# INTERNET OF THINGS AND MACHINE LEARNING: A SMART FUTURE

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**Abstract -** Combination of Internet of Things (IOT) & Machine Learning (ML) results into smarter world. IOT and ML combined together plays a major role in industry, they easily incorporate ecosystem with our lives. Machine learning helps machines combined with numerous machines in order to realize the necessities of people from the data made by individuals. As well as machine learning plays an important role in IoT for handle the vast amount of data generated by those machines. With the increase of need Internet of Things (IoT) nearly growth rate of 27.4%, applications have become smarter and related devices furnish their exploitation in all aspects. While configuring clusters of IoT one of the main issues is that how to keep track of IoT Transportation by human action. As the amount of the composed data increases, Machine Learning (ML) techniques are used to further enhance the cleverness and the capabilities of an application. The main aim of the paper is to discuss about IoT techniques and how Machine learning will be used as a part of it. IoT is network of connected devices each with a unique identifier that automatically collect and exchange data over a network. Connected devices make use of built in sensor to accumulate data and in some case act on it Machine learning is the science of getting computer to learn and act like human do and improve their learning over time in independent style.

***Key Words*:** Internet of Things (IOT), Machine Learning (ML), Algorithms

## 1. INTRODUCTION

Virtual illustration along with the recent trends along with all interlinked devices (known as "Things") is the recent trend nowadays. The present proposal on introducing IoT demands various platforms in this world. Machine can deal with human thinking somehow where Artificial Intelligence comes into play. Machine learning is autonomously varying the algorithm that decides how input signals are analyzed and on the basis of that output is determined. Variety of algorithms and models are used to analyze the data to archive learning process. The illustration of data are typically characterized by quantifiable uniqueness called features and an ML algorithm attempts to locate a relationship among the features and some labeled output values.

**Internet of Things**

The internet of things, or IoT, means connecting interrelated devices, various machines, things, animal or human which contains unique identifiers (UIDs) and the skill to transmit data over a network without the need of human-to-human or human-to-computer communication. Machine to Machine (M2M) means wireless or wired set-up which allows devices of the similar version and capability to correspond generously.

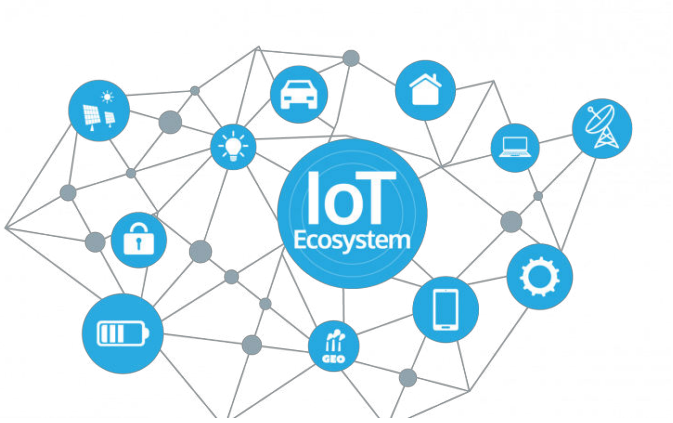


Fig – 1: IOT

IoT ecosystem: It's a collective system of components that empower organizations, governance with the governments, and peer customers to associate with their useful IoT gadgets with additional components such as remotes, dashboards, systems, entryways, Investigation, information stock piling, and security.

## 2. Aim of IOT:

- May have intends to detect physical wonders (e.g., temperature, light, electromagnetic radiation level) or to trigger activities affecting the physical reality (actuators).
- Possess one kind of identifier.
- Have physical epitome and an arrangement of related physical components (e.g., measure, shape, and so forth.)
- Have an in significant arrangement of correspondence functionalities, for example, the capacity to be found and to acknowledge approaching messages and answer to them.

## 3. Device management

As the devices used are enormous and they correspond with each other and servers. As a result of it, devices may not be all associated with each other, numerous statistics involving issues should be managed efficiently.

**Device diversity and interoperability**
Several MNCs invent their new strategies i.e. goods and services in various domains. For instance, in smart grid, where range of sensors aims to decrease power utilization from different MNCs in another standard. Making these devices to work continuously is a great challenge.

