

A Review on Identifying Suitable Machine Learning Approach for Internet of Things Applications

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Abstract

Recently, IoT is referred as a descriptive term for the idea that everything in the world should be connected to the internet. Healthcare and social goods, industrial automation, and energy are just a few of the areas where the Internet of Things applications are widely used. Applications are becoming smarter and linked devices are enabling their exploitation in every element of the Internet of Things [IoT]. Machine Learning (ML) methods are used to improve an application's intelligence and capabilities by analysing the large amounts of data. ML and IoT have been used for smart transportation, which has gained the increasing research interest. This research covers a range of Internet of Things (IoT) applications that use suitable machine learning techniques to enhance efficiency and reliability in the intelligent automation sector. Furthermore, this research article examines and identifies various applications such as energy, high-quality sensors associated, and G-map associated appropriate applications for IoT. In addition to that, the proposed research work includes comparisons and tabulations of several different machine learning algorithms for IoT applications.

Keywords: IoT application, machine learning



1. Introduction

Since the early 1990s, there has been an increasing interest in expanding the existing Internet to include all linked objects (often known as "Things") and their virtual representation. Smart homes and medical health care, automotive industrial application, and environmental monitoring (weather forecasting) are just a few examples of what will be possible as a result of the existing research works [1-5]. Figure 1 has shown IoT association devices.



Figure 1. IoT Association Devices

Educational, industrial business, and other organizations are working together to promote automation in their vast fields, which has lately obtained a lot of effort and money from sectors including telecommunications, medical health insurance, semantic websites, and details. The result is that huge amounts of venture money follow the current [6-9].

For a long time, standard systems were restricted to being built for particular objectives and offering little wiggle room. Thus, a system that is already in use cannot be modified quickly and easily. Currently, the IoT application project requires sensors devices and service platforms to work out for that can collect data from the sensor output through physical medium and interact

with it. This is particularly important now that they can communicate with the rest of the world [10-12]. As a result, a wide variety of new possibilities will be opened up, including in the fields of smart health and retail as well as green energy, manufacturing, and smart homes.

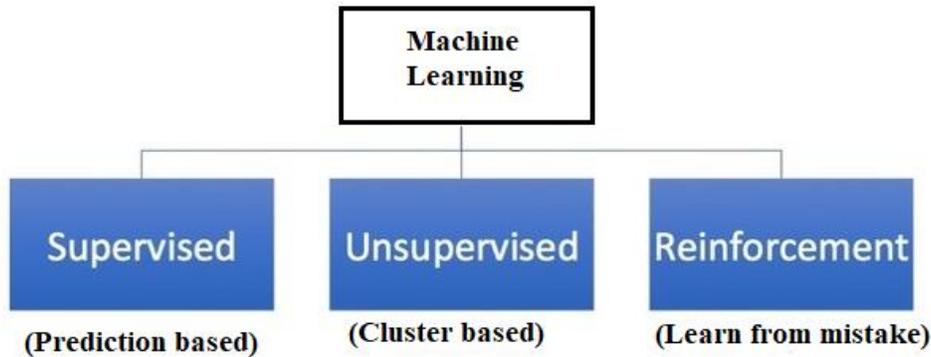


Figure 2. Classification of machine learning methods

The Computer Vision and Internet of Things (IoT) technologies enable the objects to be interconnected, interact with one another, and generate massive amounts of data on a daily basis. IoT devices may be configured to perform certain actions depending on preset circumstances or feedback from the data gathered in various applications. On the other hand, human involvement is required for data analysis and extraction, as well as for the development of intelligent applications [13-16].

Devices in the Internet of Things (IoT) must be able to gather data, interact with one another, and operate independently. Context-based decision-making and learning from gathered data are essential for them. That's why "Cognitive IoT" (CIoT) was coined [11]. One of the main IoT applications must be able to build an automated smart home or medical healthcare with automatic resource allocation, communication, and network layer operation to be used by intelligent IoT devices for routing [17].

IoT infrastructure may benefit greatly from the use of machine learning (ML) techniques. In addition to IoT sensor device optimization, congestion avoidance or detection, and resource allocation, machine learning may be used for decision-making in the real-time application or offline setup of the device [18]. Figure 2 shows classification of ML methods.

Additionally, as the number of devices increases, the quantity of data being gathered will also be increased. In the Internet of Things (IoT) applications, it is frequently required to deal with the big data challenges. Conventional databases are not equipped to manage large amounts of data. To manage the massive amounts of structured and unstructured data, specialized infrastructure and analysis methods are required [19]. Large data sets may be effectively handled by using ML techniques such as "Ensemble," or Artificial Neural Networks. These algorithms will be described in the following sections.

