced. The main cause of controversy and fear is the idea that AI can automate services and replace human work. The opposite argument, however, is that artificial intelligence frees up resources for people to pursue creative interests and projects, as well as scientific discoveries.

Smart management is the key to reducing threats and challenges

AI will not realize its full potential if governments do not cooperate to compete. Competition brings the situation "to an end," which means that values and ethical standards are lowered so that products can be marketed more quickly. This scenario highlights the growing need for standardized procedures to hold companies accountable. Another challenge is prejudice: as AI is used to collect, store, and exchange data, it must be as representative and objective as possible. This is not possible without strategic and sensible management.

Apprehensions about AI in Governance

New Threats, Fears, and Risks Related to Using Artificial Intelligence Algorithms in a Major Role Society As the idea of AI has been developed. People are afraid of a world where robots take over humans and conquer humanity. While science fiction exaggerates most of these fears, it is perfectly legitimate to fear that AI may gain more power. As long as AI is implemented in health care, infrastructure, and the legal system, people will justify that it will ultimately deprive human autonomy. The main way to prevent this is to hold people accountable instead of Amnesty International and not give them power over key community roles. For example, when AI is used for medical diagnosis, a team of doctors may use the information collected by AI to draw its own conclusions and plan treatment. In court, AI can be used to speed up investigations, but people are responsible for court decisions. The result is that technology must be used to complement rather than replace human responsibility.

Careful usage of AI

Developing people's identities and roles What would a world be without a traditional working week? Will people be productive and lead a satisfying life, or will they be illegal and idle members of society? These questions were raised as participants involved themselves in the world of artificial intelligence task automation and task optimization as all staff could revolutionize. If AI can make goods and services cheaper and more accessible, people may not meet their basic needs. Instead of AI, traditional work raises philosophical questions about the role of humans in society. This revolution also requires a restructuring of the construction of our cities and our education systems. Our lives are focused on working to meet our needs, and it is not clear how society will change if it is no longer a factor. It invites anthropologists, behavioral scientists, and philosophers to come together to resolve these issues. The facilitation talks contained in this report are the starting point for the management of HEIs and should continue at a local and global level.

Currently, the US and China are leading the way in innovation and AI implementation, but if these governments see innovation as a nation, it will create political instability and increase the risks involved. to AI. One way to facilitate these conversations at the local level is through community education programs. When properly implemented, Amnesty International can empower marginalized communities and promote equality, but without careful consideration, it can lead to greater economic and social division. Giving people the power to know their rights to AI, to understand the risks and benefits, and to provide access to goods and services can lead to inclusion in education.

People always have expectations from the emerging technologies for a better future. However, if emerging technologies don't address them, situations would lead to havoc. No government would take the risk to experience it. Hence, almost every government would take care of its citizens to provide a better life and better businesses by 2050.

Climate and Weather

This is a historic moment for Artificial Intelligence (AI). All compositions are united: Big Data open source community, hardware discoveries, new AI algorithms, and tools that will reduce access barriers for startups. The result: AI is used from research labs and in our online life, from cities, distribution centers, and energy networks to the online world.

In 2018, everyone was beginning to realize the commercial value of AI. Every year, it adds more and more clever things - accelerating people's discoveries. As artificial intelligence becomes more powerful, autonomous, and more widespread in its use and effectiveness, the unsolved problem of artificial intelligence security is important. Risks: Artificial Intelligence Abuse, such as prejudice, poor decision making, low transparency, job loss, and autonomous weapons.

However, the challenge is not limited to "artificial intelligence," which aims to provide "ecological intelligence." Due to the great importance and need for economic and human health loss of our natural environment, we have the opportunity to see how AI can help transform traditional systems and systems to cope with climate change, ensure food and water security and build sustainable cities. And protect biodiversity and human well-being. With this in mind, in a new Forum-PWC report published this year in Davos, an important opportunity has been offered to use AI for Earth. These include eight of the Game Changer's artificial intelligence applications identified to meet the challenges of this planet:

Autonomous and connected electric vehicles

Autonomous AI-driven vehicles will allow years and decades to switch to on-demand mobility. Significant reductions in greenhouse gas emissions from urban transport can be achieved by optimizing routes and traffic, eco-driving algorithms, car "sacks" for traffic and services, and autonomous parking. Electric audiovisual vehicles are important for real benefits.

Distributed electricity networks

Capacity demand and repeatability in distributed network AI improves support efficiency, improves energy storage, capacity, and load management, helps integrate and reproducibility in reliability, and enables dynamic pricing and exchange, creating market incentives.

Smart agricultural and food systems

AI-enhanced agriculture includes automated data collection, decision-making, and robotic corrective actions to anticipate disease and crop problems, feed livestock in a timely manner, and optimize agricultural resources and outcomes based on supply and demand as a whole. It promises to increase the resource efficiency of the agricultural sector, reduce the use of water, fertilizers, and pesticides, which damage important ecosystems, and increase resistance to climate extremes.

Next-generation climate and weather forecasts

A new field of "climate analytics" has been developed that uses AI to fundamentally change climate forecasts and improve our understanding of the effects of climate change. This field has traditionally required high-power, high-power computing, but deep learning networks allow computers to run much faster and compute the complexity of the real-world code system.

In just a decade, AI computing power and advancements have enabled PCs to get the same power as today's supercomputers, reduce research costs, increase scientific productivity, and accelerate productivity, and innovation. Artificial intelligence techniques can help correct model anomalies, prevent data degradation, predict serious events, and model impact.

Intelligent disaster response

AI can analyze weather and disaster simulation and real-time data (including social media data) in the region, prioritize risk-based interventions, and improve disaster preparedness, provide early warning, and coordinate emergency communication capabilities. Deep reinforcement learning can be used for these purposes, which is much like artificial intelligence. A symbolic depiction of the burden of disaster management is shown in the Figure 7.5.

Figure 7.5: *Geolocations help AI to extend its assistance for disaster mitigation (Source: https://www.ozy.com/opinion/artificial-intelligence-will-save-humanity-but-does-anyone-care/90195/)*

Smart AI cities that are smart, connected, and usable

Artificial intelligence can be used to create zoning laws, building regulations, and floodplains, along with augmented and virtual reality (AR and VR). City real-time data on fuel, water use and availability, traffic flows, public movement, and weather can create a "city dashboard" to optimize urban sustainability.

Transparent Digital Earth

This enables you to monitor, model, and manage real-time, open-source digital geospatial dashboard ecosystem APIs filtered by AI for the planet - illegal deforestation, water extraction, fishing and hunting, air pollution, natural disaster response, and smart agriculture.

Reinforcing the progress of earth sciences

This new artificial intelligence technology, which requires no input data, requires much less computing power and provides evolutionary intelligence with lessons that will soon evolve and become operational in real-world science. Collaboration with Earth scientists to identify systems - in meteorology, material science, biology, and beyond - can be codified to use teaching reinforcement for scientific progress and innovation. For example, Demis Hasabis, co-founder of Deep Mind in Materials Science, suggested that Alfago Zero's successor could be used to search for superconductors at room temperature, a hazardous material for highly efficient energy systems.

Transportation

The transport technology is developing more slowly than some other sciences such as information technology, biotechnology, and nanotechnology. For example, the world speed record was set in 1969, 50 years ago when Thomas Stafford, John Young, and Jean Kern drove the Apollo 10 at 24,790 mph. Although there is a lot of talk about jumping at a speed approaching the speed of light, very little effort is currently being made in this area. However, in the next few years, transport technology will be much faster: frictionless vehicles and binary power.

Throughout history, we have learned that freedom and control are the fundamental requirements of the two principles of humanity. Current automotive technology gives our car the ability to drive as quickly as possible, and while we control our time and direction, we are still limited to ground driving and have a hornet jack to fight in this regard. Speed, flow, and action are also the requirements for the vehicles that are targeted for 2050.

Understanding the "freedom and control" factors is essential to understanding the future of transport. Any new cargo that does not measure our free spirit or gives us control over our lives is failing in the transport market. A depiction of cooperative driving is shown in the Figure 7.6.

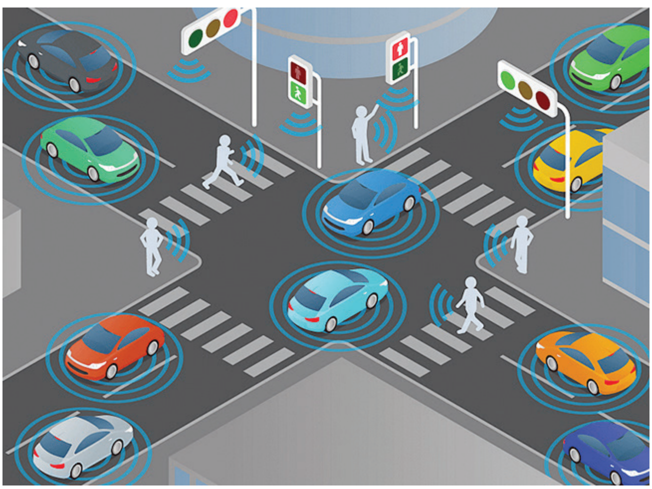


Figure 7.6: *Inter-vehicular interaction makes cooperative driving (Source: https://www.phoneweek.co.uk/artificial-intelligence-in-transportation-market-share-growth-rate-2019-to-2025/)*

In the short term, automakers will focus on fully automated vehicles, where users can "point" or "talk" wherever they want, and the vehicle will drive them there automatically. This "management functionality" opens up huge additional markets for automotive companies looking to sell to seniors, families with very young children, and the visually impaired. The advent of fully automated navigation systems for land vehicles opens the way for fully automated navigation systems for in-flight vehicles.

A few additional transport steps will help pave the way for more innovation. Starting in 2010, personal transport equipment was very strange, and electric skateboards with integrated roller skates attracted more attention. After nine years of strong media coverage, the Segway Human Transporter is gaining significant market share. As electric and hybrid vehicles slow down by 2015, the number of conventional gasoline vehicles will begin to decline. By 2050, self-illuminated roads, roads that glow in the dark, would become a standard while laying roads. "Shining roads" radically change the nightlife of big cities, improving night-time driving safety, and reduce the need for street lighting.

Frictionless vehicles

In 2030, we will see the sale of the first flying vehicle without moving parts and without collision, considered by many to be the ultimate freedom vehicle. As the information technology world evolves from analog to digital, classical mechanics and conventional aerodynamics will be replaced by new physics that regulate vehicle movement. Even today, many flying cars on the radar screen have become the next generation of automotive technology. They start with a more personalized version of the current fleet and eventually turn into non-friction cars.

Car flying time

The era of flying cars really has begun in 2015 with flying drones. Flex drones are used for FedEx and UPS shipments, while Kroger and Safeway are used for Pizza Hut and grocery deliveries. But outside, the drone can remove the home from the grid, distributing water and electricity (replacing the batteries in the house), collecting waste and sewage, and so on. They also start as inflatable vehicles and then turn into frictionless drones.

Six major technological breakthroughs are needed to make the first generations of flying cars viable: fully automated navigation systems, airspace overlap, low impact vertical take-off, adaptive traction ability, silent engines, and unique security systems.

- Fully automated navigation systems: It is very difficult for the average person to navigate on a two-dimensional surface. The flying car industry "can't take off" without an "on-board navigator." Yes, people do, under certain circumstances, seek the freedom to make creative maneuvers, but this is only rarely allowed.
- Airspace Overlap: Millions of vehicles flying over the city require an organized traffic management system. Moving all vehicles to the specified height avoids many problems. For example, all vehicles moving at 1,000 feet should travel north, from 1 degree east to 1010 feet north, 2 degrees east to 1,020 feet, and so on. Vehicles turn up or down to make turns. Although not an exact solution, the North Pole can be a base for those traveling north, which is a good starting point for a technical solution.
- Low Impact Vertical Take-Off: An average one-on-one car in-flight does not require a runway. They should be removed and stood without disturbing the tree leaves or shutters in your home.
- Adaptive Traction Ability: While humankind is in flight from land vehicles to cars, it is important to land and fly by air.
- Silent engines: Very few cities today want to increase the noise of millions of in-flight vehicles if they look like airplanes.
- Unique Security Systems: To date, cabin crew and airspace security have been strictly regulated by agencies such as the FAA and NTSB. Because of the small size of the vehicle, it is necessary to introduce additional security measures. Safety technologies include collision avoidance systems and airbags outside vehicles.

