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PERUNDURAI -638 057, TAMILNADU, INDIA.



DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE TITLE

**DATA-DRIVEN IOT: APPLICATIONS OF MACHINE
LEARNING IN CONNECTED SYSTEMS**

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1.IOT AND MACHINE LEARNING

1.a.Introduction to IOT and IOT Development

IoT comprises things that have unique identities and are connected to internet. By 2020 there will be a total of 50 billion devices /things connected to internet. IoT is not limited to just connecting things to the internet but also allow things to communicate and exchange data

Characteristics

- 1) Dynamic & Self Adapting: IoT devices and systems may have the capability to dynamically adapt with the changing contexts and take actions based on their operating conditions, user's context or sensed environment. Eg: the surveillance system is adapting itself based on context and changing conditions.
- 2) Self Configuring: allowing a large number of devices to work together to provide certain functionality.
- 3) Inter Operable Communication Protocols: support a number of interoperable communication protocols and can communicate with other devices and also with infrastructure.
- 4) Unique Identity: Each IoT device has a unique identity and a unique identifier(IP address).
- 5) Integrated into Information Network: that allow them to communicate and exchange data with other devices and systems.

Applications of IoT:

- 1) Home
- 2) Cities
- 3) Environment
- 4) Energy
- 5) Retail
- 6) Logistics
- 7) Agriculture
- 8) Industry
- 9) Health & LifeStyle

1.b.Main components used in IoT

These are some techniques related to Internet of Things:

1. Radio Frequency Identification (RFID): It uses radio waves to transmit the identity of the object wirelessly in a serial number format. RFID technology plays an important role in the IoT to solve the identification issues of objects. It is classified into three categories based on the processing method, namely active, passive, and semi active. RFID consists mainly of tag, reader, antenna, access controller, software, and server. It is useful to carry an automatic definition and assigns a unique digital identity to everything for the purpose of subscribing to a network. It is reliable, efficient, cheap, and accurate. It is included in



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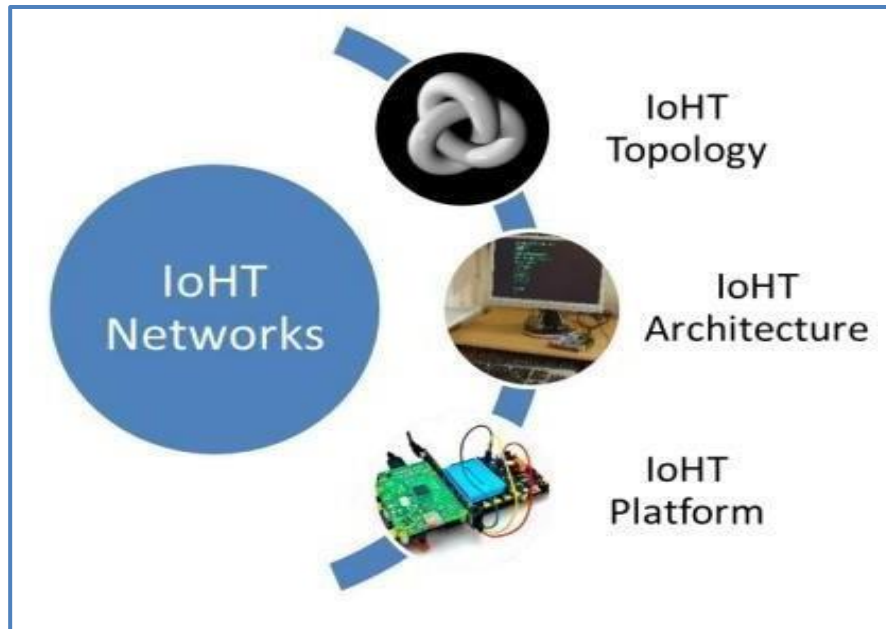
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many wireless applications, such as traceability, patient monitoring, and military applications.

2. **Electronic product code (EPC):** This is a 64bit or 98-bit code that electronically registers on an RFID tag and is designed to improve the design of the EPC bar code and store information about the EPC type, product serial number, product specification, and manufacturer information. It consists of four components, ONS Object Naming Service, EPCDS Discovery service, EPCIS Information Service, and EPCSS security service.
- Barcode:** This is a different way of encoding numbers and messages using a set of bars and spaces with different widths. The barcode is an optical machine-readable label placed on items that records information associated with the item. There are three types of barcode, Alpha Numeric, Numeric 2, and Dimensional. It is designed to be readable by machine but can be read with laser scanner or cameras.
3. **Internet Protocol (IP):** It is the primary network protocol used to connect data migration across the perimeter and network boundaries. There are two versions of IP presently in use: IPV4 and IPV6. IPV4 is currently used on the Internet.
4. **Addressing scheme:** In the Internet of Things, the connections between things are created for the purpose of establishing a smart environment. Thus, all objects must be uniquely identified and their location and function must be known. This is important for the purpose of digitizing all entities associated with Internet of Things and everything is identified with a unique number that distinguishes it from other things for the purpose of remote control over the Internet. This is important for the IoT success. Reliability and scalability are also important, as is individuality, all of which address key needs for developing a unique addressing scheme. IPV4 assigns a range of sensors to be geographically defined. IPV6 is also a good option to remotely access sources in a unique way.
5. **Wireless sensor network:** It is a wireless network consisting of distributed devices that use smart sensors to form a set and cooperate in monitoring physical or environmental conditions, such as temperature, sound, etc. The collected information is sent to a centralized system for analysis.
6. **Wireless Fidelity (WI-Fi):** This is a networking technology that allows computers and other devices to communicate via a wireless signal.
7. **Bluetooth:** This is a cheap wireless technology utilizing short-range radio waves.
8. **ZigBee:** A protocol developed to improve the advantages of wireless sensor networks.
9. **Near Field Communication (NFC):** This wireless technology is short-term.
10. **Middleware:** The middle layer plays an important role in the connections and interconnections between objects and the application layer, because there is the difference and multiplicity of things used in the Internet of Things, in addition to the restricted storage and diversity of applications. This layer facilitates the integration of functions and communication between connected devices. In addition, it allows for data storage, analysis, use of appropriate software to use data smartly and take appropriate automatic decisions.
11. **Actuators:** These are found in the physical layer and convert the energy into motion. There are three types of actuators, hydraulic (which use a hydraulic fluid), the electric (use the electric current), while the third type uses compressed air. The movement is

linear, circular or pulsed, covering small distances, up to 30 feet. Connected to less than 1 Mbps (1, 8, 18).



1.c. Working with IoT Devices

The following steps show how the IoT works:

1. Information is obtained from the sense of identified and connected things, such as humidity, temperature, vibration, movement, direction, acceleration, chemical changes in the air, etc., depending on the type of sensor. Different sensors can be combined to design a smart service.
2. Trigger of the action, the information received from the object is processed by a system or intelligent device that determines the automatic action to be invoked.
3. There is a mechanism of feedback to the administration by the device or the smart system about the state of the general system and evokes the results of the acts (2)

1.d. Machine Learning And IoT In Healthcare

An intelligent home-based wireless medicine box with an android (Health-IoT) application was reviewed and detailed by the authors in order to improve communication between patients and doctors. On the suggested platform, a smart medicine box is available that notifies patients when it is time to take their medication. To provide prompt notifications of medications informed to the patient's mobile in the Android software, the box features wireless internet access. The patient receives the proper medicine at the appropriate time thanks to the machine's automated warning. Additionally, the preset protector gets SMS alerts if any critical indications change. While [10] in their paper proposes a technique or framework for monitoring patients'



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medicinal usage. Similar to the International Journal of