2. Organization of the Research

The following is the structure of this survey study article: Section 3 summarizes current research on the Internet of Things-based applications on different domains. Section 4 presents a contemporary machine learning technique that may be used for a variety of Internet of Things applications. Section 5 provides an explanation for the appropriate approach to majorly analyze the Internet of Things [IoT] applications. This research study has been successfully concluded in the last section.

3. Preliminaries

Many Internet-of-things (IoT) applications are carried out in different ways. Zielonka et al. developed a conventional Internet of Things [IoT] system. Their method is a remote platform control system, which collects sensor data from the users present all around the home and further

computational intelligence model is used to modify the IoT convection system's settings for obtaining the improved family comfort in order to optimize its performance [20].

The industrial IoT was used by Abdel-Basset et al. to explore a smart learning environment [21]. By using a network design, Ahmed et al. have initiated the research efforts to manage the rural agricultural locations [22].

In the IoT context, Fu et al. have proposed an intrusion detection method. Using this method, various kinds of assaults may be detected and reported, including reply-attacks, jam-attacks, and false attacks. The researchers also carried out different tests to evaluate the suggested strategy against the RADIUS application [23].

In order to secure IoT networks, Loulianou et al. have developed an intrusion detection system. The study has used both distributed and centralised modules, as well as a signature-based intrusion detection approach. Using the Cooja simulator, they created a denial-of-service scenario to demonstrate how assaults like this might impact the availability of IoT devices [24].

IoT sensor networks have been subjected to eight different data mining methods by Almomani and Alenezi in order to identify and categorize DoS (Denial of Service) attacks [25]. In this dataset, five types of DoS assaults are included, including flooding, TDMA, grey hole, and blackhole. The dataset was developed by Almomani et al. [26]. In spite of the fact that their intrusion detection system's accuracy increased to 98%, the feature selection algorithm decreased 53% of the total features.

Besides, swarm intelligence algorithm for route planning has been used to investigate the potential of mobile crowd-sensing in Intelligent Transportation Systems. The Ant Colony Optimization [ACO] method is modified by the authors to use Modified Crowd-Sensing

(MoCSACO). As with ants following pheromone trails to get food, users will share information and move to less crowded pathways by following the signals received from other users [27].

The authors of [28] looked for a link between traffic congestion, fuel emissions, and Google's "popular times" feature to see whether there was any connection. A GNSS data logger in the vehicle collects traffic data, as do cameras placed along the route. The VSP model is used to estimate emissions, while Google Maps is used to gather popular time data.

4. Methodologies

4.1 Energy based application (EBA)

The energy consumption of a mixer machine may be minimized by using Arduino MEGA. This is a basic IoT ML implementation. However, additional items like lights and air conditioners can certainly be included in this kind of IoT.

When not in use, the coffee machine is turned off completely. As a result, the efficiency of the energy saved may be increased even more by providing more states in this hard division. While these types of energy modeling are useful in certain ways, they are unable to deal with the emergency power consumption of a single machine. Because of the big number theory, expanding the scale to include the whole electric system will provide better results. As a result, a supervised learning process may complete the energy-based application. If you want excellent efficiency and great dependability, use regression learning [29].

4.2 Sensors in smart home and agriculture (SSHA)

With a smart home, you can link all of your gadgets and appliances to the internet so that they can be managed from anywhere with a mobile or remote device. It is common knowledge that smart meters are here to stay. When we think about smart meters, we immediately picture the

current generation. We prefer to limit the number of individuals who are familiar with the market, especially when it comes to presents and how many of them are given away. Because no information is available on the precise circumstances of every system component, some assumptions are made. Light, humidity, and temperature sensors, as well as a slew of buzzer sensors for alerts, are all part of the setup in an apartment. It's like a look into the future at what life will be like in 20 years [30].

Agrirobots, IoT devices, and sensor modules, as well as security management for all integrating devices, make up the intelligent IoT [19]. Using the centralized processing servers, the IoT device processes sensor data and feeds it back to the real-time green fieldwork devices. As a result, every sensor infrastructure is being integrated into IoT devices. The system's output may be seen on the audio and video interfaces [20]. The IoT central processing unit (CPU) processes sensor data at an optimally planned time from raw data generated from soil or any other suitable location. As a result, only with excellent prediction and process optimization can this energy-based smart house and farm be effectively learned. This kind of IoT application is better suited to the regression learning process since it is more efficient and reliable.