All the above six systems or functions help the driving cars be safe on the road, which further ensures the safety of the passengers.

Binary power

Vehicles that are friction-free with mon-removable-parts that do run in the near future, utmost by 2050, are what we call "binary power."

Binary power is two other harmless beams of energy that intersect at a particular space to form an energy source. To better describe binary energy, imagine two invisible rays that meet in space, and the point where they meet is the bright spot of light. Eventually, binary power will replace all bulbs that are being used. And if you think it is only used for extreme forms of energy, you can also use it to create sound "dots," eliminating the need for speakers and headphones.

2050 and the transport sector

Energy transfer significantly reduces the cost, weight, and complexity of these vehicles. This is why the industry is moving very fast, leaving behind the mechanical artifacts we know today as scrap cars. By 2050 it will be:

- Considering technological advances and physical friction, the average passenger vehicle weight is less than 200 kg.
- Automation, lack of detail, and complexity significantly reduce vehicle preparation time.
- The average cost of vehicles will be less than $ 5,000.
- The use of automated navigation systems, traffic judiciary systems will become a distant memory.

With the departure of the flying car industry, the existing road system is gradually deteriorating. From 2070, the highway will eventually be lost.

Manufacturing

Powerful trends will allow production to be fully automated by 2050, but people working in the industry will be able to innovate faster than ever before. Warren Bennie said a few years ago: "There will only be two workers in the future factory - a man and a dog. A man is there to feed the dog. There will be a dog to not touch the man's equipment." Though we're have reached that point yet, but many strong and interdependent trends will bring us to this state by 2050, and industry will have the power to innovate and build faster than ever before.

Multitasking and Automation

This means that by 2050 the average machine will be fully automated and more efficient. Multitasking is widespread, almost universal, and this trend would be well established. Like Scott Walker, president of Mitsui Seeki USA (Franklin Lakes, NJ), noted in the industry: "In the early 2000s, the market for North American five-axis machines was 150. Today it is 3000". Machines also combine grinding and milling or laser metal deposition and grinding, or grinding and hardening. "While the ability to achieve more in an envelope is an advantage, the nightmare is to do everything right and consistent." It will change as technology, monitoring, and the software for these would become available. One of the key functions which needs AI intervention in the process the vehicle building is the assembling and it is shown in the *Figure 7.7*.

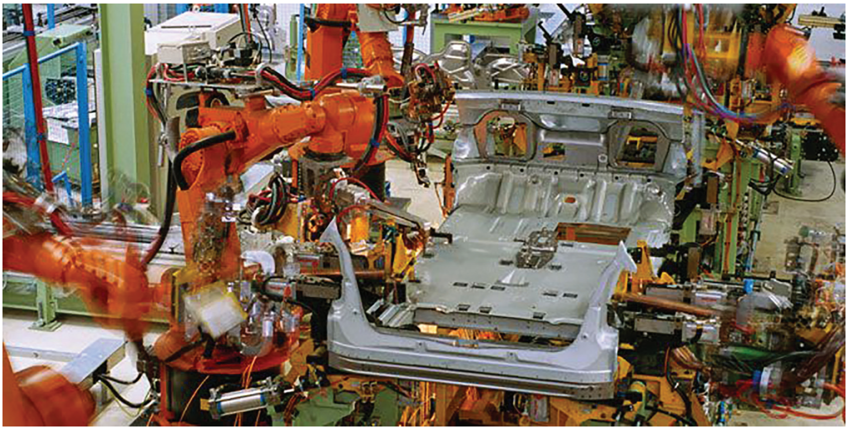


Figure 7.7: *AI help assembly lining to be more accurate (Source: https://www.manufacturingtomorrow.com/article/2019/09/data-requirements-for-artificial-intelligence-in-manufacturing/13896)*

How does 3D printing technology relate to and even beyond its influence on product design and many other issues? So far, the speed of additive production and the high cost of raw materials have severely limited its viability beyond prototyping. Terry Volher, senior consultant and president of Wohler Associates (Fort Collins, CO), says that in 2050, speed "is not the enemy."

Take the Powder Bed System: The bulk production through the Laser system to weld the material results in the consumption of the production time. "But now the systems are available with multiple lasers operating simultaneously on a construction platform," says Wohler. "The electron beam energy is divided into 100 rays to help speed up the process." On the other hand, this policy requires a lot of energy, which is expensive. Wehler thinks we can overcome these limitations, perhaps by "using solar energy to directly melt materials rather than going through 440 volts."

Wohler noted that the deposition of directed energy is inherently faster than the powder coat method for fabricating metal parts, but that "consumers have a limited trade-off between the number of materials they can produce and the resolution that usually requires processing, and sometimes considerable." This brings us back to the hybrid systems that combine CNC milling. Like Walkers, Wohler believes that the problems of harmonious operation with these two systems will be largely resolved by the year 2050.

Another assumption in favor of more widespread use of enhanced methods is the reduction of material costs and choice of acceptance. " For example, though thousands of conventional products are available modern machines work with only a few dozen thermoplastic materials," says Wohler.

Perhaps more importantly, the polymers currently used in 3D printing are 50 times more expensive than conventional polymers. It degrades hundreds to thousands of pieces depending on the size of the piece. Wohler says patents on polymer-based machines for making parts have become obsolete, resulting in new machines using cheaper materials. "The breaking point has been dramatically improved, so assembly can pose a challenge for casting a wide range of products, including large-scale applications."

This is the case for metal, but Walker is skeptical that metal additives will justify replacing traditional methods. "60 tons of roll sheet is much easier to heat than dry metal or coated construction," says Walker. It can be considered that additives as a function that one can put in a machining envelope to add value to this process. However, it may not be considered that additives as a substitute for steel production unless the technology is inverted, and molecular manipulations are made using another type of energy source.

Additive manufacturing is still an advantage, at least for some players: the ability to create otherwise impossible forms. Not only does it open up the potential for new products and features, but it also helps reduce the problem of 3D printing speed. The open network structure, enabled by 3D printing, provides the durability and rigidity needed by most applications with far less material than texture. The 3D printing speed is directly proportional to the cubic volume of the material.

Automated and creative design

According to Walker, the industry is poised to achieve the highest productivity growth in two areas, one of which is the digitalization of all work needed to prepare the production process. Nowadays:

- A designer starts with a digital model and then creates a tool
- Then someone designs the device
- Then you look for the development
- Then the application engineer loads the drip program onto the machine and monitors how the tool outputs and how it looks.
- In the end, it is part of what can make a machine
- And it can improve the range of motion, so it represents the cycle time of the cumbersome item.

It's actually worse because getting the original design can be boring. Fortunately, very bright minds work hard to make every part of the process easier and faster.

Bringing product design technology to the forefront helps the ever-expanding creative team quickly explore new geometric capabilities. In the case of Autodesk's Fashion 360 (San Rafael, CA), the software runs in the cloud and uses machine learning and artificial intelligence to automatically create hundreds of designs, each meeting resistance criteria, cost, and designer fabrication, hardware and so on. In addition, Bob Jance, Director of Production and Manufacturing Strategy at Autodesk, explained that the models "are not just perfect geometry that cannot be used, but is truly CAD models that can be further manipulated in CAD software."

Yancey also refers to this process as "productive conscious," meaning that they are initiated by preferred production methods that are created from scratch. "So if you say you need to create a five-axis numerical control part, your design choice will fit that barrier," he says. This does not eliminate the need for a human designer. As Yancey adds, "To accurately and skillfully describe a design challenge is a technical skill that never disappears. Production design software gives you more design options than any human being, so you are more confident that you are considering more options and getting better results. We see it as the future of engineering and co-creation of computer or human intelligence and artificial intelligence. "

Perhaps deeper models are often surprising and superior to what a person can do. As Diego Tamburini, Head of Community / Cloud + AI at Microsoft (Redmond, WA), said: "If my CAD tool sits in front of a room, I already have 1000 prerequisites based on centuries-old ideas. AI does not have such a concept. Design automation is a complex problem because it is difficult to imagine the complex design of computer-aided objects. We must recognize that there are many examples of life with human concepts optimal. " Since the raw materials are limited to blocks, bars, and sheets, our experience has some pre-accepted ideas. But 3D printing is not limited to these inputs. Nor is it limited to the forms it can create. If you remove those barriers and let AI work, product design often creates "completely different designs than what we had before. It's more organic than animal bones," Tamburini said.

Wohler repeats this, and nature offers outstanding examples of structures with excellent strength to weight ratios. Until recently, 3D printers produced lattice, mesh, or cellular structures that defined applications with little understanding of their resistance properties. "New topology optimization tools can create lattice and lattice engineering with impedance precision," says Wohler. "In the future, we could see very lightweight structures in various metal alloys that are lighter than carbon fiber alloys, which can be time-consuming and expensive to make." He has seen cases where a computer has created a Latin form that does not promote human confidence (it seems very light and thin), so the designer covers it with something that makes it solid. People are just people, and they prevail.

Speed up the process

Christina "Z" Holly, founder and chief inventor of Make It In LA (Los Angeles), emphasizes the benefits of combining sophisticated software with 3D printing and other new technologies (such as virtual reality) to speed up the renewable product development cycle. She points out that not only can consumers get more feedback earlier, it can also lead to better products, while new tools democratize the design and build process.

"What does innovation mean, and who are we? I think the world would be different if we allowed non-engineers to create the products they want," she said. It's also easy for entrepreneurs to start a manufacturing business - if people can set up a physical products business as easily as digital products, what products will they get? One of the expected results is: Two skill sets become very valuable. One is the advanced technical skills to code these systems and understands what works and what doesn't, and the other is understanding customer needs and market opportunities.

Which skills are becoming less critical? To actually operate the machines, the design process at Computer-Aided Manufacturing is more or less automated. As Walkers explains, if a design model contains material information (normalized), the machine must be smart enough to do the rest. Choose the right tools from the 8000 shelves and follow the right course at the right speed. To avoid collisions, the machine must have visual and audible monitoring capabilities. It also evaluates cutting conditions and adjusts speed and feed accordingly. This is what application engineers do today. How Much Do We Need in 30 Years? Let's hope there are none. "

After a word from Holly is a warning to the people to focus solely on deeds. First, there will be jobs - different, more creative jobs. And secondly, "it is important to maintain local innovation," she says. There are a lot of drawbacks to sending design and production overseas, and you lose control of your intellectual property, it's not environmentally friendly, you lose what you can unless you have it in the manual process.

Made to order, onsite

While everyone seems to agree that production is more geographically dispersed, this process greatly enhances the ability of each machine to reproduce. Many manufacturers want to reduce risk and make their products more customer-friendly and market-ready, Yancey said. Walker agreed and also said the transport costs and environmental impact would encourage companies to produce locally. There is also mandatory compensation in the government, where the producer has to produce a certain number of coins in the country to sell the products. Another motivation to maintain profitability despite currency fluctuations is that it is exacerbated by the increase in spread.

At the same time, there will be much more customization and a much finer supply chain. Summarizing the Tamburini words: Demand estimation and production of large quantities of components in response to demand. It's closer to the customer, the manufacturer can say what he wants, and the manufacturer does. Digitization and automation make this dream even more technologically and economically feasible.