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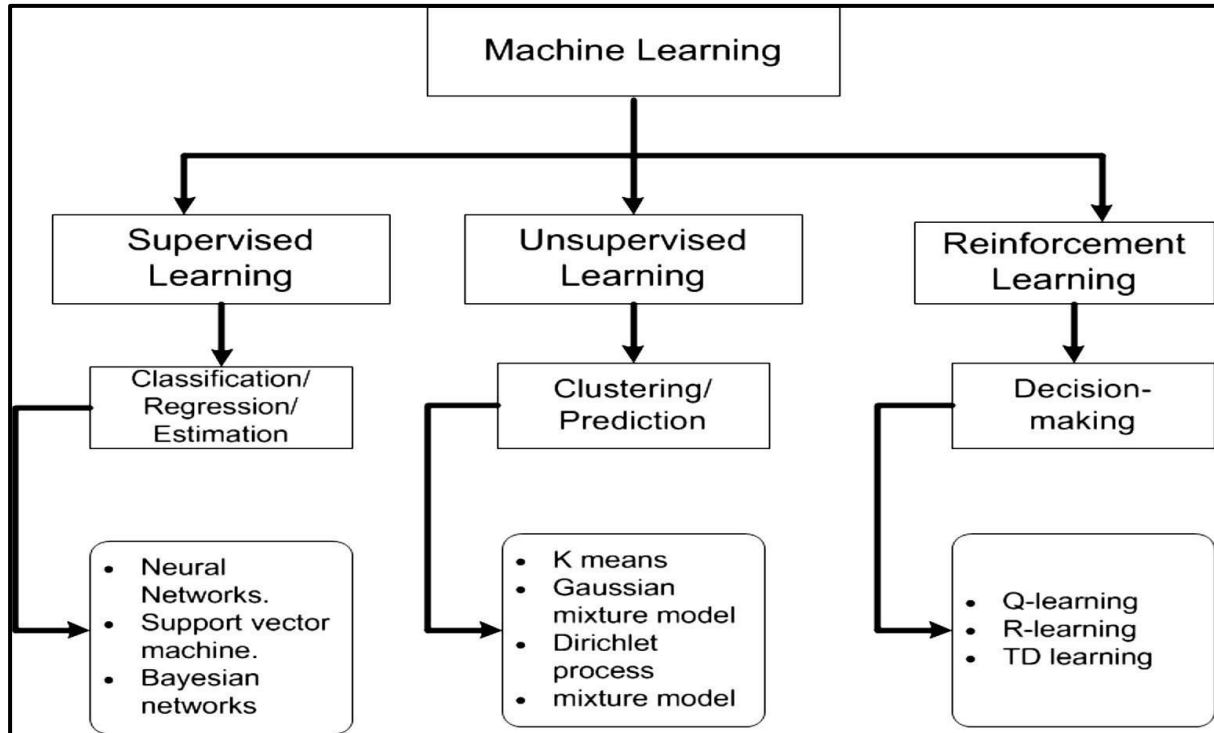
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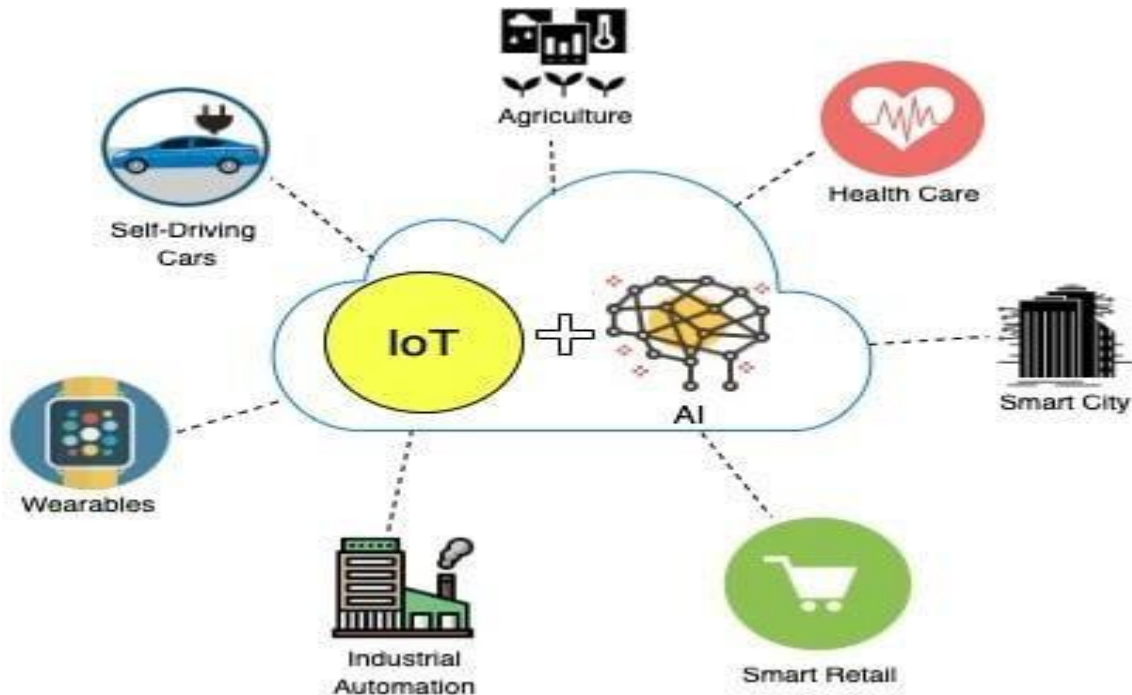


Pure and Applied Mathematics, it provides frameworks for the distribution of prescription medications and the tracking of prescription histories.



1.e. Uses Of Machine Learning And IoT

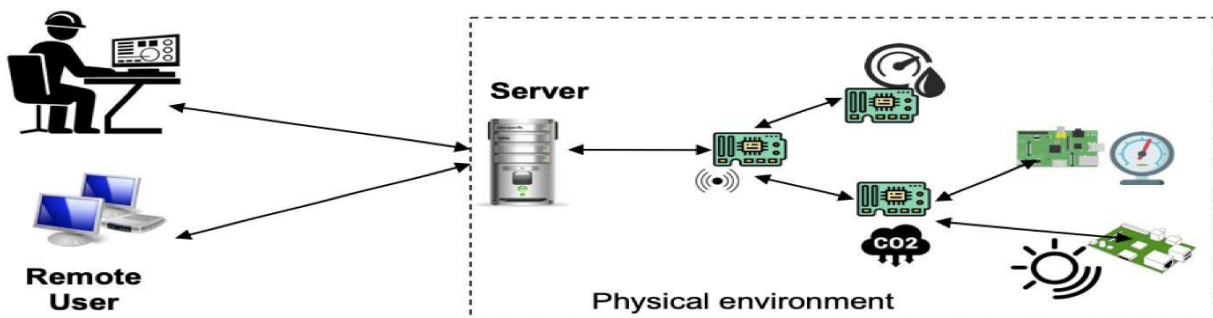
Machine learning can help demystify the hidden patterns in IoT data by analyzing massive volumes of data using sophisticated algorithms. Machine learning inference can supplement or replace manual processes with automated systems using statistically derived actions in critical processes.



2.IOT– HARDWARE

2.a. IOT Server

The most important hardware in IoT might be its sensors. These devices consist of energy modules, power management modules, RF modules, and sensing modules. RF modules manage communications through their signal processing, WiFi, ZigBee, Bluetooth, radio transceiver, duplexer, and BAW.



Devices	
accelerometers	temperature sensors



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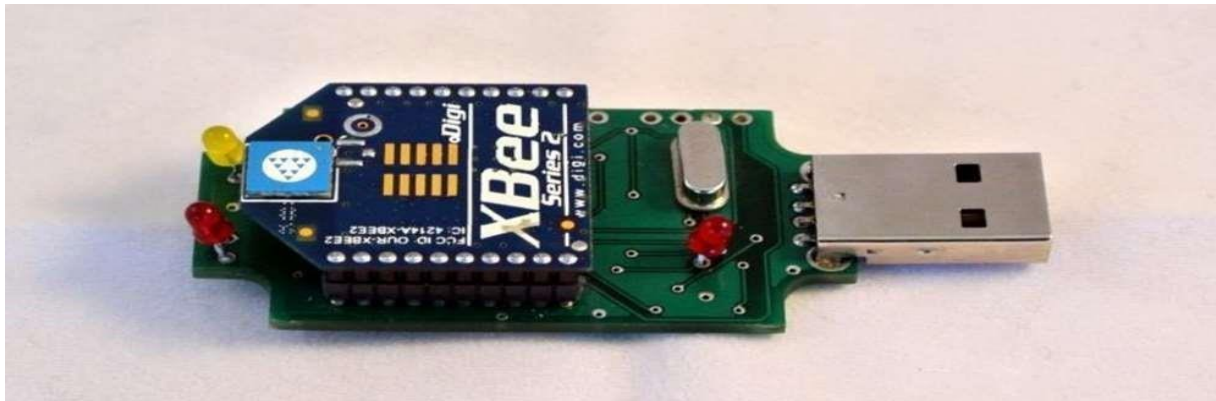
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magnetometers	proximity sensors
gyroscopes	image sensors
acoustic sensors	light sensors
pressure sensors	gas RFID sensors
humidity sensors	micro flow sensors

IoT – Sensors



2.b. Wearable Electronics

Wearable electronic devices are small devices worn on the head, neck, arms, torso, and feet.





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Current smart wearable devices include:

- **Head** – Helmets, glasses
- **Neck** – Jewelry, collars
- **Arm** – Watches, wristbands, rings
- **Torso** – Clothing, backpacks



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- **Feet** – Socks, shoes

2.c. Standard Devices

The desktop, tablet, and cellphone remain integral parts of IoT as the command center and remotes.

- The **desktop** provides the user with the highest level of control over the system and its settings.
- The **tablet** provides access to the key features of the system in a way resembling the desktop, and also acts as a remote.
- The **cellphone** allows some essential settings modification and also provides remote functionality.