4.3 Routing based application (RBA)

Intelligent traffic routing is a promising application for sensor-ML algorithms. The LarKC platform is used by the Milano academics to build their system. The whole system may recommend various routes to the destination based on traffic and weather benchmark data.

To send and receive requests, the system makes use of a RESTful API. Path-finding and traffic prediction are two of the system's real-time processes. The information that's being analyzed includes the things like traffic flow, weather, and calendar data. An unsupervised learning method may, thus, efficiently handle this node-based routing application. Due to the different classification

tree branches, the decision tree learning process is better suited for high efficiency and dependability.

4.4 Google Map based application (GMA)

The use of a Google map-based application system to monitor a route and pinpoint a place is very popular these days. This is a well-established system, and ML and IoT will help it become even more precise. We can collect up-to-the-minute traffic data with the help of sensors installed in the streets. ML utilises the data to build a decent model and then uses that model to make predictions in minutes or seconds. The system's usefulness is obvious, but the sensors on every roadway are expensive. One approach to improve accuracy and save costs would be to utilise images and internet information about traffic. Unsupervised learning is also effective for node-based routing applications. In order to map the position from one point to another, reinforcement learning is preferable. Due to its high skill acquisition, this learning process is also better suited for real-time choices that need both efficiency and dependability [31].

4.5 Industrial based IoT application (IIA)

Utility companies, manufacturers, healthcare providers, insurance companies, retail stores, and transportation companies are all included in this section's discussion of IoT applications [32]. Most of these applications rely on machine learning techniques to make the data more understandable.

4.5.1 Transportation unit

Many companies and governments use IoT and ML algorithms for health care, traffic, etc. Such applications are highly valued in light of the billions of pieces of data collected from machines. In utilities, we want to save energy by predicting the usage and dynamically allocating

it. Before this time, we may have operated in several ways to do this, but we could not show the customer the exact data and energy saved. But with those smart meters for gas, electronics, and water, we can store the history of usage by machines. Furthermore, we can do load balancing and dynamical allocating.

4.5.2 Device control system

An IoT system with cameras and controllers may save a lot of human resources in production. The system has the ability to send an alert and take necessary action if it identifies an anomalous activity. As an added bonus, it can foretell things like "this field is likely to fail at a particular time, so take action now." Factories may save a significant amount of money and time by identifying potential problems before they happen.

4.5.3 Health monitoring system

The problem in healthcare is the monitoring of a patient's personal medical history. Doctors can get a better picture of a patient's health if the patient is wearing a variety of trackable gadgets. And it's far less expensive than employing a personal nurse to keep tabs on everyone's health status using this system.

4.5.4 Financial tally system

When it comes to insurance, the business examines the financial documents for property values. Instead of relying on collected data from personal devices, we can now make use of it. We can offer customized insurance that is tailored to individual needs by gathering and evaluating this data. As a result, we're trying to figure out when what, and how much our consumers will spend. There will be sensors in the store and data may be collected via the internet, such as shopping

applications. It's a method to let consumers get what they want while also encouraging them to make additional purchases.

4.5.5 Dynamic setup

We can utilize data on people and vehicle movement in transportation. As long as the number of vehicles available matches the number of people using buses and subways, the allocation is efficient. We may reduce operating costs when idle or raise the quality of service while actively working when restricted resources are dynamically organized.

4.5.6 Manufacturing system

The dataset is used by the sensor manufacturers to figure out how the system operates. With the use of unstructured input like text, audio, videos, and pictures, the system can make predictions about the final product's quality while also building up the overall structured data. Common manufacturers often use machine learning (ML) technologies on the Internet of Things (IoT). The production system may be highly automated if quality and operation are controlled. The production system is used by Visible Machines to examine the material.

In short, industrial-based applications should be able to manage a large number of sensors' inputs and outputs in order to perform their general processes with feedback from the sensors. The system structure should be able to make real-time choices via learning tasks of skill development that are elicited from the user's preferences. Therefore, for clustering using dimensionally reduced units, it is suggested that big data visualization techniques be used in conjunction with each other. This process will be divided into sections based on client satisfaction. This industrial application process will also be optimized via unsupervised learning for suggested systems, in addition to other factors.

5. Results & Discussion

This section discusses about different Internet of Things [IoT] applications for appropriate machine learning model based on our survey work, and it categorizes the most efficient groupings. Additionally, it offers a method for determining the efficiency and dependability of the group based on measurements. Figure 3 shows supervised learning based IoT application.