This does not apply to all products, and the boundaries between standardization, personalization, and customization are not clear. Tamburini can be assured that the product customization mode will increase exponentially using a predefined list of options. Some products, such as prosthetics and clothing, are fully customized. Likewise, most manufacturers are neither generalized service desks nor experts. Machines rely on demand for what's happening on the cloud.

As Walkers said, "Today, a company needs a three to five-year contract to make a part because the cost of buying a machine, programming, and tools to make it stable and accurate is huge." Manufacturing a machine is automated with multifunctional capabilities. Most configuration efforts are operational and liquidated, and production is more agile and possibly less profitable. As per Holly from Make It In LA, the design process, as well as tools and design interfaces, are even more important.

Keep going

Advances in digitization, “hyper-connectivity” and AI will greatly improve our ability to track work and downtime. Tamburini said most of the data currently is used to monitor what is happening at the plant and in the supply chain. “But we’re starting to think about why things are happening, and we use AI to control what’s going on. The next step in the process is to use AI and machine learning to allow autonomous answers.”

In other words, if there is enough data for analysis, machine learning can accurately predict the failure of specific components. Thanks to good decision-making algorithms and knowledge of all product requests in the workshop, the system can also decide what to do in the event of an expected failure: order part, schedule deadline, transfer work to other machines, etc. Although Walker doesn’t think we can ever avoid having to have human control technicians, one may be able to repair their machine or order a robot. However, he hopes the machines will intelligently communicate what they do - no portable devices, monitors, and controls.

Microsoft offers a head-mounted product (HoloLens) that allows you to interact with the surrounding holograms. “It covers digital information about the reality that gives you superpowers. People have discovered that reality can be used to increase tasks like assembly instructions, quality control instructions, or maintenance instructions, reducing the need for training. For example, a remote-control professional can help a local technician by suggesting the item or how to move it as if he were looking for the same item in the same store.

Finally, one of the benefits of machine learning, Tamburi, emphasized: “As soon as they are improved, these capabilities or knowledge are immediately passed on to the world because it is software. To make everyone smarter and more comfortable, we think we can share data.” As opposed to a factory expert who uses his years of experience to understand machine sounds, it’s very difficult to spread this kind of knowledge.

Defense

Allow your computer to make life or death decisions? As artificial intelligence plays an increasingly important role and there is still much debate in parliament and in society, Ulrich Frank spoke about the ongoing debate on arms autonomy and the future of weapons and war. Ulrike Frank is a researcher at the European Relations Council (ECFR) office in London and is part of the ECFR's new European Security Initiative. She works on the security and defense of Germany and Europe, the future of war, and the influence of new technologies.

From a security and defense perspective, what is the military strategy based on the war on autonomous weapons? From a military point of view, there are many reasons to be of interest in autonomous weapons. Speed number one: war is accelerating. Computers and machines are usually better able to make decisions faster than people, especially if you have to think about a lot of information.

The second reason is stealth. For the time being, unmanned systems such as drones require communications and command links for the pilot to use them. The problem is, these links are easy to find, which means the system is easy to find. If you want to sneak in without watching, autonomous weapons can do what traditional weapons can't. A virtual assistant that helps the soldiers in the battle field, is illustrated in the Figure 7.8.

Figure 7.8: *Virtual assistant helps reduce life loss in the battlefields (Source: https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/May-June-2017/Pros-and-Cons-of-Autonomous-Weapons-Systems/)*

The third reason companies and the military are interested in autonomy, and artificial intelligence is that it allows for the creation of new military capabilities, including groups. It is not possible for a man to control all the drones in such a group. Drones can communicate with each other and respond to each other. Therefore, they need sensors and decision support algorithms. Again, you are in the AI and autonomy phase. In the subsequent subsections, various issues are discussed, which would be seriously addressed and be solved by 2050.

Change of warfare in future course

During the war, we will see more AI and autonomous weapon systems. However, this does not mean the “killer robot” scenario, although we are entering the gravitational logic that enters the arms race. When one party starts using these systems, it can be expected that the other to do the same. And this leads to mistakes and misunderstandings. There can be dangerous chain reactions that cause computers to react and trigger wars.

When it comes to deadly autonomous weapons systems (LAW), the governments must be very careful in defining and distinguishing between autonomy and intelligence from different forms. This is really important because autonomy and AI are always mentioned together. They are connected but not identical. Intelligence is the ability to determine the best course of action to achieve system goals. Autonomy is the freedom that a system can achieve its goals - for example, and less supervision means more autonomy. The intelligence thus allows the system to make decisions in a complex environment. This usually allows the system to achieve its goals. But autonomy means he has freedom.

In fact, if anyone wants to create an autonomous system, they want to be as smart as possible because nobody wants a silly system that works with such freedom. But most of all, it is quite possible to create a very intelligent system that does not have much autonomy. This is a link that can sometimes be a little blurry. But in general, the more autonomous systems are that they use more artificial intelligence.

When addressed about the killer robots which are prone to make mistakes, then the piracy of data plays a major damaging role. Piracy is certainly one of the problems, but I am particularly concerned about prejudice. The problem is: an artificially intelligent system is as good as the data it provides. And data is almost always created in one way or another by humans. Because it records human behavior or that it is collected identified and coded by a human. And data is almost always biased - often unconscious. For example, when you look at artificial intelligence in the civilian field, the US Police Service uses face recognition. The American Civil Liberties Union (ACLU) has tested these face recognition systems by comparing members of Congress. And they found that the system estimates that 28 of them are criminals. And the system disproportionately identifies people of color as criminals.

The problem that is observed more often is that as a society, we are always used to the fact that the computer is right: your calculator is always right; you ask the calculator multiply by 2, and you have to calculate the square root of 5756. But unlike artificial intelligence systems are not rational and always correct, just like a programmed computer. So, we need to change our mindset, think about AI systems, not the professionals we trust, and think we know more than we do, but question what they say. I think our policies need to change.

A European Parliament resolution in July called for "a ban on international weapons systems if people do not control power." Delegates of the United Nations met in Geneva last week to discuss the law. Requests have also been made for an international treaty on autonomous arms control. I wish that would happen.

Though there is severe demand from the people to ban AI usage, it is doubtful that it might not happen. It is very difficult, if not impossible, to ban all types of autonomous weapons. Firstly, because some autonomous systems already exist. Secondly, there is a military logic to finding such systems. And thirdly, no one knows if we want to ban anyone with a certain level of autonomy and artificial intelligence, it is difficult to draw the line.

If we ever get a ban, it will be very specific. And we can express satisfaction later: you celebrate the ban; you turn your head - and you don't realize there are so many loopholes. Therefore, the ban cannot be treated as a policy. As far as the use of this technology is concerned, there are more terms and conditions.

As an example of what is currently in use, Germany uses Patriot and Mantis air defense systems. They are automated, firing missiles. Not all incoming rockets have a person sitting and pressing a button. The reason is they are not fast enough, and it is the speed issue. If anyone is worried if the ban will hamper innovation, then treat it as an important issue to understand in it brings the boons for the humankind.

Artificial Intelligence and Autonomy

A significant amount of "dual-use" technology and research has already taken place in the civilian rather than the military field. I think it is possible to ban military use and continue research in other areas, but that is a cause for concern. Many people have apprehensions over AI-based arms attracting end of the human race. On the contrary, artificial intelligence brings enormous benefits to society. Despite the headlines, AI fears are just Hollywood fantasies, writes Patrice Kaine. However, the problem is that you can do research and use it for military purposes, and it is very difficult to prevent any of it. The ban does not include non-state actors or even terrorism.

Again, the ban means that large, very complex platforms of autonomy are not developed and therefore do not fall into the hands of non-state actors. It is already possible to find the appropriate code online and to create stand-alone systems. Non-state actors can benefit from it. Usually, if it is available in one way or another, someone finds it an unpleasant advantage. There was a debate started in 2013 when activist groups, especially the campaign to stop the killer robots, and has further launched a ban campaign. Law has aroused great interest as artificial intelligence has become a hot topic nowadays. But AI in surveillance shall also be taken into serious consideration. As soon as we address using AI in surveillance technology, the sooner the law attracts the policies. Quite simply, because the former is already happening, it has its own influence, and mistakes are made regularly.

Business services

The power of artificial intelligence (AI) to transform the consumer journey has dominated industry debate in recent years. At the lowest common denominator, AI enables brands to better synthesize their data and integrate this practice to enhance their business experience. This takes a variety of forms, from grocery shopping to personalization and more powerful research.

Artificial Intelligence, a technology that can do things, would normally require human intelligence, dates back many centuries. The idea of cognitive computing grew in the 1930s when Alan Turing suggested that the machine could mimic any potential mathematical deduction activity. Although artificial intelligence technologies were commercially available in the 1980s, cognitive abilities that emerged in the 2000s, with a tendency toward artificial intelligence, really took off. In 2011, IBM Watson defeated Jeopardy champions and began to spread personal assistants like Siri, Google Now, and Cortana. In 2015, Elon Musk and others announced a billion-dollar initiative to develop safer artificial intelligence. In a similar manner, many businesses have started investing for better prospects by 2050 or even far beyond that.

The fusion of three powerful engines - exponential data growth, more sophisticated distributed networks, and intelligent algorithms - have created artificial intelligence at the heart of its core applications. Almost 60% of the 602 industry professionals surveyed by Euromonitor International in September 2018 stated that the impact of artificial intelligence on business over the next five years was the most effective technology on the IoT, Robots / Automation, and Cloud. Figure 7.9 is the symbolic representation of the data analysis and decision making.

Figure 7.9: *Business and AI go hand-in-hand*
(Source: https://www.fieldez.com/unconventional-ways-artificial-intelligence-drives-business-value/)

When Euromonitor International last conducted the same survey, the vision of technologies that will have the most impact on business has changed in the last six months. In a survey conducted in February 2018 among 1,445 people, the Internet of Things stimulated artificial intelligence by several percentage points. No doubt, both are important companies that will have an impact on future businesses. Over the same period, the impact of cloud on businesses has been less than robotic / automation. The perceived effects of robots and automation have been exacerbated by headlines for unattended checkout programs from people like Alibaba, JD.com, and Amazon.

In the same survey, industry experts were asked which trading aspects would be most affected by key technologies, such as artificial intelligence from Euromonitor International. In the short term, respondents expected artificial intelligence to improve customer engagement, such as personalized marketing and personalized recommendations, as well as better site search. Five years on, respondents are increasingly influenced by the way artificial intelligence companies handle customer service requests. Artificial Intelligence is a key technology that lets you chat - the next customer service representative.

Voice-activated applications should be one of the areas most affected by the rise of artificial intelligence. In fact, respondents seem to be increasingly confident about the long-term consequences. In many of the surveys, almost 57% of respondents agreed that artificial intelligence affects voice-activated apps, which is eight percentage points higher than what was experienced earlier to those surveys.

Bill Gates announced in 2000 that most computer interfaces are done by voice, and we are slowly beginning to see how reality changes. Chat rooms and smart speakers flare-up on stage, but their impact on results is minimal. While voice-activated robots like Alexa and Google Home still have more homes, the ability to generate sales for consumer services is still very low. However, voice is welcomed as the next big thing in the trade.

“We are in an important transition,” said Patrick Pay Gautier, Vice President of Amazon Pay, in his address to Money 20/20 USA at the end of 2018. “We will have a different accent of complementary experience with the company.”

Oil, gas, and mining

Oil prices have fallen dramatically in recent years as some major oil companies have to deal with complex measures such as redundancies, reduced investments, and budgets, etc. For example, Shell has abandoned investment projects in Qatar, Aramco has stopped deepwater exploration in the Red Sea, Schlumberger has laid off a few thousand workers, and the list is long. In the face of falling oil prices and the resulting cash flow, the oil and gas sector has been challenged to optimize and optimize its performance to maintain profitability while maintaining investment and investment opportunities. long-term surgery. At present, it is very difficult for oil and gas companies to invest in the same level of exploration and production when crude oil prices are high. The oil and gas sector is now focused on increasing returns on investment and reducing trade-offs to gain competitive advantage. A symbolic representation which needs the AI intervention is shown in the Figure 7.10.

