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ijrset@gmail.com

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Machine Learning for IoT: A Review

Aryaman Yaduvanshi ¹

Student, Delhi Technological University, Delhi, India¹

ABSTRACT: With the advent of rapid improvements and the help of IoT, many smart devices can now be connected to one another. The Internet of Things (IoT) is a technology that connects multiple devices via the Internet and creates a variety of different features and quality of data. IoT and Machine Learning (ML) ensure progress in expanding IoT device and application findings. Machine learning and Artificial Intelligence have come a long way in the past few years. It enables a system or machine to learn better than humans. When we learn a system concerning from our experiment or knowledge, we have gained it after analyzing it. Combining IoT with fast-evolving machine learning technology can lead to breakthroughs in various industries. Machine learning is a suitable answer for the IoT world for at least two main reasons. The first is the amount of data and the opportunities for automation. The second is because of the foresight research. Machine learning can help with data monitoring, processing, systematic inquiry, and smart application in various sectors. In addition, it may be useful in assisting users in processing large amounts of data. As a result, this literature review focuses on how machine learning benefits IoT, how they interact, and their significance in diverse industries such as building, manufacturing, and farming.

KEYWORDS: IoT, Smart devices, Machine Learning, Artificial Intelligence, Automation, Research, Data monitoring, Systematic inquiry, Smart application, Diverse industries.

I. INTRODUCTION

IoT gadgets (Senthil Kumar, Suresh, Lekashri, Babu Loganathan, & Manikandan, 2021) are getting increasingly popular these days. The growing usage of IoT generates vast quantities of unprocessed data. This data can be processed successfully using machine learning to obtain a plethora of helpful insights that can impact industry players and significantly impact our lives.

Machine learning is advancing rapidly, paralleling the expansion of the Internet of Things. Tiny cameras, sensors, and other IoT components (Chen, Tang, Lu, Wu, Duan, Huang, & Tang, 2019) are already common, installed in laptops, mobile phones, traffic control centers, parking lots, and home appliances. In addition, lots of IoT devices are in use around the world, with more being produced each day. They gather vast volumes of data and feed it to machines through the Internet, allowing the systems to 'learn' from the data and improve their efficiency. It's vital to remember that a single device or component can produce enormous amounts of data per second in the Internet of Things. All of this IoT data is sent to servers or gateways in order to improve machine learning models (Wexler, Pushkarna, Bolukbasi, Wattenberg, Viégas, & Wilson, 2019). Data analytics software can turn this unprocessed data into actionable insights, allowing the machine to become more sophisticated and operate better while remaining cost-effective and long-lasting. The majority of the data captured by such devices is about machines.

Machines can learn better and conquer their inherent flaws by utilizing this data; you can:

- Imbibe and convert the data into a uniform form with machine learning for IoT
- Construct an ML model
- Use this ML model on edge, cloud, and devices.

An organization can, for example, automate quality check and error monitoring on its assembly line, track asset activities in the field, and estimate utilization and demand patterns using ML.

II. UNDERSTANDING MACHINE LEARNING

Machine learning (ML) is (Greener, Kandathil, Moffat, & Jones, 2022) studying computer algorithms that develop on their own with data and expertise. It is an artificial intelligence (AI) component. ML algorithms (Mahesh, 2020) create a model based on training data to predict or judge without having to be programmed. These algorithms are utilized in many types of applications, including medicine, speech recognition, email filtering, and computer vision, where developing traditional algorithms to do the required tasks is tedious or impossible. However, not all machine learning is statistical learning. Machine learning subset is yet strongly relevant to computational statistics, which is predicting using computers. The discipline of machine learning benefits from the study of mathematical optimization since it provides tools, theory, and application areas. Data mining (Sugiyarti, Jasmi, Basiron, Huda, Shankar, & Maselena, 2018) is a branch of research that focuses on unsupervised learning for exploratory data analysis. Data and neuronal networks are used in some machine learning implementations to replicate the functioning of a brain. Machine learning, also known as predictive analytics, is used to solve business challenges.