Other key connected devices include standard network devices like **routers** and **switches**.

2.d. Application and Process Extension

The **Process Extensions** node lets you define custom actions that extend the functionality of the Agile PLM system. The custom actions you define can be used to create custom reports, user-driven and workflow-triggered custom actions, and custom tools accessible through Agile PLM clients.

A Process Extension (PX) is either a Java class deployed on the Agile Application Server or a link to a URL. The URL can be a simple website or the location of a Web-based application.

There are two types of process extensions available in Agile PLM:

- *Custom process extensions* (Custom PX) is a general name for PXs created in **Data Settings > Process Extensions** node. These PXs have limited initiation capability. This node continues as the site to store and manage your custom PXs.
- *Event-based process extensions* (Event PX) are created in the **System Settings > Event Management > Event Handlers** node. For more information about Event-based process extensions.

There are several integration points for process extensions available in Agile PLM clients. You can invoke process extensions from the following areas:

- Actions menu
- Tools menu
- Workflow Status
- External reports
- Dashboard – URL-based process extensions that are created with Dashboard as the integration point are listed in the Dashboard Extension field, while a Dashboard table with View Type List is created. The output of the URL-based process extension is displayed in the Dashboard table.



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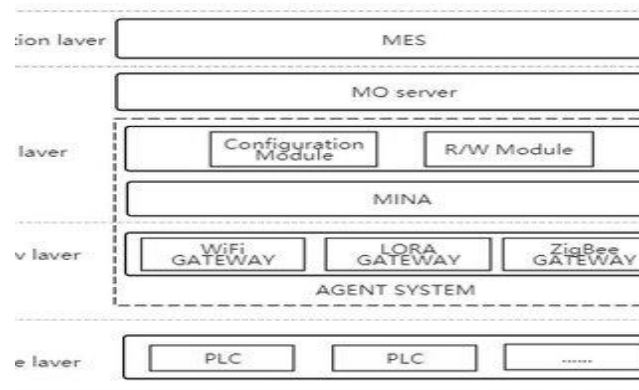
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2.e. Device Integration

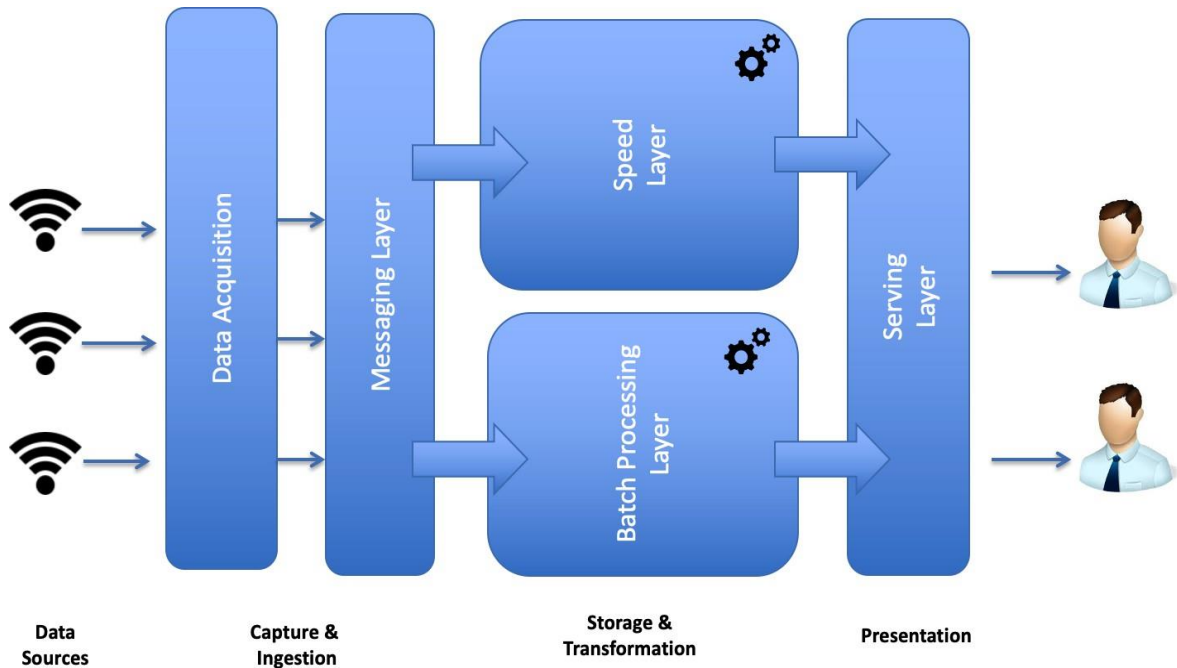
The service of devices integration is an agent-base devices integration framework, which is easy for SMEs to make information transformation. Per the informational level, the devices are divided into devices with supporting information control system, devices that provide reserved communication modules such as DNC network card, macro instruction, PLC communication module, etc., and devices which have no access module. The device integration service provides corresponding device access modules for these three types of devices to achieve positive access.



The device integration service based on Agent technology can realize unified access to various types and models of devices in the shop floor. If SMEs need to update or upgrade a device, they only need to perform positive integration with the device access module in the device integration service according to the informational level type of manufacturing device. From the perspective of MES, the message queue MQ, the declarative service call framework, and the MQTT can be used to implement communication problems between the Agent service and other application systems or cloud applications.

2.f. Real-Time Analytics

It seems like the world moves at a faster pace every day. People and places become more connected, and people and organizations try to react at an ever-increasing pace. Reaching the limits of a human's ability to respond, tools are built to process the vast amounts of data available to decision makers, analyze it, present it, and, in some cases, respond to events as they happen. The collection and processing of this data has a number of application areas, some of which are discussed in the next section. These applications, which are discussed later in this chapter, require an infrastructure and method of analysis specific to streaming data. Fortunately, like batch processing before it, the state of the art of streaming infrastructure is focused on using commodity hardware and software to build its systems rather than the specialized systems required for real-time analysis prior to the Internet era. This, combined with flexible cloud-based environment, puts the implementation of a real-time system within the reach of nearly any organization. These commodity systems allow organizations to analyze their data in real time and scale that infrastructure to meet future needs as the organization grows and changes over time.



3.RECENT MACHINE LEARNING

3.a. Knowledge Hierarchy

The friendliest of the four terms is “information.” Information literacy refers to information-seeking behaviors, information-seeking strategies, and information sources. Given the context in which the student writing a term paper for a class is sent to the campus library to find “information,” and that the pertinent sources of information to be found in such a library are in the form of commodified and reified documents, in this model “information” is delimited to the intellectual content of these commodified and reified documents. Students are seeking documentary information found in texts, regardless of the communication technology employed in reifying and then accessing those texts. Data may be inferred from the information, and one way or another, depending on the discipline, it should be verifiable. Some research methods work inductively from data to form conclusions; other methods deduce the data from the conclusions. Defining knowledge is also problematic. Epistemologists will never run out of issues to debate, so I will use as a “caption” the classical definition of knowledge: “justified true belief.” Drawing on terminology coined by Lyotard (1984), I suggest that wisdom be tagged as “knowledge legitimized by performativity.” Justified true beliefs find expression in action, and these actions can then be evaluated and assessed.