Figure 7.10 *Precision drilling and automated tasks need AI (Source: https://www.worldoil.com/techtalk/rockwell-automation/intelligent-artificial-lift-systems-improve-digital-oilfield-operations)*

It is important to adopt the results and optimize production costs per barrel. Companies have a lot of optimization opportunities when they start using huge amounts of data generated by oil fields. Oil and gas companies can turn this crisis into an opportunity by making technological innovations such as artificial intelligence the basis for long-term success. If oil price volatility is the new norm, it is important to succeed in moving from value to volume. From these crises, the subsequent discussion would indirectly address the requirements from AI to the Oil and Gas industry by the time it reaches 2050.

Artificial intelligence tools enable bottom-up oil and gas companies to streamline processes from production to delivery at all costs. They need to manage benefits and manage risks well to optimize barrel production costs. To do this, they need to integrate all aspects of product management, collect data for analysis and evaluation, and use artificial intelligence to optimize operations.

When remote sensors are connected to wireless networks, data can be collected from anywhere and analyzed centrally. According to the consulting firm McKinsey, the adoption of AI will save the oil and gas supply chain $ 50 billion and increase profits. For example, the use of AI algorithms to more accurately filter signals and noise in seismic data reduces the development of dry wellheads by 10%.

How oil and gas affect artificial intelligence

1. Planning and evaluation: At the macro level, deep machine learning can help engage stakeholders in macroeconomic trends to guide investment and investment decisions. Investments may also take into account economic and weather conditions as well as production intensity.
2. Avoid expensive drilling risks: Drilling is a costly and risky investment, applying AI in the operational planning and deployment phases can greatly improve well-planned and real-time drill optimization, friction pull evaluation, and safety. In addition, geographers can better estimate variables such as improved penetration, integrity, troubleshooting, condition of drilling equipment, real-time drilling hazard identification, and operational decisions.

   When drilling, machine learning software takes into account several factors, including seismic vibration, thermal gradients, and layer permeability. Artificial intelligence can help optimize drilling operations by making real-time decisions such as direction and speed. It can also anticipate equipment failures, such as semi-submersible pumps, to reduce unexpected costs and time.

3. Maintenance of well storage sites: The reservoir and plant management involve the integration of several disciplines: reservoir engineering, geology, production technology, petrophysics, operations, and seismic interpretation. Artificial Intelligence helps create tools that enable asset management teams to identify opportunities to raise professional awareness and improve performance.

   AI methods can also be used for other operations such as reservoir characterization, modeling, and field monitoring. Fuzzy logic, artificial neural networks, and expert systems are widely used in the industry to accurately describe reservoirs to achieve optimal production levels.

Today, AI systems are the foundation of Digital Oil Field (DOF) Concepts and Implementation. However, there is still great potential for new ways of optimizing field development and production costs, extending field life, and increasing the regeneration rate.

1. Expected maintenance: At present, artificial intelligence is taking the industry by storm. AI-powered detection software and hardware allow us to use large amounts of data to respond to future best practices. In the presence of analysis and cognitive security, oil and gas companies can safely operate equipment while receiving recommendations to prevent future failures or potential security breaches.
2. Oil and gas well exploration and inspection: Drones have been a part of the oil and gas industry since 2013 when they used the Konoco Philips Boeing Scan Eagle drone for testing in the Chakcha Sea. In June 2014, the Federal Aviation Administration (FAA) issued its first commercial drone license on BP US soil, allowing it to control pipelines, roads, and equipment in Prudhoe Bay, Alaska. In January 2015, Sky-Futures completed its first drone test in the Gulf of Mexico.

   Although UAVs are mainly used in the mid-size industry, they can be used in almost every aspect of the industry, including surveying and mapping, drilling, and pipeline inspection and security. Technology is being developed to allow drones to detect early methane leaks. Additionally, one day at the convenience of the office, drones can be used to locate oil and gas reservoirs in remote, uninhabited areas.

3. Remote logistics: As logistics remains a challenge for offshore sites, artificial intelligence enhanced drones can be used to transport material to remote offshore locations.

Adoption of current AI

Chevron is currently using AI to identify new wells and simulation candidates in California. By using artificial intelligence software to analyze important historical operating data, the company is drilling in better locations, and production has increased by 30% compared to traditional methods. Chevron uses presence models to analyze the performance of thousands of rotating devices. By solving them before problems get complicated, Chevron avoids unplanned downtime and reduces repair costs. Increased production and reduced costs increased the profit of each well.

The journey of the future

Today's oil and gas industry has changed in the last two decades of economic downturn. While the adoption of strong new technologies such as directional drilling and hydraulic fracking (hydraulic fracturing) could help, the oil and gas industry needs to innovate in today's low-cost market. AI has the potential to differentiate between growing businesses and remaining businesses.

The AI promise in the oil and gas sector has already been fulfilled. First-time users take their chances to bid and protect their properties. The industry is still driving technology to adapt to change, and early users have always benefited greatly. As competition in the oil and gas sector continues to intensify, especially for those who understand and adopt the opportunities cannot afford to be neglected.

Insurance

Financial technology has revolutionized the way banks and insurance companies operate. Instead of prioritizing their services, as in the past, banks in the new technological era must focus on customer needs.

The focus on personalized financial services is visible in fintech, a financial infrastructure for consumers. As fintech applies data and technology to financial services to address industry challenges, fintech needs, and artificial intelligence to survive. Artificial intelligence experts have transformed financial services to much profitable mode. Stakeholders stressed the complexity of fintech, recognizing that new financial technology companies must act like technology companies while respecting financial rules. Fintech is leaving the traditional banking industry to engage in financial inclusion, access to credit, and customer credit adjustment. Combined with FinTech's five pillars of social networking, analytics, artificial intelligence, blockchain, and digitization, financial technology companies face not only financial challenges but also financial literacy dilemmas such as security and regulatory issues related to artificial intelligence.

Potential takeaways

Artificial intelligence allows fintech to be realized in real-time as Fintech gives priority to financial inclusion. To do this, real-time play an important role in facilitating fintech implementation, as people with smartphones now have access to fast, customized, and personalized financial services. As Lee says, who, when, and how AI intervenes to disrupt funding, immediate decision making and credit assessment can improve access to services in real-time.

Artificial intelligence creates deep personalization

Extensive customization of financial services enables fintech to meet customer needs without dealing with customers themselves. Samir Gulati notes that Artificial Intelligence connects end-users and financial technology companies to create a seamless interaction where artificial intelligence and machine learning generate and process personal and non-financial data. The intention of the investors for the better decision making with the AI assistance is symbolized in 7.11

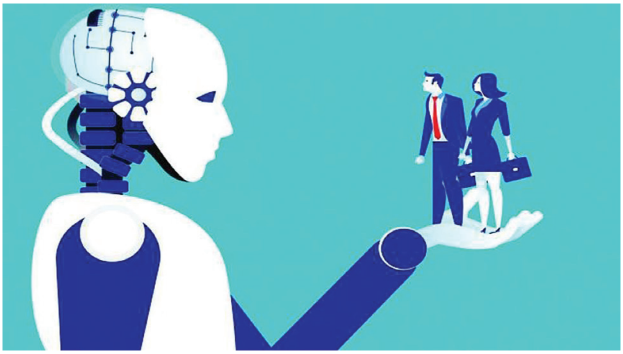


Figure 7.11: *Futuristic personalized insurance*
(Source: https://insurancemarket.sg/articles/blogs/insurtech/)

Artificial intelligence helps lenders and borrowers speed up financial services' processes and improve the customer experience. AI has redefined the concept of real-time and applied it to finance as it creates new customer relationships.

Fintech prefers the speed of financial services

The advantage of financial technology is that customers improve their financial services. As consumers prefer speed and convenience in their daily lives, FinTech does the same. Technology applications such as mobile payments and Luchang Zheng accelerate the speed of financial services and improve the efficiency and accessibility of financial transactions. As individuals demand faster economic activity, financial technologies are forced to respond to current demands by prioritizing real-time management of financial services.

Fintech is changing its financial services business model

Financial technology is an innovation of the business model. As financial technologies are focused on information technology to innovate in financial services, the financial sector must also be more innovative in the light of technological developments. Fintech's business model focuses on peer-to-peer lending and aims to transcend legacy management - where business executives do not understand or are not inspired by technology and automation - where business and technology play an important role.

Technology launches the fintech business model

The fifth pillar of financial technology, digitalization, is at the heart of its business model. Digitization has allowed inventors like Lending Club to use financial services technology and make FinTech technology a venture capital category. Technology has helped financial technology companies create new business models by making mobile payments to venture capitalists by investing in financial technology companies.

Banks and fintech companies do not maintain regular commercial cooperation

Bill Reichert stressed the role of Silicon Valley spirit and financial industry ignorance in defining the current business model, noting that Fintech is more embarrassing than “collaboration and Kumbaya.” The nature of financial services and related regulations may prevent people who are familiar with financial activities from innovating in the industry. Reichert points out that many entrepreneurs are turning to the “crazy thing” and that, with their most worrying trial and error experience, large financial institutions are dealing with business survival or disrupting the regulatory and business environment and commercial models.

Stimulate progress in the industry

AI control applications can help manage financial risks. The main reason for the job loss is the financial crisis. While many have given automation or control to the main movers, the global economic crises have caused more unemployment than any other factor in the last century. As the financial sector tries to reduce the risk of another downturn, one question is whether AI can be used at the highest regulatory level to manage financial risks while innovating in financial services.

AI helps to control and reduce risk

Artificial intelligence and machine learning try to reduce errors. Reichert insisted that artificial intelligence should play a role in overall economic governance. Currently, artificial intelligence finds only strong signs. But to give AI a greater regulatory role in risk mitigation, systems also need to capture weak signals. Carlson noted that artificial intelligence systems are needed to identify small underlying signals that are not the main drivers of today but could become more serious signals and dangers tomorrow. In so doing, artificial intelligence applies its predictive power to financial control.

Benefits from technical regulations: China scenario

Although artificial intelligence technology was born in the United States, Paulo Sironi said China had made significant progress in developing technologies that could become the largest technology owner in the future. As China has been in a state of steady economic growth for 40 years and has avoided a recession, advocates associate it with the country's regulatory climate. Zina Bay notes that, compared to South Korea, China allows for continued insurance of most financial activities, unless specifically stated by insurance companies and banks. The opposite is true in South Korea, where the Korean government restricts most economic activities unless it is deemed acceptable.

Over-regulation limits innovation

While regulation helps manage financial risks, it has a negative impact on insurance companies, banks, and conglomerates, hindering their innovative growth. Bey mentioned the challenges facing Hanwah Asset Management under South Korean control. After investing in a major peer-to-peer lender in China and hoping for a joint venture, the South Korean government has essentially stopped its lending business. However, Asian conglomerates deal very effectively with the government as they offer the opportunity to interact with modern market leaders. Korean conglomerates are helping businesses grow in Asia by convincing governments to open their markets over time.

AI and blockchain can overcome security problems

Security issues are often added to the scan. Artificial intelligence continues to grow, as do its threats to privacy and data security. While artificial intelligence often contributes to security dilemmas, artificial intelligence can also solve them. For technology to solve security problems, machine learning and artificial intelligence must be human-centered, and people must be aware that they often create security problems and be part of the solution.

Financial services are digital and secure through AI

AI vendors such as Ayasdi, which build sensitive models and automate applications using AI, can prevent financial security problems. Using machine learning to segment populations and transactions by risk, artificial intelligence alerts researchers to fraudulent transactions, money lending, and data protection threats. Gunnar Karlsson said the alarm was not enough and allowed AI researchers to determine if transactions were secure or not, but the systems do not accurately predict fraud but help filter cases.