**4. IOT and Cloud**
Cloud is an idea which deals with IoT. The "Cloud" is effective for all intents and purposes of a data storage, calculation and dealing out resource which practically is made up of servers in data center far-away from the point of consumption of the IoT nodes. This allows the use of comparatively "dumb", inexpensive and less power-hungry strategy as IoT sensors, while the "Cloud" resource on the Internet does all the intense stimulating in the application.
If data from the IoT nodes (called the "Edge") enters the "Cloud", data analytics and statistics can be leveraged to illustrate the inference that requires for our scrupulous use-case. For example, energy utilization of appliances in a household can be calculated using internet linked with sensors at the Edge, whereas highly developed data analytics such as analysis of convention patterns, utilization by biological location or visualizations of such data can be done in the Cloud.

Fig – 2: IOT and Cloud

**5. Applications of IoT**
**Smart Homes**
In this category, conventional house appliances, like refrigerator, washing machines, or light bulbs, that have been developed and are able to correspond with each other or with recognized users via internet, contributing a better way of supervising and managing the devices as well as energy consumption. Other than conventional devices, various innovative technologies spread, by automatic home products. Consider an example of smart thermostat in home automation.


Fig -3: IOT Applications

Fig – 4a: Smart Home

**Smart Thermostat**
To control air conditioner in house the smart thermostat can be used. We can monitor and be in command of temperature of home using a planner that has features like sensors and WiFi connectivity through a smart thermostat. Heating, Ventilation and Air Conditioning (HVAC) system can even be informed you if the air filter needs to be changed.

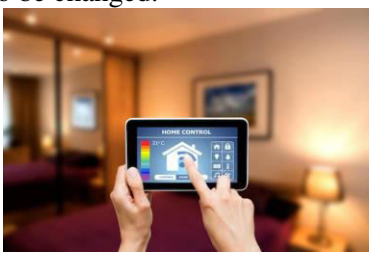

Fig – 4b: Smart Thermostat

**Health-care assistance**
For growth of patient's health, innovative devices have been designed. Plasters with wireless sensors can supervise a wound's condition and report the statistics to the general practitioner even by their absence. Other sensors in the outline of wearable devices or tiny implants can track and report an extensive range of dimensions, such as heart rate, blood oxygen level, blood sugar level, or temperature.

**Smart Transportation**

By means of sensors embedded to the vehicles, or mobile devices and devices incorporated in the city, it is achievable to recommend optimized itinerary suggestions, simple parking reservations, financial street lighting, telemetric for public means of transportation, accident prevention, and autonomous driving.

**Self-Driving Cars**

Self-driving cars are cars without drivers, also known as an Autonomous Vehicle. They can move safely without any inputs from human. The control system in the vehicles makes out sensory information to recognize routing paths and appropriate signage.


Fig – 5: Smart Vehicle

**Environmental Conditions Monitoring**

Wireless sensors scattered in the city build the ideal infrastructure for an extensive range of ecological circumstance monitoring. Barometers, humidity sensors, or ultrasonic wind sensors can facilitate to make superior weather stations. Additionally, smart sensors can observe the quality of air and water pollution levels across the city.

**Logistics and Supply Chain Management**

We can able to track the product manufacture to the store with the help of smart RFID tags by reducing price and time drastically. In addition, smart packaging offers properties like trademark protection, quality assurance, and client personalization.


Fig – 6: Logistics Management


Fig – 7: Supply Chain Management

**Security and Surveillance Systems**

Smart cameras can get hold of video input across the streets. With real-time visual entity detection, smart security systems can be aware of suspects or stay away from unsafe situations. A cloud illicit interference exposure system uses locality aware services, where the geo location of every node of home automation arrangement can autonomously detected and stored in the cloud.

Fig – 8: Surveillance Systems

**Robotic Vacuum Cleaners**

Automated vacuum cleaners also called Robovac, has exceptional programming for flooring clean-up systems. Robotic vacuums cleaners are valuable compared to a standard cleaner machine as they vacuum on their own. Robovac can be located wherever; whether it's below the cot or benches as well as a distinctive vacuum cleaner requires huge space.

Fig – 9: Robotic Vacuum Cleaners

As increasing number of internet-connected sensors are built into cars, planes, trains and buildings, businesses are accrual enormous amounts of data.

**6. Machine Learning**

Machine Learning is required for tasks that are too difficult for humans to code directly, i.e. daily jobs that are so complex that it is not practical, for us to work out all of the nuances and code for them clearly. So as a substitute, we afford a machine learning algorithm with a huge quantity of data and let it investigate and explore for a model that will work out with which the programmers have set out to achieve.