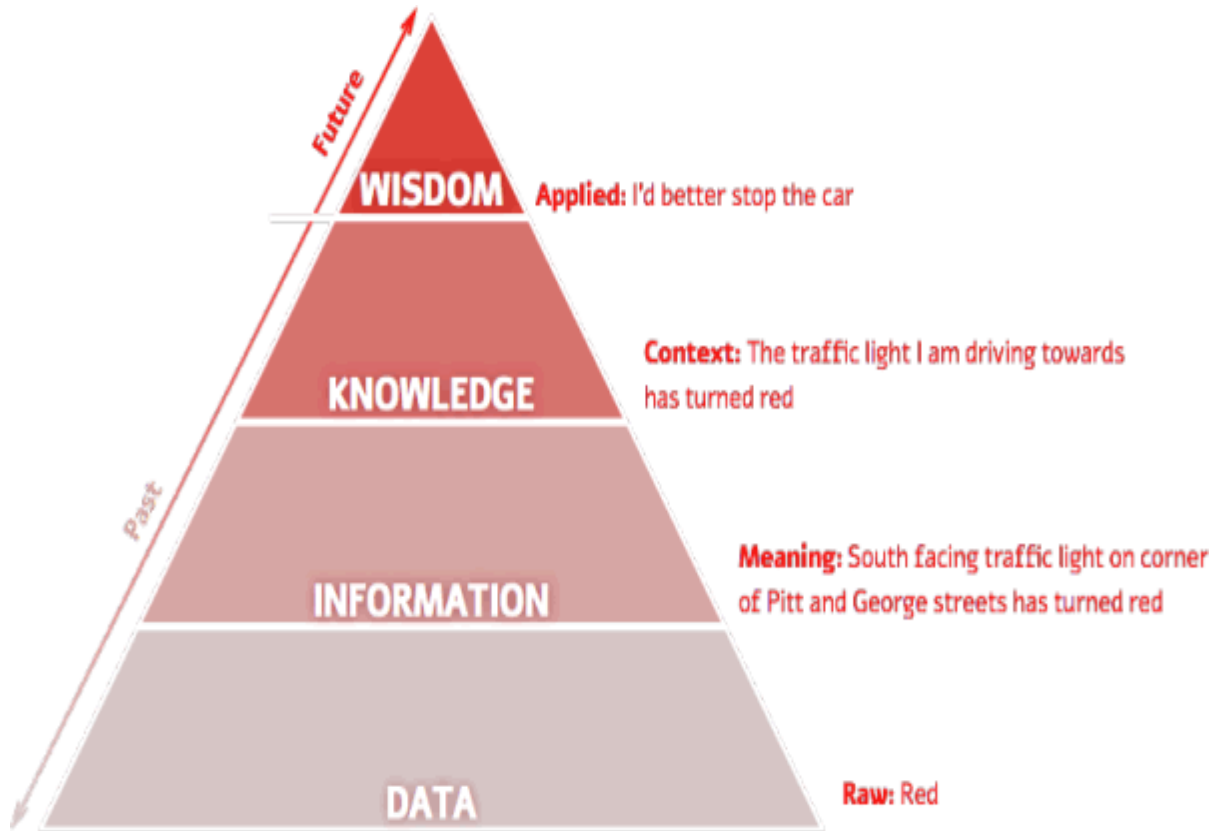
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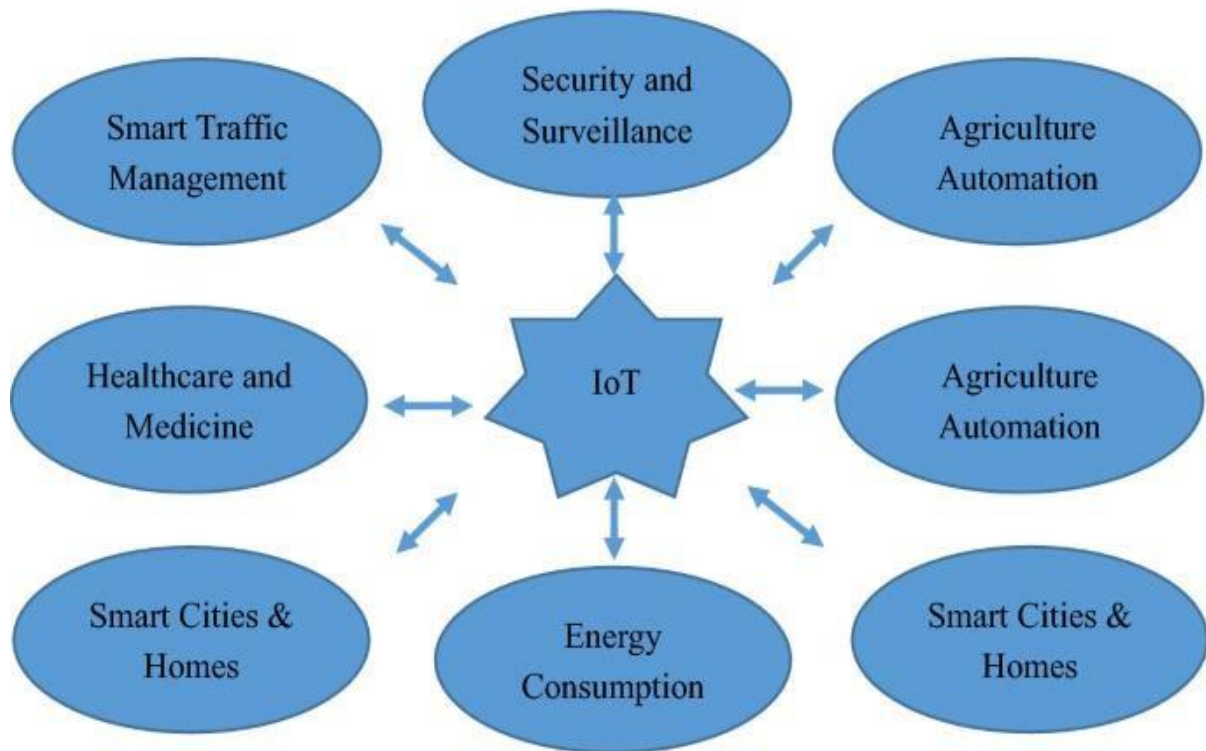


3.b. Technology Challenges in IoT

Technologies shape our modern life in one way or another. Out of many promising technologies is the internet of things (IoT). The term 'IoT' formed and appeared in 2002 from the title of a Forbes article by Kevin Ashton, when he said: "We need an 'internet-for-things', a standardised way for computers to understand the real world".

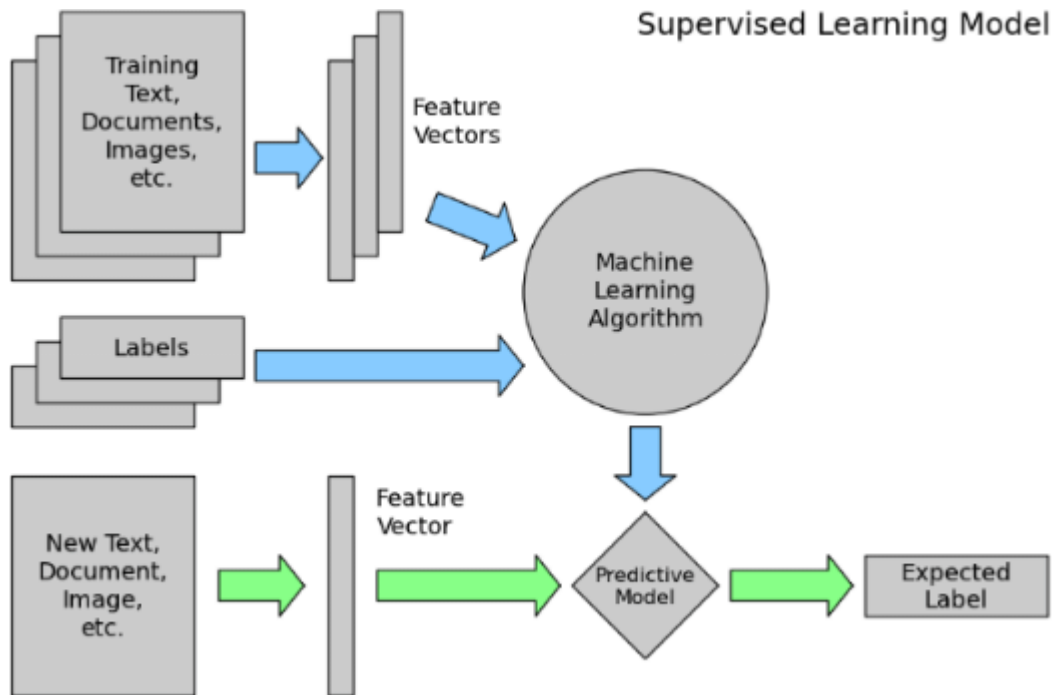
- Provide in-depth study towards the state-of-the-art of major IoT challenges and issues that need to be tackled in order to fulfil the requirements of full, functional, and safe deployment of IoT scenarios in our daily activities.
- Provide readers of what have been done or proposed to address those IoT challenges and issues and what still remains to be addressed.

The rest of this paper is organised in many sections as follows. Section 2 presents the main challenges and issues that limit the reliable global use of IoT. Section 3 presents a number of IoT standards and protocols along with their challenges and issues. Section 4 presents the technical and operational IoT challenges and issues. Section 5 presents data and software challenges in IoT.



3.c. Introduction to Machine Learning (ML)

Machine learning can appear in many guises. We now discuss a number of applications, the types of data they deal with, and finally, we formalize the problems in a somewhat more stylized fashion. The latter is key if we want to avoid reinventing the wheel for every new application. Instead, much of the art of machine learning is to reduce a range of fairly disparate problems to a set of fairly narrow prototypes. Much of the science of machine learning is then to solve those problems and provide good guarantees for the solutions. Over the past two decades Machine Learning has become one of the mainstays of information technology and with that, a rather central, albeit usually hidden, part of our life.