Blockchain improves transparency and traceability of financial data

Blockchain technology protects your data from being stored and therefore modified. Blockchain can help protect end-user information and privacy with its zero-proof technology. Luchang Zheng said that blockchain technology captures relevant information only anonymously, rather than collecting all information from the banking system when certain information is needed. Blockchain not only reduces the data mining process but also ensures the security of the entire banking system.

How FinTech in 2050

By 2050 almost every country would get relief from printing the currency notes and would adopt pure digital currency. Moreover, it would not be a surprise crypto-currency becomes a globally accepted standard. This would attract more adaptability of technology and developing more insights into the customers and their requirements. More research is needed in this sector as the Financial Technology is the heart for finance and economics for any country.

Sports

The image of Moneyball, among other things, can be considered as an excellent example of data-driven performance optimization in sports. For those who haven't seen the movie or read the book, Auckland Athletics general manager Billy Bane explains how to use statistics and analysis to build a competitive team, despite the team's small budget. His team gathered to analyze players' personal statistics, after an unexpected and fruitful season and unprecedented records. In the historic 2002 season, the Oakland Athletics competed with Major League Baseball (MLB) senior teams, with budgets well above their own. Team achievements and their famous 20 consecutive wins have shown how, in general, a data-driven approach can compensate for resource shortages and improve performance by enabling effective decision-making.

Now, more than 15 years after the events of Moneyball, the sports world has grown rapidly. It uses many types of technology, the most important of which is the use of Big Data for sports analysis. Now, with the introduction of artificial intelligence in sports, we are witnessing a new wave of change, from playing games to the way fans around the world are experiencing them.

Use of Artificial Intelligence in sports

There are some things in the world that cannot be counted. Everything can be accurately measured using data analysis and artificial intelligence. The world of sport is rich in quantitative aspects, as it is ideally suited to the use of artificial intelligence. The use of artificial intelligence in sports has become widespread in recent years. Given the positive impact of their growing abilities, they continue to enter the sports arena. Further discussion exemplifies various issues that the AI shall address by 2050.

Intelligence and recruitment

Although people are far from being measured using objective and quantitative indicators, their performance is certainly subject to quantitative testing. Sports teams, whether they are baseball, football, or any other sport, are increasingly relying on players' personal data for their aptitude and likelihood. However, performance data used to find potential employees is not the use of publicly known statistics, such as home trips, goals, or passes, but rather more complex measures that take into account a number of factors. However, human perceptual boundaries are far from recording and accurately measuring these metrics. The introduction of big data and artificial intelligence in sports management makes recording and measuring these future success rates easier and more reliable.

AI can use historical data to predict its future potential before investing in players. It can also be used to gauge players' market value for new deals by acquiring new talents.

Training-cum-performance analysis

As mentioned above, using simple metrics like passes and goals is not the best way to accurately measure performance individually and collectively. To measure performance in any sport, analysts and coaches need to analyze many data points about individual players and collective performances. This helps them identify areas where players are performing better and where they are lagging behind. Depending on the role of individual players in the team, the dimensions of their contribution will vary. For example, in football, the key performance indicators of players progressing or attacking are different from those of midfield players (creative players) and defenders (defense players). Although not all aspects of the performance can be measured, for the time being, an increasing proportion of the player's game becomes quantifiable and therefore measurable. For this, artificial intelligence makes it possible to determine correlations between qualitative characteristics and quantitative variables, and then measure them to assess the relative qualitative value of participants. One of the instances of AI assisted robots playing soccer is shown the Figure 7.12.

Figure 7.12: *Sports with AI drive to a new horizon (Source: https://www.thetechnologyheadlines.com/technology/artificial-intelligence/Sports_Industry/)*

Artificial intelligence can also be used to identify trends, strengths, and weaknesses of opponent strategies in game preparation. This helps coaches to create detailed game plans based on opposition ratings and maximizing chances of success.

Maintain health, fitness, and safety

It is well known that the introduction of AI in many ways is changing the health industry. Exceptional predictive capabilities and diagnostic capabilities of AI can also be used in sports where health and fitness are of the utmost importance. Because the essence of sports is to maintain optimal fitness, sports teams invest heavily in the physical and mental welfare of their players. In an effort to ensure the health and fitness of players, they are increasingly using technology in healthcare. Artificial intelligence has become the last technology in the medical kits of these teams. Players routinely undergo physical tests that use AI to analyze various health parameters and their movements to assess their health potential and to detect the first signs of fatigue or injury caused by stress. This helps the medical teams and respective sports organizations maintain their athletes in shape and protect them from injury by taking appropriate action.

Most management teams use wearable technology to track player movement and physical parameters to track players' general health. These handheld devices can use AI systems to continuously analyze the flow of data collected to identify signals that represent players experiencing musculoskeletal or cardiovascular problems. This allows sports teams to place their most valuable assets at the forefront of long competitive seasons.

Streaming and broadcasting

In addition to the sports revolution for players and sports leaders, artificial intelligence can reverse the revolution live and influence public attitudes towards sport. AI is also ready to change the way broadcasters make money with sports events. Depending on what is happening in the field, Artificial Intelligence systems can be used to automatically select the correct camera angle for display on the digital screens. It automatically provides subtitles for live events in different languages based on viewer location and language preferences. Artificial Intelligence systems can also be used to identify good advertising opportunities based on the level of public enthusiasm for sports, allowing broadcasters to make better use of advertising opportunities.

There is no doubt that the use of artificial intelligence in sports will make a prediction of race results more convincing and reliable. No matter how much we try to build and attend sport, the human element is always an undeniable and astonishing factor. First of all, sports are fascinating and exciting to audiences all over the world. As long as sport attracts the general public, businesses will always be able to benefit from it. As long as the sports world is profitable, investment and integration of sports technology will continue.

Energy

The United States Energy Information Agency (EIA) defines renewable energy as a renewable energy source, such as solar or wind power. In contrast, fossil fuels are considered to be limited. The United States EIA in 2016 reports that 10% of the energy consumed during the year comes from renewable sources. That's about 10.2 quadrillions British Thermal Units (BTUs).

Despite the increasing use of renewable energy, which became the world's leading energy source in 2015, the widespread adoption of policies and technologies is still hampered. Researchers and organizations are exploring how artificial intelligence can help improve the availability and effectiveness of renewable energy technologies. The key components that are required in the process of creating energy intelligence is shown in the Figure 7.13.

Figure 7.13: *Energy savings with AI assistance*
(Source: http://www.logicladder.com/save-energy/energy-intelligence-service)

In further discussion, few examples of renewable energy technologies that include AI are provided for better insights. Three major categories of renewable technologies are covered that are of interest to entrepreneurs in the green energy industry:

- **Energy Forecasting**: Industry data is used to construct artificial intelligence algorithms to create accurate estimates to help inform energy supply and demand.
- **Energy Efficiency**: AI is used to monitor and optimize energy efficiency.
- **Access to Energy**: Artificial Intelligence is used to model utility cost savings and make recommendations for housing investments

For each application, we provide an overview of the company, the performance of the platform, and the data and / or results obtained. Each example is organized into a subtitle, which is useful as a quick reference when browsing an article.

AI for energy reference

Xcel

A constant problem with renewables, such as wind and solar, is their reliability. Climate energy sources often fluctuate. Colorado energy supplier Xcel is implementing AI to try to deal with these issues. Thanks to the new artificial intelligence-based data mining method at the National Atmospheric Research Center, Xcel has been able to access meteorological bulletins with high accuracy and detail.

This means that the energy produced can be more carefully preserved and conserved. To provide these detailed weather reports, AI mines from the data which is collected from local satellite reports, meteorological centers, and wind farms in the region. The algorithms that drive the system are trained to identify patterns in these data sets and make predictions based on these data points. Excel reported that wind power in Colorado has doubled since 2009. Earlier this year, Excel announced plans to expand the wind farm by 50% by 2021.

Nnergix

Weather conditions are often unpredictable, which might destabilize the supply of electricity from climatic sources such as solar and wind. This requires the renewable energy sector to effectively balance supply and demand. Historically, weather forecasts have helped fuel suppliers predict their energy supply. Today, companies like Nergix are using artificial intelligence to improve the accuracy of renewable energy forecasts.

Nnergix is a web-based data mining and energy measurement platform that collects data from the energy industry. The company combines satellite data from meteorological forecasts and machine learning algorithms built from industry data to produce more accurate forecasts.

High-resolution weather forecasts appear to have been generated from satellite imagery. Based on these images, large and small-scale weather conditions are created. Machine learning algorithms can analyze this data and evaluate the state of the environment in a given area.

AI for energy efficiency

Verdigris technologies

Founded in 2011, Verdigris Technologies, based in California, offers a cloud-based software platform that uses artificial intelligence to help customers optimize their energy usage. This process is designed for managers of large commercial buildings and corporate premises and starts with installing IoT hardware. The smart sensors are directly connected to the customer's electrical circuits to track power consumption. Sensor-sensed data is sent to the cloud "securely over Wi-Fi or Verizon 4G / LTE" and is available online 24/7 on the dashboard.

Verizon's involvement is a little deeper than a wireless connection.

Each device has a unique electrical footprint, resulting in algorithms designed to detect each unique power source while providing comprehensive analysis compiled by smart sensor hardware. Data analysis is made available to Verdigris cloud servers. In a case study, Verdigris said Hotel W has partnered with San Francisco to identify energy inefficiencies in the hotel's commercial kitchen. Within three months, the company realized the inefficiency that cost the hotel more than $ 13,000 with inevitable annual losses.

Google DeepMind

Founded in London in 2010 and acquired in 2014, DeepMind Technologies, an artificial intelligence company, has announced that it has reduced the amount of power needed to cool Google's data centers by 40%. However, DeepMind reported these results in July 2016 and announced that it had started using machine learning to improve fuel efficiency two years ago. In particular, a set of data center operating scenarios and parameters have been used to build the neural network system. The neural network has "learned" how to operate a data center and has begun to identify optimization opportunities.

According to Google, the data comes from thousands of sensors located in data centers. The information collected includes temperature and power consumption. The power consumption effect is defined as the "building's total power consumption / computer usage ratio" and is used to form neural networks. The PUE model provides efficiency so that when the neural network system provides recommendations, they do not exceed performance limits.

Google Data Centers have servers that provide Google's most popular apps, including Gmail and YouTube, with billions of users representing one-third of all Internet users. Google's capital expenditure was primarily used to support data center operations and improvements. Total spending in 2016 was $ 10.9 billion, compared to $ 9.9 billion in 2015.

AI for energy accessibility

PowerScout

In an effort to improve consumer education and access to renewable energy technologies, the PowerScout sector would use AI to model potential utility cost savings. The company uses data analytics to identify "smart home improvement projects" based on the unique features and energy consumption of the customer's home. The purpose of the PowerCut algorithm is to match customers with potential hardware installation service providers in an online marketplace format to provide competitive pricing.

More importantly, AI acts as a market consultant and advises clients to make decisions about purchasing renewable energy technology for their homes. We imagine that using this AI is similar to the redirects found in other markets. The development team said the platform collectively oversaw the installation of equivalent solar power by March 2017 to power 250,000 households. PowerCout lists Google and the US Department of Energy among its partners. In fact, the company has received two grants totaling $ 2.5 million from the US Department of Energy.

Verve

Verve is an AI-based home assistant created by London-based Green Running Limited. The system has already been reported to use its technology to help customers manage their home power. Verve provides device energy data and classifies energy costs as fixed costs. Customers will be able to see how each appliance in the house consumes energy and monitor and control their energy costs before receiving their bills.

When the device is on, the algorithms that drive the Artificial Intelligence wizard can identify models and automatically automate the energy costs of the object. Verve would also have tips for reducing the carbon footprint of home security, which will alert users if the equipment is kept on hold for a long time. This app is available for tablets, laptops, and smartphones.