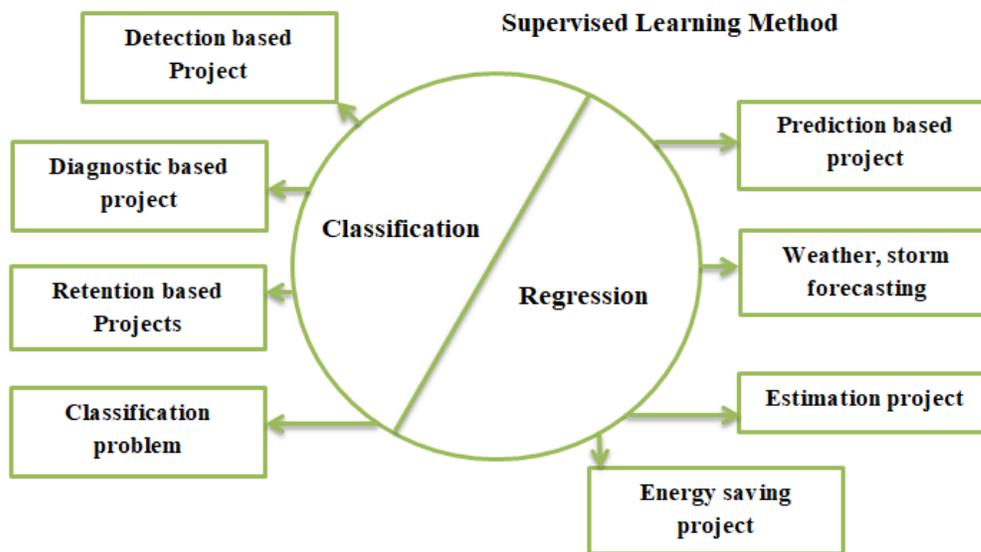


Figure 3. Supervised Learning based IoT Application

Models for control applications may be made more accurate and efficient using machine learning. The historical data collected in a large data warehouse is often used to update models. New models are utilized by control applications after data analysts have verified their applicability and dexterity. It is also possible to store the instructions that control applications send to actuators in a large data warehouse. There's a good chance that this will help investigators to gain resourceful insight to handle troublesome situations. The use of low-energy wireless IoT sensors

has two advantages: reduced consumption and longer device life. Figure 4 shows unsupervised learning based IoT application.

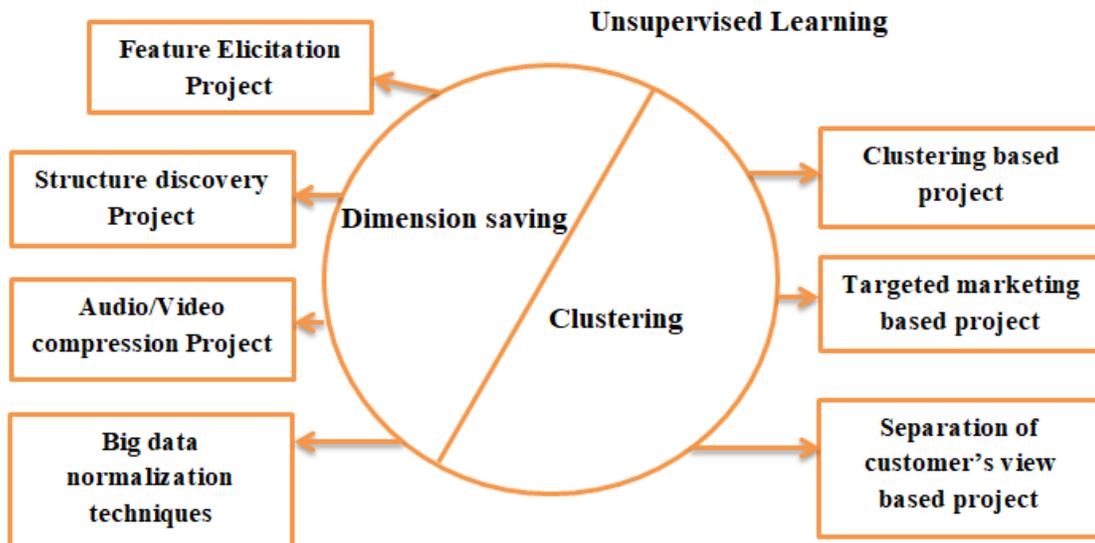


Figure 4. Unsupervised Learning based IoT Application

Tracking and managing linked device fleets is critical in IoT installations with tens of thousands to millions of connected devices. In device management, you need to make sure that IoT devices operate correctly and securely once they have been deployed. Compression-based projects are very efficient when dealing with unsupervised learning initiatives that save space by compressing data. Figure 4 depicts a breakdown of the several foundation initiatives in terms of structure discovery, feature elicitation, and clustering.