3.d. Algorithms

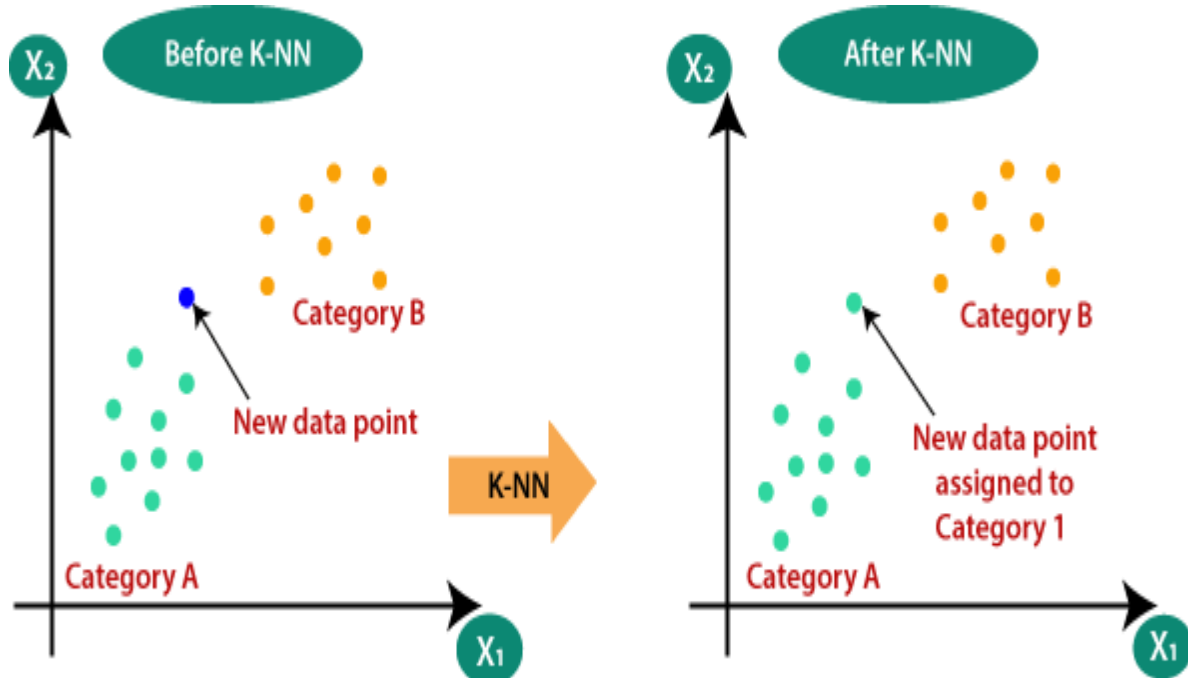
The paradigm of machine learning and artificial intelligence has pervaded our everyday life in such a way that it is no longer an area for esoteric academics and scientists putting their effort to solve a challenging research problem. The evolution is quite natural rather than accidental. With the exponential growth in processing speed and with the emergence of smarter algorithms for solving complex and challenging problems, organizations have found it possible to harness a humongous volume of data in realizing solutions that have far-reaching business values. Financial services, banking, and insurance remain one of the most significant sectors that has a very high potential in reaping the benefits of machine learning and artificial intelligence with the availability of rich data, innovative algorithms, and novel methods in its various applications. While the organizations have only skimmed the surface of the rapidly evolving areas such as deep neural networks and reinforcement learning, the possibility of applying these techniques in many applications vastly remains unexplored. Organizations are leveraging the benefits of innovative applications of machine learning in applications like customer segmentation for target marketing of their newly launched products, designing optimal portfolio strategies, detection, and prevention of money laundering and other illegal activities in the financial markets, smarter and effective risk management is credit, adherence to the regulatory frameworks in finance, accounts, and other operations, and so on. However, the full capability of machine learning and artificial intelligence still remains unexplored and unexploited. Leveraging such capabilities will be critical for organizations to achieve and maintain a long-term competitive edge. While one of the major reasons for the slow adoption of AI/ML models and methods in financial applications is that the algorithms are not well known and there is an inevitable trust deficit in deploying them in critical and privacy-sensitive applications, the so-called “black-box” nature of such models and frameworks that analyzes their internal operations in producing

outputs and their validations also impede faster acceptance and deployment of such models in real-world applications.

3.e.k-Nearest Neighbors(k-NN)

The storage complexity of the algorithm is $O(n)$, where n is the number of training objects. The time complexity is also $O(n)$, since the distance needs to be computed between the target and each training object. However, there is no time taken for the construction of the classification model, for example, a decision tree or separating hyperplane. Thus, kNN is different from most other classification techniques which have moderately to quite expensive model-building stages, but very inexpensive $O(\text{constant})$ classification steps.

One of the simplest and rather trivial classifiers is the Rote classifier, which memorizes the entire training data and performs classification only if the attributes of the test object exactly match the attributes of one of the training objects. An obvious problem with this approach is that many test records will not be classified because they do not exactly match any of the training records. Another issue arises when two or more training records have the same attributes but different class labels.



4.ML Application to IoT

4.a. Trends in Machine Learning

As machine learning is a relatively hot new topic, it is still significantly fast-evolving, usually through the development of novel formalizations of ML-based problems directed by real-world applications such as recommendation systems. One significant trend supporting this



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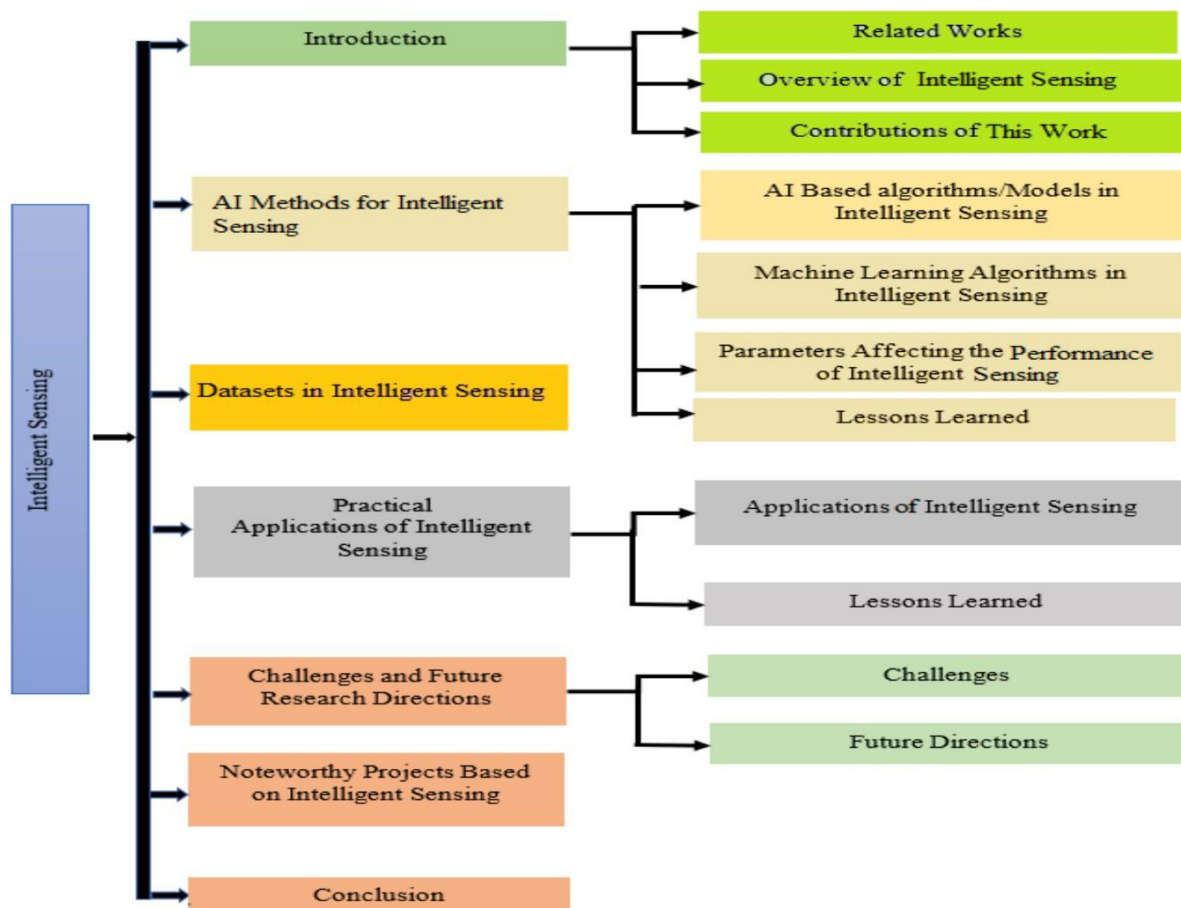
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expansion is the exponential growth concern in which ML-based algorithms work. Whereas, a conventional ML system is comprised of an individual program operating on a single system. Additionally, it is now normal for ML-based systems to be deployed in models with many tens of thousands of chipsets, alleviating communication limitations and parallelism (Dwork, McSherry and Nissim). The term "environment" refers to the data source, which might range from a group of individuals with privacy or ownership issues to an expert or selection with specific criteria for an ML system. Additionally, the environment may involve other ML systems or agents. The sets of systems may be collaborative or offer an ML learning algorithm with a variety of resources and confine those resources. Furthermore, machine learning analysts are significantly formalizing these connections, with the aim of developing algorithms that are proven to be effective in a variety of situations and directly enable users to express and handle resource exchanges. Recent research trends have focused on expansion methods, including sampling, dimensionality reduction, and classifier weakening, in order to attain scalability while keeping statistical control.