Fashion

People won't be surprised by the amount of technology going into the fashion industry these days if they are following the trends of AI and its disruption into various industries. This trend will continue, and people will hear a lot about Fashion Technology (FashionTech). The future of fashion has Holographic Fashion Shows and Virtual Reality (VR) based entities, fabric, hair, and other innovative material too. In the subsequent discussion, we will observe the potential changes in the Fashion Industry and how they would move towards positive development by 2050.

3D printing

3D printing has been used for rapid prototyping and can now be used for printing jewelry, eye wears, and other garments. In fashion and luxury-embroidery, laces and other soft material can be developed using innovative designs.

3D printing would surely revolutionize the fashion industry. 3D printed clothes can respond to the environment, Clothes that can change their shape and design are possible to be printed. But, before you scan it, print it and wear it -make sure you are not violating any copyright or trademark. The process of verification for the violation of copyright and/or trademark would further attract more machine intelligence. Apart from fashion technology, these verification issues will also be matured by 2050.

Innovations and new materials

Other than 3D printing clothes, there are various other new innovative materials that the fashion industry is working on. There are polymer threads five times thinner than a human hair. The textile industry in the U.S. is the 5th largest contributor to CO2 emissions in the country. While 3D Printing reduces wastage and makes the fashion industry a bit more sustainable. There are materials such as Pinatex, the leather made of pineapple fiber, and there are also fashionable fabrics that can be made out of milk, tea, and coffee beans.

Researchers have also developed a coating for textiles that can heal itself and neutralize harmful chemicals. Such coatings are thin, less than a micron, so they wouldn't be noticed in everyday wear and increase the lifecycle of garments.

Fashion technology (FashionTech)

Big Data can be used to provide a premium shopping experience. Companies are tracking trends on Pinterest and Instagram -looking at what is hot and what is not. Personalized Shopping Experience with Virtual Fitting Room than allow customers to select specific garments and see how they would look wearing them. Push notifications can be sent directly to customers' mobile phones when they are around the store. Any attractive time-sensitive offer will be able to pull the customer in the store. An augmented reality product that was installed in the stores for the shoppers' convenience, is shown in the Figure 7.14.

Figure 7.14: *Augmented Reality surprises customer's fashion experience (Source: https://www.cita.org.hk/en/event/free-seminar-your-fashion-re-industrialization-partners-artificial-intelligence-ai-3d-technology/)*

Future Fashion Technology will allow you to change the color and design of your garments via touch on your smartphone for your ultimate personal fashion statement. Technology-driven fabric will be able to color in response to light, water, or temperature. Nanotechnology and nanomaterials will further create an autonomous garment that can do many things in order to adapt to the world outside. Spray-clothing for creating fabric layer directly on your skin. A great looking fashion statement for the future. Digital technologies have transformed the front-end of fashion, but the industry's less glossy back-end systems have remained relatively untouched for a long time — but now it's changing.

Wearable fashion technology

Digital fabrics with built-in sensors transmit data to the cloud and analyze them for medical or stylistic purposes. While mentioning about the shoes that connect with Google Maps are able to pair with a smartphone. When the user turns to their left or right then, they vibrate. Different vibrations are generated for different turns. The fashion industry is increasingly interested in the apparel market, reporting on rings that alert you to calls and text messages, fancy bracelets, and options that meet health parameters.

Luxury hijabs

By 2050, there will be 2.76 billion Muslims and 2.92 billion Christians worldwide. High-end fashion is already developing in the Middle East. Tommy Hilfiger, Oscar De La Renta, DKNY, H&M, Net-a-Porter, and Monique Lhuillier have all retained hijab lines for Muslim women and veils for the Christians in recent years.

Startup FashionTech

There are many new technology companies that are transforming the fashion industry. Large amounts of data can be used to improve the size calculation and sizing tools recommended when shopping online. This significantly reduces the amount of returned goods. Machine learning can be applied to product recommendations by adding style tags to different categories.

Advertising

Everything has been interconnected in the last three decades, and now more than half of the world's population is online. This means that four billion people a day spend an average of six hours using internet devices or services. The rapid pace of technological progress led some to adopt the "fourth industrial revolution" or Industry 4.0. The first revolution concerned steam power. The second revolutionized electricity and the third digitization. The block approach of the AI assisted advertisements is shown in the Figure 7.15.

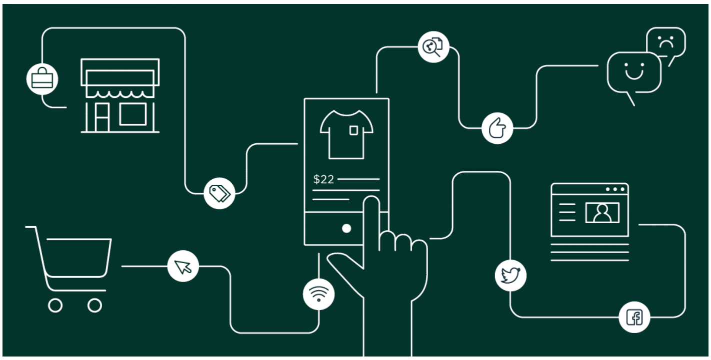


Figure 7.15: *Targeted advertisements require AI and analytics (Source: https://www.ibm.com/blogs/watson/2017/07/ai-to-ai-communication-helps-increase-brand-safety-and-drive-better-ad-performance/)*

The speed of progress is probably due to the strength of Moore's Law. In 1965, Gordon Moore observed that the number of transistors mounted on a computer chip would double every year, and for the next ten years, the power of a computer would double every two years. This calculation took exactly 50 years. Although debatable, the law has become a self-fulfilling prophecy run by big business.

Technology and advertising

Technology has changed the way consumers access information. Traditional linear media, such as television, are dazzled by an endless source of digital content available at the touch of a button. These changes in content consumption have created a "careful economy," brands no longer have to compete for differentiation; they must first compete with each other.

In 2016, digital advertising costs exceeded TV costs. Studies show that 55% of television ads do not pay attention to time. In contrast, YouTube mobile ads are more likely to attract attention. The same study found that "the attention was just as effective" with the recall of the ad, which was significantly related to the attention paid. Although Google, the owner of YouTube, funded the study, non-partisan studies show similar trends.

In a world of economy, it's not just big brands that look into technology but also every budding business. Technology has democratized the media, meaning that "good strategy, internet connectivity, and basic web design skills can now compete. With teenagers filming videos in their bedroom with webcam, technology has encouraged audiences into a size most brands don't even dream of. This shift from passive users to active content creators has led to an influential marketing era where new laws are needed to protect consumers from uncertain lines of influence.

Kevin Kelly says the trend toward media decentralization continues, with each ad reaching an integrated tracking code wherever it is viewed, and with the audience, anyone can choose to place ads on their channels. Enjoy the action of both parties.

There are two ways advertisers can attract this type of consumer:

1. **Pay for service**: Buy digital media to stream content to a specific or important audience
2. **Earn from service**: Create content that users want and want to share

As a result, the success of both companies is based on the use of quality consumer data, letting them know exactly who to contact and how to engage them. Brands have been collecting data on their customers for years, but advances in machine learning now make this information more effectively than ever.

Artificial Intelligence & advertising

Advertisements attract attention while provoking emotions in the target audience. Previously, it was almost impossible to predict its success before the campaign was broadcasted. Large-scale audience data analysis is expensive, labor-intensive, and not completely reliable. Henry Ford is mistakenly quoted as saying, "If I ask people what they want, they'll say fast horses."

However, AI facilitates evaluations that promote good decision making. It is a tool that can communicate with one user at a time, recording and analyzing all the details of this interaction. The AI can know the user's digital car, which is better than he knows.

The discussion addresses two main areas of AI is disrupting the advertising:

- How content is created
- How the content is displayed to the user

Disruption 1: How content is created

Creativity, defined as "using inventions or original ideas to create something," is a good content's central point. According to this definition, one may wonder whether artificial intelligence always contains true creativity, as we have always learned from the original human dataset. While the same argument is often applied to human creativity, Austin Klein is a proud warrior for the inheritance of "nothing is original."

However, AI technologies have been trained in an artistic mode for decades, but more recently, in the interest of media, for example, in AI-produced videos, paintings, and films. AI even competed with the creative directors to create an ad, with 46% of people thinking that humans have created rather than by AI. At the time of testing, these headlines contain considerable human support, but many believe that "the future of full automation is possible."

As an assistant, artificial intelligence is already essential to help in almost all areas of content creation; This is called augmented intelligence, where artificial intelligence takes the place of a creative role, giving it back to human creativity without replacing it. Here are examples of advanced intelligence tools for each step of the advertising agency process:

1. **Studies and perspectives**
    - **Picasso Labs**: AI creative analysis that checks brand content, company and competitors to provide information

- **Automatic Insight**: Understands readable articles in Big Data using natural language processing software

2. **Creative**
   - **Lyrebird**: Creates sound from small samples with the ability to create scripts in seconds as well as emotions.
   - **Persado**: An AI-generated copy that uses data and customization to create custom mail subject lines and social media ads.
   - **Adobe Sensei**: Enhance the smart features of Adobe products to help designers create video and images
3. **Account management**
   - **Albert**: Comprehensive AI Marketing Platform Automates Multimedia Acquisition and Multi-Channel Targeting
   - **Lobster**: Allows special searches and licensing of social media images

Disruption 2: How content is delivered to users

"Technology drives mankind to be faster," which causes a constant flow of things. Everything becomes redundant, not permanent. In advertising, this is a huge opportunity for continuous content development. For example, Facebook allows A / B testing for content using their split test ad formats.

Generative content and machine learning create customization possibilities that were previously impossible. In the past, agencies have come up with a unique and singular idea that has attracted more customers. However, AI is such an incredible idea that it can now offer a range of connected ideas, each tailored to respond individually to each user it can reach. While creating productive content has not yet generated the data to provide a unique, customized experience, brands have begun experimenting with creating multiple versions of content to test consumer groups. In addition, startups offer automated AI customization and dynamic video content.

For decades, Hollywood and the media have championed artificial intelligence as a distant vision. Cameron's 'Terminator' or Garland's 'Ex-Machina.' The third law by futurist Arthur Clarke states that "inadequate modern technology is inseparable from magic," and for many, and this is the way Artificial Intelligence feels.

However, this future has already begun in the way that "Computers are pervasive and intelligent enough to perform our most important tasks. We are surrounded by AIs and the machines that work for us". This will soon become operational, and AI is making decisions for us every day.

It's time to stop thinking about AI as a human replacement and wait for the value it can bring to new products, services, and innovations. However, it is important not to forget the moral implications. Rapid technological improvement is often motivated by greed. Everyone wants to be the first to look for money and fame, which means that the hardest served technology and employees can leave quickly.

Construction

There are many opportunities to use machine learning and AI in construction. Requirements for Information, unresolved issues are the standards in the industry. Machine learning is like an intelligent assistant who can monitor this mountain of data. He warns project managers about critical issues that need to be addressed. Many applications already use AI this way. Its benefits range from trivial spam filtering to advanced security monitoring.

10 AI examples in architecture

1. **Prevent cost overruns**: Most mega projects are over budget, even if they recruit the best project teams. Artificial neural networks are used in projects to estimate cost overruns based on project size, contract type, and project management capacity. A symbolic scenario of AI assisted construction is shown in the *Figure 7.16*.