Let's look at these two examples:

It's extremely hard to write programs that work out problems like recognizing a 3D entity, from original point of view, in fresh illumination circumstances, in a chaotic prospective. Though we have idea of programming it's quite complicated to design also program to calculate the probability that a credit card transaction is fraudulent. There may not be set of rules that are both easy and dependable. We need to combine an extremely huge amount of pathetic rules. Fraud is a moving objective, but the line up requests to continue shifting.

**Machine Learning Approach**

As an alternative of writing a program by hand for all precise tasks, we bring together lots of examples so as to identify an exact output for a known input. The program created by the learning algorithm could look extremely different from a distinctive hand-written program — it may contain millions of numbers. Prediction of Weather, calculation of life skills, and population enlargement forecast, by using algorithms like Linear Regression or Random Forest. Additionally, supervised learning influences classification problems such as number detection, voice recognition, diagnostics, and identity fraud detection, by using algorithms such as Support Vector Machines, Nearest Neighbor, Random Forest, and others. The data sets used for the guidance stage need to have identified labels.

**Supervised Learning**

The algorithms learn the connection among the input values and labels and make an effort to calculate the output values of the testing data. A supervised learning algorithm analyzes the guidance data and produces an inferred function, which can be used for setting up of other examples. A most advantageous scenario will permit for the algorithm to appropriately establish the class labels for unseen instances. Two phases in supervised learning are training phase and testing phase.

**Unsupervised Learning**

Unsupervised learning deals with troubles connecting dimensionality reduction used for huge data apparition, quality elicitation, or the detection of unseen structures. In addition, supervised learning is used for clustering problems like suggestion systems, client segmentation, and targeted marketing. Converse to supervised learning, in this type, labels are not available. Algorithms in this grouping attempt to recognize patterns on testing data and cluster the data or predict upcoming values.

**Semi-supervised Learning**

Combination of the previous two categories i.e. grouping of labeled data and unlabeled data are used. It works similarly like the unsupervised learning with the development that a part of labeled data can bring.

**Reinforcement Learning**

In this learning style, the algorithms aim to forecast the output difficulty based on a set of modification parameters. Then, the deliberate output becomes an input constraint and new output is considered until the finest output is found. Reinforcement learning is mostly used for applications like AI gaming, skill acquirement, robot navigation, and real-time decision.

**7. Main Uses of Machine Learning in IoT**

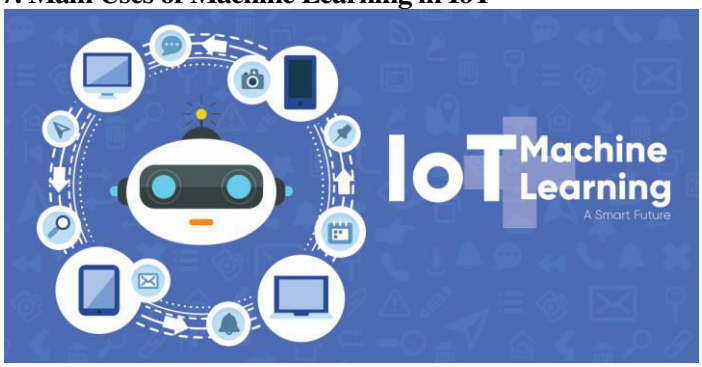


Fig – 10: IoT Machine Learning

**Prediction of data trends**

Regression algorithms are the group of algorithms which make possible of estimating the leaning of the data points by formulating a representation based on existing composed data.

**Linear Regression**

Linear connection among the amount calculated by the sensor, and time which is the simplest linear regression used to robust a straight line to facts. Simple and Multiple Linear Regression are the two types of linear regression.

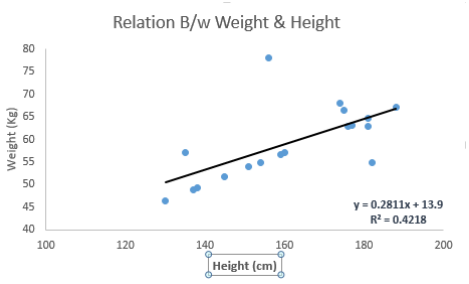


Fig – 11: Linear Regression

**Logistic Regression**

It is a categorization not a regression algorithm used to approximate discrete values (Binary values like 0/1, yes/no, true/false) based on specified lay down of free variable(s). It predicts the likelihood of incidence of an episode by appropriate data to a logit function also known as logit regression.