4.b. Trends in Machine Learning related to IOT

Machine learning (ML) was introduced in the late 1950's as a technique for artificial intelligence (AI). Over time, its focus evolved and shifted more to algorithms which are computationally viable and robust. In the last decade, machine learning techniques have been used extensively for a wide range of tasks including classification, regression and density estimation in a variety of application areas such as bioinformatics, speech recognition, spam



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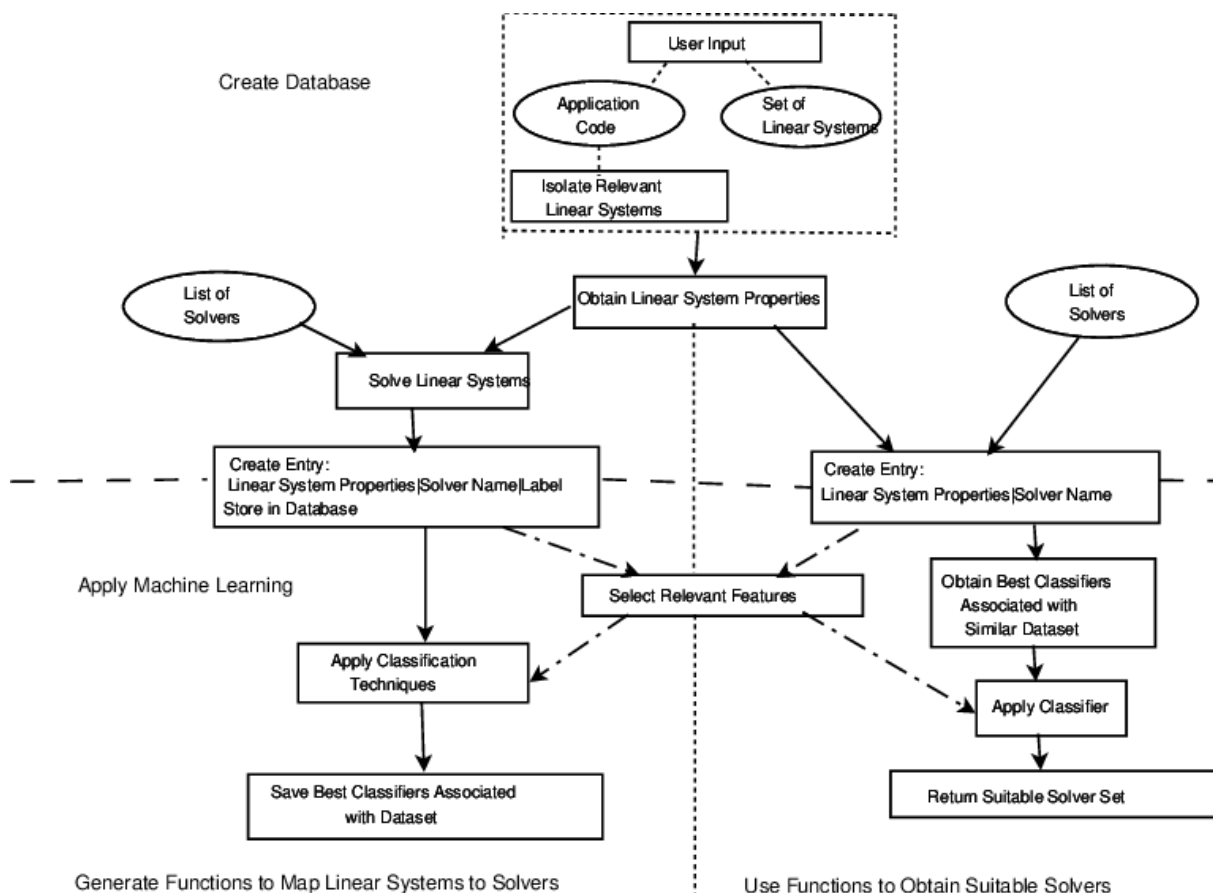


detection, computer vision, fraud detection and advertising networks. The algorithms and

techniques come from Recent Machine Learning Applications to Internet of Things (IoT) diverse fields including statistics, mathematics, neuroscience, and computer science and used even boarder, or most areas related to machines nowadays.

The following two classical definitions capture the essence of machine learning:

- 1) The development of computer models for learning processes that provide solutions to the problem of knowledge acquisition and enhance the performance of developed systems.
- 2) The adoption of computational methods for improving machine performance by detecting and describing consistencies and patterns in training data.



4.c. Types of machine learning algorithms

- Supervised learning --- where the algorithm generates a function that maps inputs to desired outputs. One standard formulation of the supervised learning task is the classification problem: the learner is required to learn (to approximate the behavior of) a function which maps a vector into one of several classes by looking at several input-output examples of the function.
- Unsupervised learning --- which models a set of inputs: labeled examples are not available.
- Semi-supervised learning --- which combines both labeled and unlabeled examples to generate an appropriate function or classifier.
- Reinforcement learning --- where the algorithm learns a policy of how to act given an observation of the world. Every action has some impact in the environment, and the environment provides feedback that guides the learning algorithm.

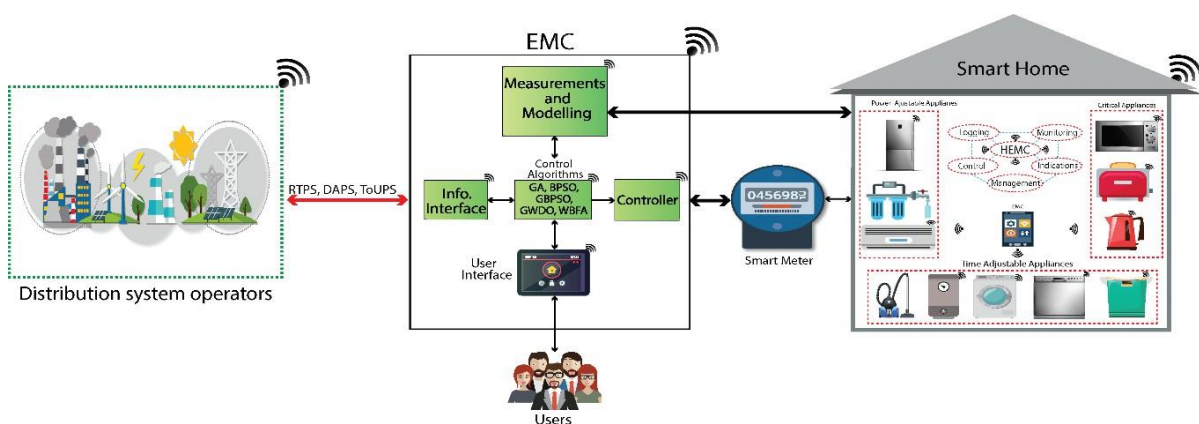
- Transduction --- similar to supervised learning, but does not explicitly construct a function: instead, tries to predict new outputs based on training inputs, training outputs, and new inputs.

4.d. Support vector machines

This set of notes presents the Support Vector Machine (SVM) learning algorithm. SVMs are among the best (and many believe is indeed the best) “off-the-shelf” supervised learning algorithm. To tell the SVM story, we’ll need to first talk about margins and the idea of separating data with a large “gap.” Next, we’ll talk about the optimal margin classifier, which will lead us into a digression on Lagrange duality. We’ll also see kernels, which give a way to apply SVMs efficiently in very high dimensional (such as infinite dimensional) feature spaces, and finally, we’ll close off the story with the SMO algorithm, which gives an efficient implementation of SVMs.

4.e. A Real IoT Implementation of a Machine-learning Architecture for reducing energy consumption

As the inclusion of more devices and appliances within the IoT ecosystem increases, methodologies for lowering their energy consumption impact are appearing. On this field, we contribute with the implementation of a RESTful infrastructure that gives support to Internetconnected appliances to reduce their energy waste in an intelligent fashion. Our work is focused on coffee machines located in common spaces where people usually do not care on saving energy, e.g. the workplace. The proposed approach lets these kind of appliances report their usage patterns and to process their data in the Cloud through ARIMA predictive models. The aim such prediction is that the appliances get back their next-week usage forecast in order to operate autonomously as efficient as possible. The underlying distributed architecture design and implementation rationale is discussed in this paper, together with the strategy followed to get an accurate prediction matching with the real data retrieved by four coffee machines.