Figure 7.16: *Loss and casualties are minimized with AI-assisted machinery (Source: http://www.constructionmanagermagazine.com//insight/how-artificial-intelligence-will-transform-constru/)*

2. Foreseeable models use historical data, such as planned start and end dates, to form actual calendars for future projects. AI helps staff remotely access real-world training materials, helping them to quickly improve their skills and knowledge. This reduces the time needed to attract new resources to projects. As a result, project execution is accelerated.AI for better building design using generative design: Building Information Modeling is a 3D-based process that provides information to architects, engineers, and construction professionals to effectively plan, design, create, and maintain buildings and infrastructure. When planning and designing a building, 3D models must take into account architectural, engineering, mechanical, electrical, and plumbing plans, as well as the order of the teams involved. The task is to prevent collisions between different subgroup models. The industry is trying to use machine learning in product design to identify and minimize conflicts between different models created by different teams during the planning and design phase to avoid replacement. The software uses machine learning algorithms to explore all solution options and create design alternatives. Machine learning is specifically done by developing 3D models

of mechanical, electrical, and plumbing systems, while ensuring that the path of the MEP systems does not touch the building but learns to offer the right solution, in each iteration.

3. **Reduce risks**: Each construction project involves different types of risks, such as quality, safety, time, and cost. The larger the project, the greater the risk, as several subcontractors work on different transactions in parallel facilities. Nowadays, there are AI and machine learning solutions that general contractors use to monitor and prioritize on-site risks. This allows the project team to spend limited time and resources on key risk factors. Artificial intelligence is used to automatically prioritize problems. Subcontractors are ranked by risk so that construction managers can work with high-risk teams to reduce risk.
4. **Project planning**: AI Startup was launched in 2018 with the promise that its robots and artificial intelligence are key to addressing late-budget and construction projects. The company uses robots to automatically capture 3D scans of construction sites and enter this data into a deep neural network that helps to rank the progress of various subprojects. If things seem routine, the management team can intervene to resolve them before small problems become big problems. Future algorithms use artificial intelligence technology called "reinforcement learning." This technique allows you to learn algorithms based on tests and errors. It can provide infinite combinations and alternatives based on similar projects. This facilitates project planning as it optimizes the best plan and corrects it over time.
5. **AI makes workplaces more productive**: Some companies have started offering separate construction machines to perform repetitive tasks more effectively than their counterparts, such as concrete pouring, bricklaying, welding, and demolition. Excavation and preparation works are done by autonomous or semi-autonomous bulldozers, who, with the help of a human programmer, prepare the site for specifications. This frees up human labor in construction and shortens the time required to complete the project. Project managers can also monitor the workplace in real-time. They use face recognition, on-site cameras, and similar technologies to ensure productivity and employee policy.

6. **IA construction safety**: Contractors are killed at work five times more often than other workers. According to OSHA, the leading causes of death in the construction industry (excluding road collisions) were reduced in the private sector, followed by the on-site electrotype and between / caught-in. With annual sales of more than $3 billion in annual sales, the Boston-based general contractor develops an algorithm that analyzes photographs from his workplace, analyzes risks related to employee safety, such as wearing protective equipment and correlating images with accident records. The company says it can calculate project risk ratings, so it can organize security briefings when dealing with high-risk threats.
7. **AI addresses labor shortages**: Labor shortages and a desire to increase the sector's low productivity are causing construction companies to invest in AI and data science. A McKinsey 2017 report indicates that construction companies can increase productivity by 50 percent through real-time data analysis. Construction companies have begun to use artificial intelligence and machine learning to better plan the supply of labor and equipment. The robot constantly monitors the progress of work and allows workstation and equipment project managers to instantly identify which sites have enough staff and equipment to implement the project. Experts expect construction robots to become smarter and more autonomous with artificial intelligence technologies.
8. **Off-site construction**: Construction companies rely heavily on off-site factories that are run by autonomous robots and that break down parts of the building that are assembled by on-site workers. Buildings like walls can complement the assembly line style with individual machines compared to their fellow human beings.
9. **AI and Big Data in construction**: Artificial intelligence systems are exposed to infinite amounts of data to learn and improve every day, but huge amounts of data are created every day. Each workplace is a potential source of AI data. Data collected on mobile devices, drone videos, security sensors, building information modeling (BIM), and images taken from others have become an information group. It offers construction professionals and clients the ability to analyze and utilize information derived

from data using artificial intelligence and machine learning systems.

10. **AI for post-construction**: Building managers can use AI when construction is complete. Building Information Modeling (BIM) stores information about the structure of a building. Artificial intelligence can be used to monitor problems and provide solutions to problems.

The AI in architecture by 2050

Robotics, AI, and the Internet of Things can reduce construction costs by up to 20%. Engineers can put on virtual reality glasses and send mini-robots to buildings under construction. These robots use cameras. Artificial intelligence is used to plan the routing of electrical and plumbing systems in modern buildings. Companies use AI to develop security systems for construction sites. Artificial Intelligence is used to track real-time interaction between workers, machines, and materials at the facility and alert supervisors to potential security issues, structural defects, and productivity issues.

Despite expectations of significant job losses, AI is unlikely to replace human work. Instead, it will change business models in the construction industry, reduce costly defects, reduce workplace injuries, and make construction operations more efficient.

Contractors must prioritize investments based on the areas where AI is most influential in the unique needs of their business and identifies the upstream direction of the transport sector and the benefits in the short and long term.

Media and entertainment

There is an obvious development that will continue to be good over the next three decades, that is, 2050. Entertainment, sports, and other activities can be a part of our lives. When we spend too much time on different devices, the social need will make to leave the house to stimulate us to spend outdoors. Tomorrow's cinematic multi-sensory experience will hypnotize the public into specially equipped rooms. The low level of digital palm tilting requires different creative grammar to engage the audience. Social media, in its current form, will disappear within ten years due to its exhaustion. Of course, a new replacement has emerged. More and more, immersive entertainment is one thing. Enhanced Virtual Reality (VR) and holography are commonly used to create streaming content. Virtual reality functions that have become part of media and entertainment is symbolized in the Figure 7.17.

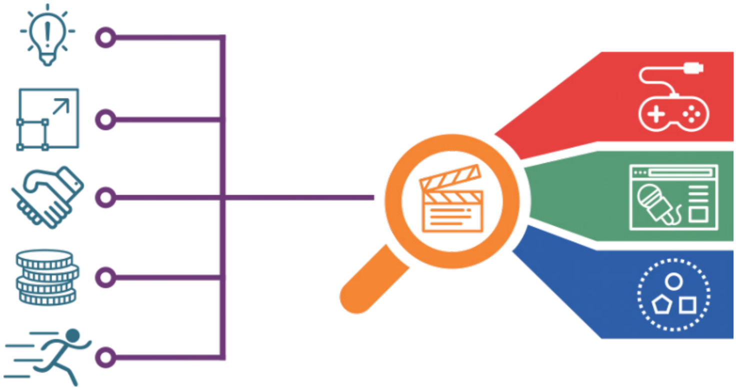


Figure 7.17: *Media houses adapt Virtual Reality for the viewers' better experience (Source: https://qualityhouse.com/index.php?page=by-industry-media-and-entertainment)*

Rob International Telecommunication Consultant IBM Van Rob said in a recent report: "In extreme weather, winners can be newcomers who move fast or strengthen the traditional core and are ready to adapt and change." If a company needs a success, it has to apply few potential changes in its business models, redesign its manufacturing site, unload minor processes, and get rid of the non-core tasks to take a new position in a changing strategic landscape and be a mark to dominate the changing industry. "Convenience, context, cost, retention, and creativity are the driving force for the coming decades.

Whether it is the industrial revolution of the last century or the digital revolution, change is inevitable. By 2050, there will be 9 billion people for food, clothing, transport, employment, education, and recreation. This goal is in harmony with tomorrow's inventors. Our current social fabric is changing. New associations are emerging that are beyond our current knowledge. New professions, new lifestyles, and personal mobilization create the media and entertainment of the future.

Evolution in StoryTelling: Augmented Reality, Virtual Reality, and First Responders

Storytelling is changing - in the media and entertainment industry, as different forms of storytelling experience improve, the number of delivery vectors continues to grow. In a radical way, the audience is enjoying the select-your-own adventure stories about Netflix, War prone Star Wars on iPhones virtual reality games and first-person stories, and "shift person stories." The industry is evolving through a selective development period.

The basis of artificial intelligence and cognitive computing

The development of cognitive testing - the rapid advancement of cognitive computing and artificial intelligence accelerates innovation in consumer products, organizations, and entertainment. Using the metaphor Test Kitchen is enriched to discuss how technology can be used to research and innovate ingredients - from cupcakes to wedding cakes.

Upgrading skills - increasing the capacity of the studio by 2050

Skills upgrading - Agencies and studios wishing to compete in the booming "new media" industry need to build capacity and culture for change. The type and composition of talent needed to broadcast non-traditional media in 2050 are very different from today. Storytellers need to develop their skills, and technicians need to connect and develop technology without losing key artistic and narrative elements. In this section, we will explore what it can be like to test early users and experience with successes and failures.

Digital people and digital assistants - Evolution of technology and ideas

Popular communications agents like Alexa from Amazon have paved the way for digital humanities and sophisticated digital assistants. What used to be pure science fiction (KITT, HAL, Ash, Jarvis, and TARS) is now closer than ever. As space matures into the second generation of "cognitive wings," we will explore similar questions:

- What do they look and sound like?
- How do they move and behave?
- What access should they have to their personal information?

The architecture of empathy systems - empathy and emotional intelligence

Identity, empathy, and emotional intelligence can support use cases and improve user experience. Signal acquisition services such as tone and emotion analyzer, understanding the natural language, adaptive natural language classification models, sentiment analysis, personality standard modeling, and mapping techniques can provide systems to adapt to user emotions and situations and responses.

Characters and content - New world and new channels

Studios and media are worth billions of dollars. For example, the Marvel Cinematic Universe (MCU) bought Disney for $4 billion in 2009 and earned more than $ 11 billion in cash. From the user experience to the financial aspects to the discovery of potential, we explore the potential for new technologies and media vectors for literally active studios. Is your own augmented reality "Jarvis" as a cognitive wing a valid proposition? If so, how much is it worth, and why?

Legal

There are thousands of cases around the world, and every year judges make at least questionable court decisions. Even the best human judges suffer from a variety of biases and prejudices, ranging from the difficulty of following a growing legal system to omissions and failures, but can be destroyed by corruption and other profitable systems. widespread.

Is there a way to avoid these failures? Create an impartial and corrupt judiciary? At least, in theory, some think that robot judges can make impartial courts a reality. In fact, the idea of an automated judgment system has been seriously debated by inventors in the legal and technical world. Robot judges are part of the automation trend and are slowly entering all stages of our legal system. For example, let's look briefly at policing.

Automatic application of the law

The discussion focuses more on automated policing. Eventually, the discussion would be useful to model some of the emerging technologies so that they can be automatically executed over the next two decades.

Video surveillance throughout the city

This technology is already widely used in cities around the world, especially in the United Kingdom. In addition, reducing the cost of durable, unremarkable, and web-based HD camcorders increases the number of surveillance cameras on our streets and in public and private buildings over time. A symbolic AI assisted judicial system is shown in the Figure 7.18.

Figure 7.18: *AI helps the Judiciary department to solve pending cases (Source: https://www.mtlblog.com/news/canada-is-testing-a-controversial-new-artificial-intelligence-based-legal-system)*

New technical standards and regulations are also being introduced that will allow police services to take camera pictures in private.

Advanced face recognition

Comprehensive technology for city CCTV cameras is now advanced face recognition software developed around the world, including the United States, Russia, and China. This technology will soon allow real-time detection of people captured through the cameras, making it easier for missing people, refugees, or suspected future programs.

Artificial Intelligence and Big Data

The combination of these two technologies will allow artificial intelligence to retrieve big data. In this case, big data is the ever-increasing number of CCTV footage associated with face recognition software that continuously tracks the faces of those who appear in CCTV footage.

In this case, Amnesty International adds value by analyzing images, identifying suspicious behavior or identifying known insurgents, and then automatically assigning police officers to the area for further investigation. Finally, this technology automatically tracks the accused throughout the city, collecting video evidence of his behavior without telling him what they see or follow.