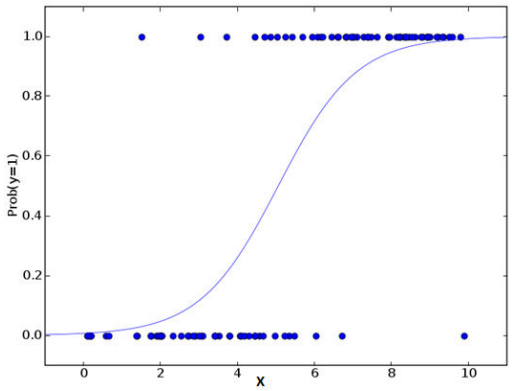


Fig – 12: Logistic Regression

**kNN (k- Nearest Neighbors)**

Classification applied in company and regression problems make use of kNN algorithms. K nearest neighbors is uncomplicated algorithm that saves all accessible belongings and classifies original cases by a greater part of its k neighbors. The case being assigned to the group is most common amongst its K adjacent neighbors deliberate by a reserve function. Primarily, three functions are used for uninterrupted task and fourth one (Hamming) for definite variables. If K = 1, then the case is simply assigned to the group of pupils of its bordering neighbor.

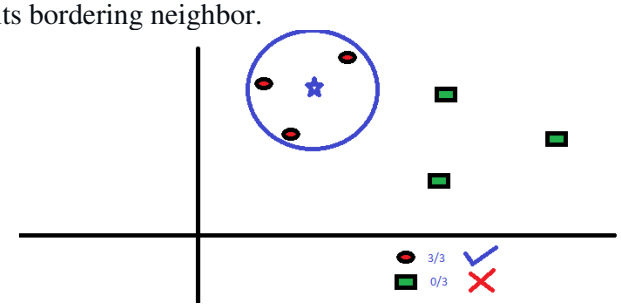


Fig – 13: kNN Mapping

SVM (Support Vector Machine)

A classification method used to plot all data points in n-dimensional space (where n is amount of features) with the importance of every feature being the charge of a scrupulous coordinate. For illustration, if we only had two features like Height and Hair length of an individual, we'd first plot these two variables in two dimensional spaces where each point has two co-ordinates called as support vectors.

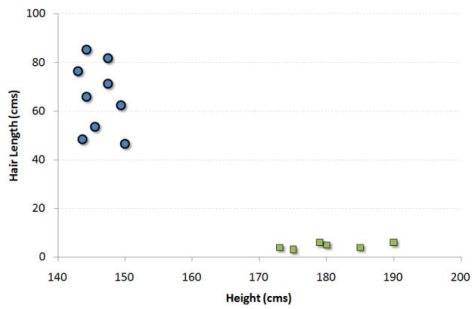


Fig – 14: Support Vector Machine

Frequently the data does not go behind a linear connection and additional complex approaches such as Polynomial Regression and more complicated algorithms have to be used. Linear Regression could also be used for non-linear trends if geared up to prepare the modifications of the self-regulating variable. The state of the art Machine Learning algorithms used for calculation in the case of IoT sensors i.e. time reliant data consist of Recurrent Neural Networks (RNNs) and Long Short Term Memory (LSTM) Networks.

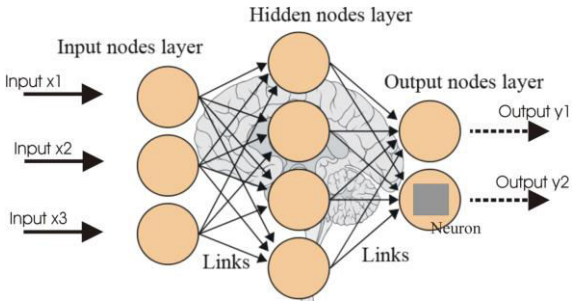


Fig – 15: Neural Networks

**Clustering of data**

It is another use-case associated to IoT which can harness the control of ML algorithms is to facilitate arrangement of data. For Binary categorization (i.e. warm or not. with a temperature sensor, of course), Logistic Regression is the finest position to begin. An application can be examination of accelerometer, gyroscope and other Inertial Measurement Unit (IMU) data to recognize behaviors such as walking, standing, running or sitting.