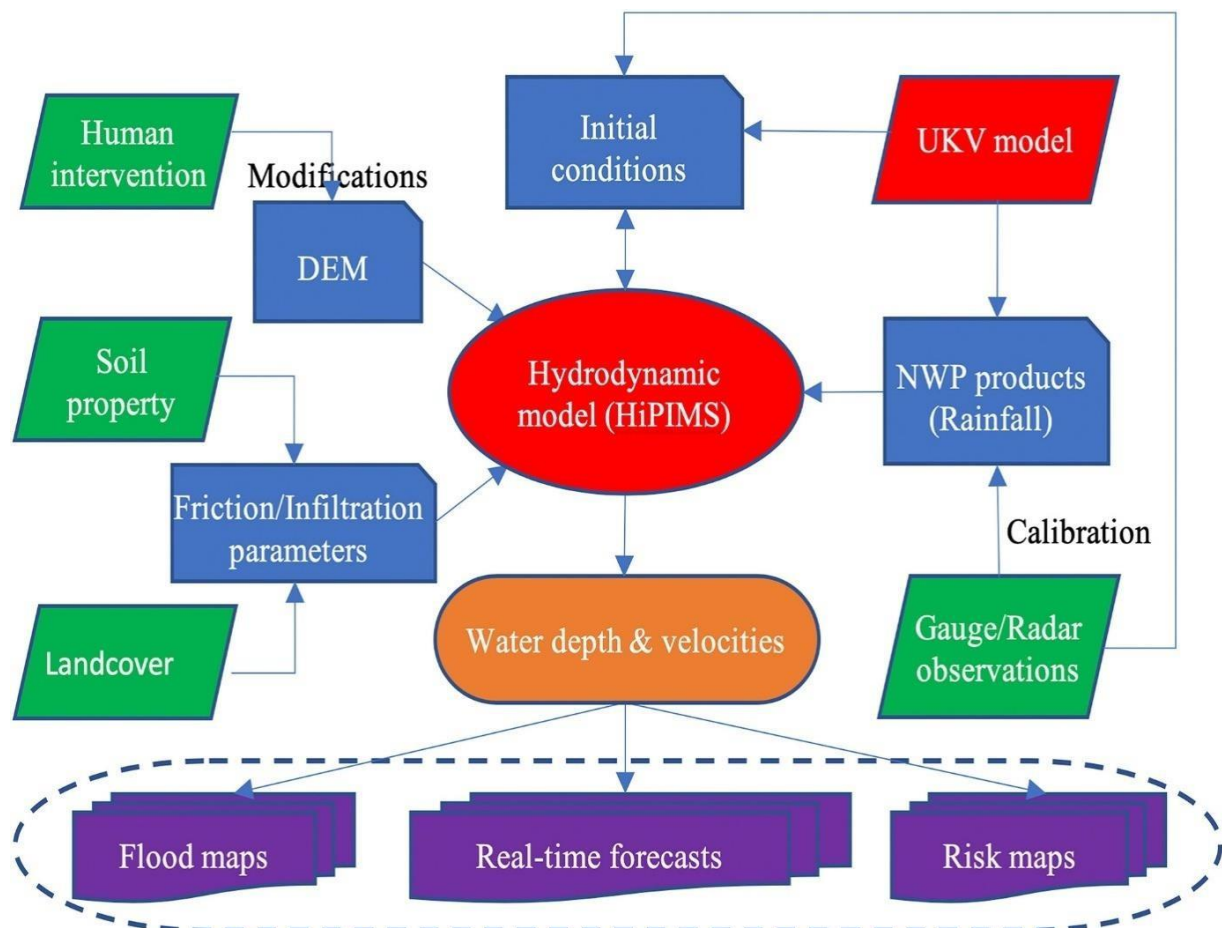
4.f. Forecasting and Routing

Courier companies receive delivery orders at different times in advance. Some orders are known long beforehand, some arise with a very short notice. Currently the order delegation, deciding which car is going to drive which order, is performed completely manually by a (TL) where the TL use their experience to guess upcoming orders. If delivery orders could be predicted beforehand, algorithms could create suggestions for vehicle routing and vehicle

selection. This thesis used the data set from a Stockholm based courier company. The Stockholm area was divided into zones using agglomerative clustering and K-Means, where the zones were used to group deliveries into time-sliced Origin Destination (OD) matrices.

One cell in one OD-matrix contained the number of deliveries from one zone to another during one hour. Long-Short Term Memory (LSTM) Recurrent Neural Networks were used for the prediction. The training features consisted of prior OD-matrices, week day, hour of day, month, precipitation, and the air temperature. The LSTM based approach performed better than the baseline, the Mean Squared Error was reduced from 1.1092 to 0.07705 and the F1 score increased from 41% to 52%. All features except for the precipitation and air temperature contributed noticeably to the prediction power.

The result indicates that it is possible to predict some future delivery orders, but that many are random and are independent from prior deliveries. Letting the model train on data as it is observed would likely boost the predictive power.



5.MACHINE LEARNING TO CHANGE THE WORLD

5.a. Communication

Due to the proliferation of applications and services that run over communication networks, ranging from video streaming and data analytics to robotics and augmented reality, tomorrow's networks will be faced with increasing challenges resulting from the explosive growth of data traffic demand with significantly varying performance requirements.



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This calls for more powerful, intelligent methods to enable novel network design, deployment, and management. To realize this vision, there is an increasing need to leverage recent developments in machine learning (ML), as well as other artificial intelligence (AI) techniques, and fully integrate them into the design and optimization of communication networks. In this editorial, we will first summarize the key problem structures in communication systems where machine learning solutions have been used. Then, we will describe the areas where there are gaps in learning algorithms for their optimal applications to communication systems.

5.b. User Experience

Customer satisfaction is the key factor in any business. By performing User Activity Tracking we ensure that honest feedback from the customers is passed on to the developers, which helps them analyze the difficulties that customers face. The feedback is collected through intermediators. The customers share the feedback with the consultants, consultants share their understanding to the lead, which then goes to product owner who then share it with the developers. In such a process, the customer feedback is prone to modification based on the stake holders understanding, which sometimes leads to an issue radically different from what the customer had stated. Marinating the sanctity of customer feedback is imperative as it allows the developers to identify the features that would enhance and enrich the User Experience. We can achieve a lossless capture of user feedback with the help of 'Clickstream'. Clickstream will capture all the events triggered along with the time of the event. This difference in the time will be plotted and a peak in the graph would determine a potential pain point for the customer. This instant data retrieval can also help us reduce the number of customer tickets that we encounter, as we would exactly know where there is an issue and can start working on it even before the incident is raised. The huge amount of user activity tracking data can be added into a Machine Learning algorithm which would help us analyze patterns of normal user behavior and abnormal user behavior (When there is any User experience issue). We can't rely on a single set of rules to ascertain that the user is facing an issue. Every application is different, features are different, customers are from different locations etc. Hence a simple rule based algorithm will not be helpful. We need Machine Learning Algorithm to find a lasting solution to the problem.

5.c. Smart Home

Smart home network technology can be classified into two main types, which are wiring system and wireless system. [3]In wiring system-here are many types of wires that people may want to install in-wall. Many home automations are connected through wiring system such as new wire (twisted pair, optical fiber), Powerline, Busline, etc. An example of outstanding technology is X10, which is open standard for home automation. X10 transmits binary data using the Amplitude Modulation (AM) technique. And X10 controllers send signals over existing AC wiring to receiver modules. In the wireless system, there must have two main elements that are sender and receiver. Many new appliances use wireless technology to communicate with other devices. The example of wireless communications system are microwaves, Infrared (IR), radio frequency (RF), Wi-Fi, Bluetooth, IEEE 802.11, and so on. Furthermore, some of smart home network standard can work using both wiring system and wireless system. An example of wireless communication system for smart home is Z-wave, which is a reliable and affordable wireless home automation solution.