Police drones

Implementing all of the above advancements would be in the form of a drone. Consider this: the aforementioned artificial police intelligence can use many drones to execute strings at the top of hot spots for suspicious crime. Artificial intelligence workers can use these drones to locate suspects throughout the city. In the event of an accident, a police officer can be used to prosecute suspects before causing any material injury or potential physical injury. In the latter case, the drones are armed with tasers and other non-deadly weapons that have already been experienced. If you add self-driving police cars to the crime scene, these drones can complete the arrest without a one-man police officer.

The various aspects of the automated enforcement system described above already exist; All the remaining sophisticated AI systems shall be applied to deliver a juggernaut that blocks crime. If this level of automation is possible by law enforcement on the street, can it also be applied to the courts? To our penalty system?

Algorithms replace judges to punish offenders

As noted above, human judges are subject to a wide variety of human errors that can affect the quality of the judgments they make every day. It is unlikely that it will slow down the idea of robotic litigation. In addition, the technology for automatically judging is not that far off.

Original design requires the following conditions

1. **Voice recognition and translation**: If you have a smartphone, you have tried to use a personal help desk like Google Now and Siri. When using these services, keep in mind that each year that passes, these services better interpret your orders, even with a fine accent or a broad background. At the same time, services like Skype Translator provide even better real-time translation year after year. By 2020, most experts expect these technologies to be perfect, and as part of the trial, an automated judge will use this technology to gather the necessary oral action.
2. **Artificial Intelligence**: Along with the above application, if you use a personal help desk like Google Now and Siri, you should consider that these services are of higher quality each year to provide you with correct or helpful answers to your questions. Indeed, the artificial intelligence systems that power these services are evolving at the speed of light.
3. Microsoft's Ross works as a digital legal expert with the inclusion of AI. Now the lawyers can now pose the questions to Ross in simple English. Subsequently, it will analyze the entire law and returns the answers and the actual works quoted in the legislation, law, and secondary sources. Any legal system of this caliber with AI will take more than a decade to develop as a trusted mediator and judge, not as a legal assistant.
4. **Digitally coded legal system**: The current law, intended for human eyes and minds, needs to be reformatted in a structured,

machine-readable (questionable) format. This allows Amnesty International lawyers and judges to effectively access relevant court documents and testimonies and then process it all through the checklist or scoring system that permits judgment / fair punishment. Although this renovation project is in progress, it is currently a manual process that will take years to complete for each jurisdiction. On the positive side, these artificial intelligence systems are widely accepted by lawyers, allowing them to create a standardized form of human-readable and machine-readable legal documents written by companies today. By 2050 this system becomes much matured so that the system can be comprehensively called as, AI Judge.

5. Between the late 2040s and mid-2050s, Amnesty International judges would be able to rule on common lawsuits such as road traffic offenses (using autonomous cars), alcohol intoxication, theft, and violent crime, with testimonies and very clear sentences in black and white. At a time when scientists had perfected the mind-reading technology, these Artificial Intelligence judges could also apply for more complex cases involving commercial litigation and family law.

Gaming

Consider the IGN crystal ball who knows everything and sees everything. What is the scope? What will the game look like by 2050? It may seem like a very long time, but it still gives life to games like movies - and it hasn't changed other forms of art and entertainment.

Here we have to consider some general factors, including the robot uprising. These changes can be compared to the transition from silent films to HD experiments in contemporary colors. Moore's Law is a crucial point that basically describes the annual doubling of processing power in terms of memory expansion and cost reduction. Prospective people prefer to use this law as a guide to the birth of a supernatural - or "singular" - artificial intelligence. These two main factors have a direct impact on the game. They affect everything from the game's artificial intelligence to human interaction with the game world - and defining the game.

Augmented Reality

We are looking at Augmented Reality (AR), the idea that the world can be seen and changed by camera and screen, but by 2050 some obstacles will not be discovered. For beginners, RA games usually require watching the world with a handheld device or seeing you there. Games like AR Games Suite from iPad or Nintendo 3DS provide examples of current activity. However, we are limited by connectivity, processing power, and reachability. Through some sort of universal wireless broadband access, we are connected. 4G broadband networks are starting to hit, providing players with the broadband connection they need. A future gaming experience is depicted in the Figure 7.19.

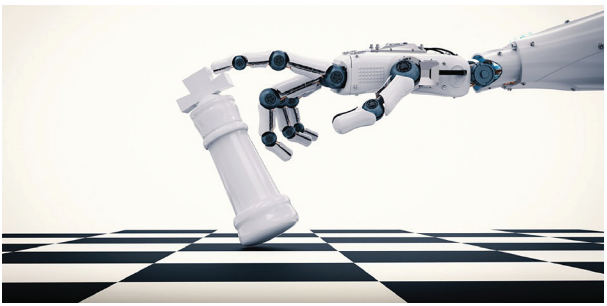


Figure 7.19: *AI machines are growing faster to surpass human intelligence (Source: https://artificialintelligence-news.com/2018/12/10/ai-alphazero-best-game-player/)*

Fifty years on, retina screens or transparent game boards allow them to see the horizon, a basic technology, and cover enemies, virtual people, and buildings with what you see. By syncing with global satellite mapping systems and GPRS, which are always connected, players can coordinate real-world RPG blower attacks in parks and start zombie hunting in the streets and in their true locations in the city.

Artificial Intelligence

Due to the increased processing power and ability to handle parallel clock speeds, the birth of self-taught, adaptive, and self-conscious AI can take 50 years. The player will not always accept the challenges the game decides, but what happens if the game learns and changes constantly depending on your actions? We've seen the first steps towards this kind of thinking in games like Left 4 Dead, where the Director's artificial intelligence system adapts to wave density, enemy elements, and difficulty.

In the future, playing with your AI friend can be a deep social experience, and playing with someone online is almost indistinguishable. In the case of Call of Duty or Battlefield style shooters, AI teammates can have a meaningful conversation with you by tailoring the look of their appearance to your performance or what's happening in the game.

In the context of an open-world adventure, other heroes may begin to take a realistic view of your gaming habits and lifestyle and approach you with a different strategy. If you have hip-hop, fast cars, and the main player in your social network, nice-looking females, AI can make adjustments based on your personality and adjust accordingly.

In fact, mixing AI and offline makes the gaming experience even more complicated. Who you are and what you do affects how the game treats you, the challenges you face, and the people you contact? This does not always apply to all types of games. For example, it is difficult to describe a Super Mario Galaxy-style platform game that utilizes a player's in-house knowledge. However, when game designers try to refer to the reality and craft worlds that work just like us, these kinds of social overlapping points seem logical, even if they are scary.

Input devices

In addition, we already see the impact of new control methods and input devices. Nowadays, various capacitive touch-sensitive devices like the Wii, Move, and Connect, as well as iPads and iPhones, have radically redefined the gameplay. To imagine what has happened in the last fifty years is truly breathtaking. One thing is clear - touch and responsiveness are important - and now motion control is still scratched, and joysticks and knobs are still players that need precision.

However, it can be a different story in 50 years. Playing touch screen surfaces is waiting to take over - and it comes with how the screens respond to the tips of your fingers and hands. We have experienced the discovery of haptic control input (Novint's Falcon Standalone Device), and haptic displays are still superbly customized. The idea is that the surface offers physical resistance to the touch of a finger. Moving the lever will make you feel the screen surface drag.

In the future, when this technology is improved, expanded, and cost-effective, players will find all sorts of ways to make the practice fun and exciting. By combining it with augmented reality and holography as well as sonic pressure, you can simulate a holographic projection that physically touches it.

If, after fifty years, Nintendo decides to build a three-point 3D projector in their hand and supply gloves tracked in three-dimensional space, we can interact with photorealistic objects and see the world with augmented reality. The potential for insanity.

Graphic and design

In addition to graphic processing, artistic skills will be required to rescue supermen like Savant Jobs. So as soon as we reach a plateau where visual performance diminishes, games need to become smarter over 50 years by 2050. Photorealism changes nothing anymore - and it focuses on artistic advancement and intelligent AR integration. After 10 to 20 years, game consoles and PCs will be treated to games that are no different from reality. We hope that the physics of the game and the way the world reacts to you will also be one of the most important features of future game design. Combining physical input with instant feedback to the real world and great game physics suddenly opens the door to all sorts of new experiences. Imagine exploring a virtual store, picking up tanks, opening doors, and securing lockers - all while using your hands in the new, sophisticated Kinect-type interface. How the world reacts - as it looks - is so important to game developers in their fifties.

Delivery

There is no doubt that boxed games today are similar to books. Retail is still the main way to buy games, but are there alternatives, and how many shelves do you have? It's a sad thing: the death of the box art, the manuals, and the smell of this "new game." But unfortunately, this is the direction we are moving on. As physical retailers begin to stumble upon the era of digital game downloads, the trend is continuing. At first, there are some mistakes that need to be overcome. More seriously, how are video game retailers going through transformations? Should they continue their business as online brokers with services such as Steam (Valve Software Developer Market)? Or are companies like Nintendo, Microsoft, and Sony creating more persistent direct download solutions that completely reduce retailers?

When this happens, retailers disable hardware storage - why bother since? Where's the money? Of course, by 2061, we will reach a point where your game history would be over 5 years - and this hardware requires very little innovation. These computer hardware manufacturers can stick to Apple's model and manage their own outlets or even sell them through licensors.

In any case, as the broadband infrastructure improves, and people continue to demand on-demand gaming experiences, the landscape will adapt to this trend.

Future Hero

At a time when pixel-less heroes could flourish, the industry was creating superstars. In fact, some are more permanent than others; Mario and Luigi have stood the test of time for almost 30 years. Sonic ran 20 races without any difficulty. Lara Croft - in various forms - has also left an indelible impression on the industry. Then there are modern heroes - Master Chief has earned stripes, and Gordon Freeman's silence tells more than a dozen other shooter heroes. Solid Snake - Well, he is young, old, monocular, and pretty much everyone.

But what about the future? Where do game designers get inspired over 50 years? There will probably always be Mario games - and happy franchisees will always create characters that will appeal to all ages. However, as the gaming industry begins to look to the future, there will also be artists and larger characters. They begin to create characters and scenes that are closely related to our future.

It's no coincidence that we're seeing a proliferation of games that get you into the middle of the game using your avatar on your Xbox 360, Mii Wii, or your player profile. You start talking to yourself digitally. Following this path, our continuous playback recording begins to shape our experience. By combining all of the above with your avatar, you suddenly become a true digital hero with all sorts of games to your credit.

So, in 50 years you will become a star. With all kinds of touch, you can live your adventures in the great augmented reality. The platforms are very powerful, sophisticated, and a part of your daily life.

Summary

This chapter has introduced various concepts to the reader, especially the state of Artificial Intelligence and the Internet of Things by 2050. The chapter consists of the insight discussion on AI and IoT applications ranging from healthcare to fashion design.

After reading through this chapter, readers would be familiarized with the pervasiveness of AI and IoT by 2050.

Questions

1. What are the apprehensions that are expressed by the health activists, when AI was integrated with healthcare applications? Are their apprehensions have proven correct? Explain your observations.
2. What are the side effects on the life-ecosystem with the usage of AI-WSN combination in the farming sector?
3. Psychologists have warned the societies and the AI researchers that usage of AI in the education sector would create a biased education when used recommender systems, which would further lead to passiveness in the students' creativity. What is your view on this warning?
4. In the recent past few of the G5 countries have expressed their concern over using AI-based warfare in the battlefields. From your understanding what could be the adversities that have made these countries to develop a policy to stop AI-based warfare?

Do some research

List the computer games which are AI-based. Shortlist those games which were existing without the implementation of AI. Understand the difference between those games when they weren't with AI versus when they are integrated with AI. What are the key enhancements? Are those enhancements to help only to increase the speed in decision-making or to help the players to enhance their knowledge over game-strategy?