Figure 5 shows reinforcement learning based IoT application. To be effective, a node must be able to route data to the correct node if it knows the target address. Since there are so many nodes that may be joined in IoT settings, good routing is essential. It's a component of a project

centred on map-based navigation. Reinforcement learning will be used to fine-tune and train the route navigation system (see Figure 5). Table 1 shows some measures of IoT application.



Figure 5. Reinforcement Learning based IoT Application

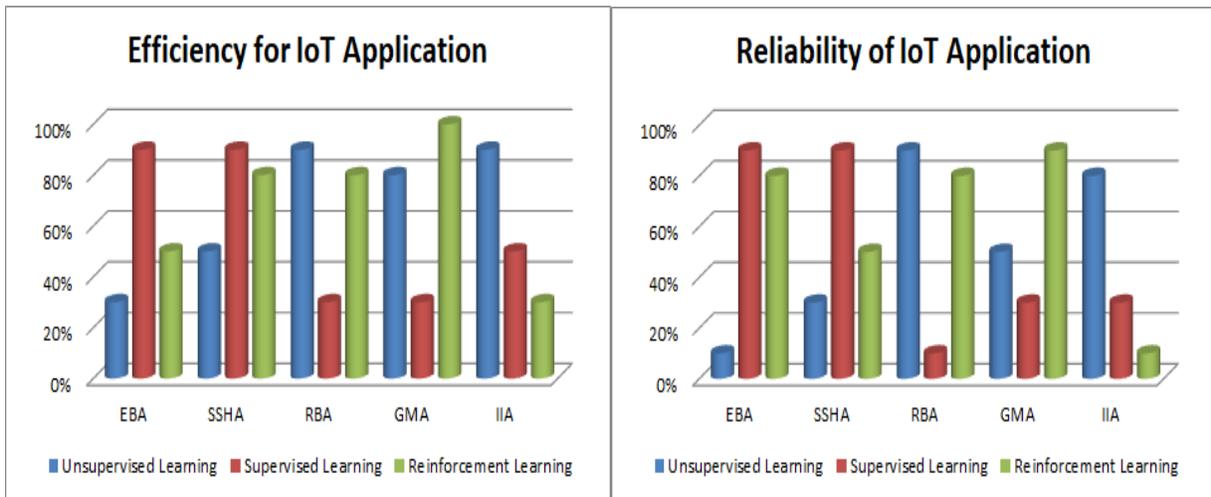


Figure 6. Efficiency and Reliability of IoT Application

Table 1. Performance measures for IoT application

Methods	Unsupervised Learning		Supervised Learning		Reinforcement Learning	
	Efficiency	Reliable	Efficiency	Reliable	Efficiency	Reliable
EBA	LOW	VERY LOW	VERY HIGH	VERY HIGH	MODERATE	HIGH
SSHA	MODERATE	LOW	VERY HIGH	VERY HIGH	HIGH	MODERATE
RBA	VERY HIGH	VERY HIGH	LOW	VERY LOW	HIGH	HIGH
GMA	HIGH	MODERATE	LOW	LOW	SUPREME	VERY HIGH
IIA	VERY HIGH	HIGH	MODERATE	LOW	LOW	VERY LOW

We have categorized as low – 20%, very low -10%, moderate – 50%, high – 80%, very high – 90% and supreme 100% for the graph plotting that has shown in the figure 6.

6. Conclusions

Machine learning methods for the Internet of Things have been analyzed for a variety of smart applications. With the help of graphs, we have tabulated the good efficiency for appropriate IoT applications. We discovered that a wide range of machine learning methods were proposed and evaluated for use in smart transportation, including reinforcement learning methods, clustering, and based on the IoT data types and sizes of these applications, as suitable for the use of machine learning (ML). The findings of this research study may help to improve device and item tracking via the use of sensors and connections. Using real-time data and analytics, they may improve their decision-making. The other two labels of the dataset may be used to identify the type of incursion activity and its subtype in future research. Other learning methods, both supervised and unsupervised should be investigated. It is also possible to test the suggested method on other IoT intrusion detection datasets for more security reasons.

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