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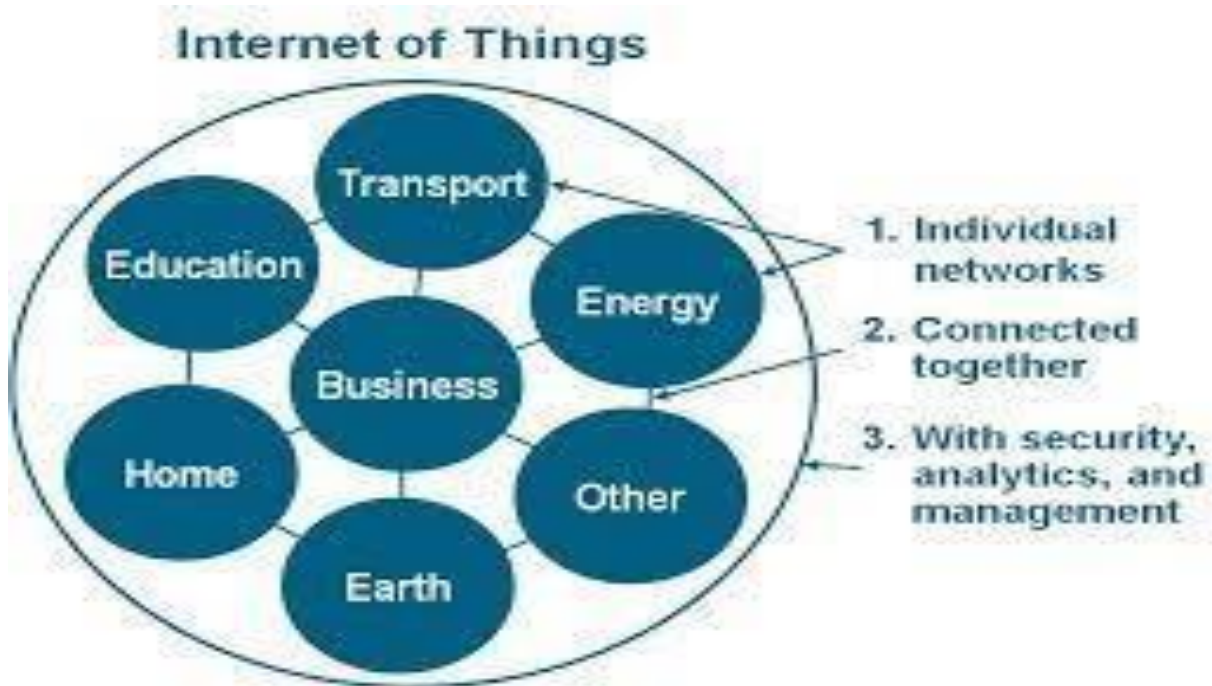
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5.d. Businesses

Business model is defined as the plan implemented by a company to generate revenue and make a profit from operations (Investopedia n.d., “Business Model”) [. That being said, it is clear that a company that lacks a clear and organized plan to generate profit and revenue will likely be unsuccessful. Traditional business models are designed on a firm-centric basis; however due to the nature of the IoT ecosystem in which firms must collaborate with competitors and across industries, it is easy to see why traditional business models are not adequate. Moreover, fast changing market environments in technology-related industries implies that companies must quickly adjust to market challenges in order to succeed. As a result, business model innovations are becoming “new routes to competitive advantage” (Sun et al., Bucherer et al., described some key issues when designing IoT business models, including “information between nodes and win-win information exchange for all stakeholders”. Furthermore, Westerlund et al., identified three contemporary challenges of the IOT, comprising the diversity of objects, the immaturity of innovation, and the unstructured ecosystems.

The diversity of objects refers to a multitude of different types of connected objects and devices without commonly accepted or emerging standards. Immaturity of innovation refers to today’s quintessential IOT innovations have not yet matured into products and services. Unstructured ecosystems refer to the lack of defined underlying structures and governance, stakeholder roles, and value-creating logics. Despite of these challenges, several IoT business model frameworks exist, but there are still some major gaps in the IoT that need to be properly addressed.

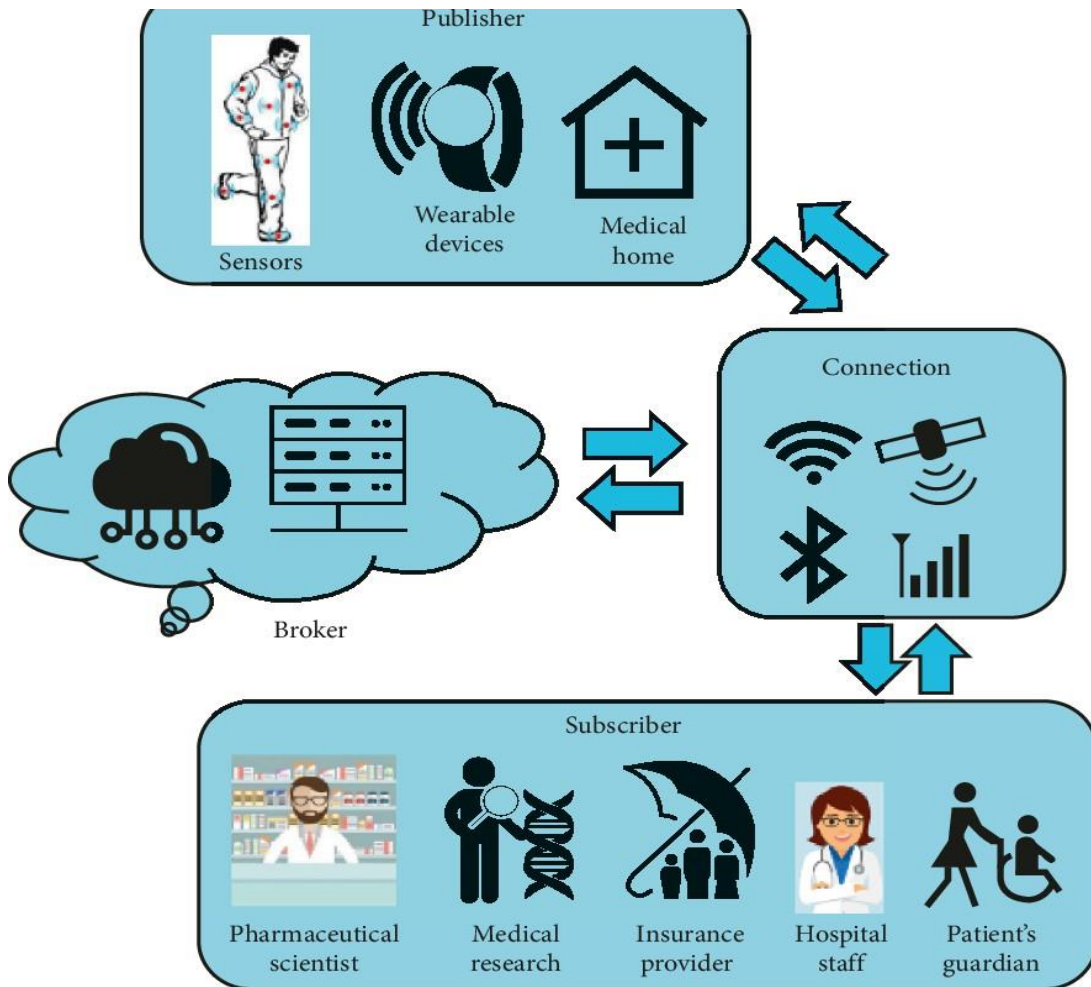


5.e. Voice-enabled Services

The programming language used in this project is Python, which is known for its versatility, and availability of wide range of libraries. For programming the Virtual Assistant, we used Microsoft Visual Studio Code (IDE) which supports Python programming language. Speech Recognition library is present in Python, and is having some in-built functions. Initially, we will define a function for converting the text to speech. For that, we use pyttsx3 library. We will initialize the library instance to a variable. We use say() method and pass the text as an argument to that, for which the output will be a voice reply. For recognizing the voice command given by user, another function has been defined. In that function, define microphone source and within its scope, we use respective functions and store the output in a variable. For the whole process, we have many services to use, like Google Speech Recognition engine, Microsoft Bing Voice Recognition engine, and products of many other big companies like IBM, Houndify etc., For this project, we choose Google's Speech Recognition Engine, that will convert the respective analog voice command into a digital text format. We pass that text as an input to the Assistant, and it will search for the keyword. If the input command has a word that matches with the respective word, the respective function will be called, and it will perform the action accordingly, like telling time, or date, or telling battery status, taking a screenshot, saving a short note, and many more. For this Personal Virtual Assistant, the main advantage is that it saves a lot of time, and it can even handle queries from people, of different voices.

5.f. Healthcare

Healthcare is one of the main priorities for all governments, basically related to population growth, rural urbanization, declining birthrate, population aging, economic growth and social unbalanced resource utilization, some social problems.



5.g. Enhanced security protocols

Intuitively, the JUC Theorem models shared state information by creating a single “multisession” protocol, which internally emulates multiple sessions of all the protocols in the network that must share the information. (This is done by implementing all those protocols as “subsessions” of the multi-session protocol, which merely maintains the shared state information and dispatches any protocol request to a corresponding instance of the true destination protocol which it runs as a subroutine). Yet, even the the JUC Theorem does not accurately model truly global shared state information.

The JUC Theorem only allows for the construction of protocols that share state amongst themselves. That is, an a priori fixed set of protocols can be proven secure if they share state information only with each other. No security guarantee is provided in the event that the shared state information is also used by other protocols which the original protocols were not specifically designed to interact with. Of course, malicious entities may take advantage of this by introducing new protocols that use the shared state information if the shared state is publicly available.