**Anomaly Detection**

A third use-case which is sturdily appropriate for IoT is Anomaly Detection, i.e. identifying outliers in a data-set. Statistical approaches to Anomaly detection grip Gaussian distributions and analyzing how far away the data point to be tested is from the historical data's mean. Z-Score is a frequently used for calculation of mean and standard deviation of the data.

**7. Machine learning and IoT used in firms**

One of the original firms to couple IoT sensor data with machine learning models was ThyssenKrupp, which runs 1.1 million elevators globally and has been feeding data composed by internet-connected sensors all the way through its elevators into qualified machine-learning models for numerous years. In the same way, Rolls-Royce collects furthermore 70 trillion data points from its engines, feeding that figures into machine-learning systems that foresee when protection is mandatory. The IIoT serves better in the cyber security, machine manufacturing and production strength, proper designing in order to relax from hidden barriers, suppliers and product buyers. The work is to pair the technology with industry commodities, quantifying and price saving.

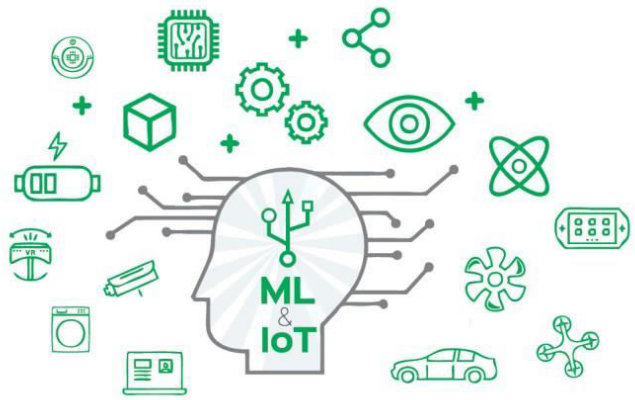


Fig – 16: ML & IOT

**8. Deep learning**

Machine learning is currently as prominent as of advances over the earlier period in the field of deep learning -- a subset of ML. Deep learning is a group of machine learning algorithms that uses numerous layers to increasingly take out upper level features from the raw input. For instance, in image processing, lesser layers possibly will spot boundaries, whereas top layers may recognize the concepts related to an individual such as digits or letters or faces.

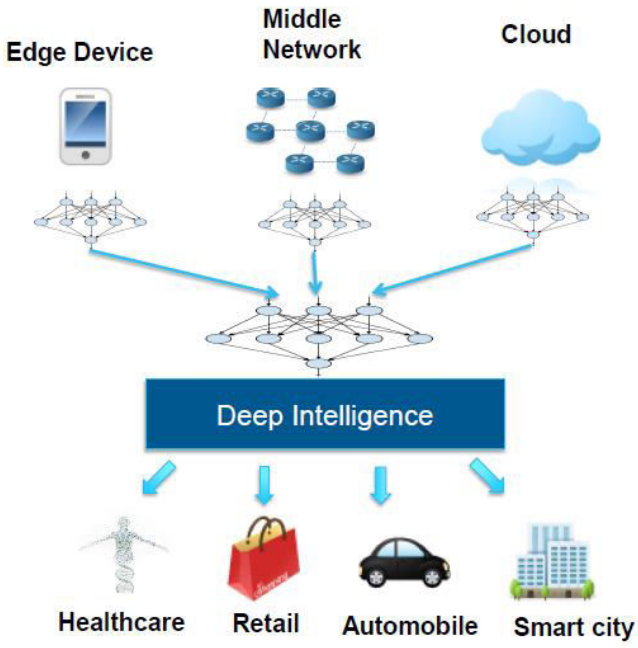


Fig – 17: Deep Learning

**9. CONCLUSIONS**

IoT consists of a huge quantity of devices with varieties which has to be associated to each other and convey large amount of data. This paper not only aims to impound machine learning in IoT to the hypothetical concept, but really generates an enabling atmosphere through easy to use software, libraries, web services etc for free. IoT has several applications for home such as smart lighting that adjust the lighting to go with the ambient conditions, smart appliances that can be monitored and controlled by remotes and smart smoke detectors. Agriculture domain, we learned about smart irrigation systems that assist in saving water while enhancing efficiency and green home control systems. Machine Learning helps identifying data and 'compose the data talk' for making decisions. By machine intelligence machines somehow learn on their own and develop the required problem solving skills. Machine learning and IoT should combine and work concern to produce a enhanced technology, which will make certain effectiveness and productivity for all sectors.

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