Learning algorithms are based on the assumption that methods, algorithms, and conclusions that have worked in the past would probably remain to work in the near future. These assumptions can be clear. Suppose because the sun has set every evening for past many decades, it will most likely west again tomorrow evening." "Y% of families include distinct geographic species with color options, thus Z% of possibility that unexplored teal ducks exist.

Machine learning programs can perform tasks without any explicit programming. Instead, it involves computers learning from data provided so that they carry out certain tasks. For simple tasks assigned to computers, it is possible to program algorithms telling the machine how to execute all steps required to solve the problem at hand; no learning is needed on the computer. However, it can be challenging for a human to create the needed algorithms (Ray, 2019, February) manually for more advanced tasks. In practice, it can be more effective to help the machine develop its algorithm. With this, having human programmers will not have to specify every step.

III. UNDERSTANDING THE INTERNET OF THINGS

The Internet of Things (IoT) refers to tangible devices with sensors, processing power, software, and other advanced technologies and may communicate with other gadgets over the Internet or other communications infrastructure (Nauman, Qadri, Amjad, Zikria, Afzal, & Kim, 2020). Gadgets don't have to be linked to the open network, yet to a network and separately accessible.

The field has progressed because of the integration of numerous technologies, such as pervasive computing, sensors, embedded systems, and machine learning. Traditional domains such as embedded systems, control systems, wireless sensor networks, and automation (including home and building automation) enabled the Internet of Things. In the consumer market, IoT must be closely associated with products that support the concept of the "smart home," such as thermostats, home security systems, lighting fixtures, cameras, and more that can be controlled by devices associated with smartphones, smart speakers and other such smart devices.

The strong rise in devices connected to and managed by the Internet has been a big thing in the IoT in recent times. Because of the wide range of applications for IoT technology, the details can vary greatly in each device, but there are some commonalities across them.

The Internet of Things allows for more direct integration of the real world with computer-based systems, leading to increased productivity, cost savings, and less human effort.

IV. MACHINE LEARNING BENEFITS IOT

For correctly forecasting coming events, machine learning is quite useful. Traditional data analytics creates static data models, whereas ML algorithms grow over time as additional data is acquired and incorporated. This implies that these algorithms in use can generate projections, contrast them to previous assumptions, observe what really occurs, and modify them to be even more precise.

ML can anticipate when an IoT device (Ghazal, Hasan, Alshurideh, Alzoubi, Ahmad, Akbar, & Akour, 2021) requires fixing; this is extremely useful, as it saves millions of dollars in repair expenditures. For example, Goldcorp, a mining business, is currently utilizing machine learning to anticipate when repairs are required with over 90% precision, resulting in significant cost savings.

Amazon and Netflix employ machine learning algorithms to learn about our tastes in order to deliver better

solutions for us, such as suggesting different things we might like and giving meaningful movie and TV show suggestions. In the case of IoT, machine learning can be highly useful in tailoring our surroundings to our specific preferences. Nest Thermostat, for example, uses machine learning to understand how hot or cold we prefer our houses to be, ensuring the house is at the appropriate temperature when we return home from work.

In any IoT circumstance, machine learning can really assist firms to clarify the billions of data points they have down to what's truly important to them.

Every machine that can generate and then aggregate such Big Data is expected to study typical behavior using machine learning and discover anything beyond the rule to examine any set of data from the IoT in real-time. That can help accurately detect previously known and new patterns.

V. RELATIONSHIP BETWEEN MACHINE LEARNING AND IOT

Millions of gadgets contribute to vast amounts of data generated by the Internet of Things. Data fuels machine learning and uses it to develop insights. Machine learning identifies patterns in previous behavior and creates a model for predicting subsequent behavior and occurrences.

The two provide insights previously hidden in data, allowing for faster, more automatic reactions and better decisions. By absorbing graphics, videos, and audios, machine learning for IoT can be used to forecast future trends, detect anomalies, and augment intelligence.

By analyzing enormous volumes of data with advanced algorithms, machine learning can assist decode the hidden patterns in IoT data. Moreover, machine learning inference can complement or replace manual processes with automated systems that use statistically derived actions in essential operations.

Let's take a closer look at just how machine learning and the Internet of Things can work synergistically (Shahriar, Al-Ali, Osman, Dhou, & Nijim, 2020). Assume some grapes and oranges have a sophisticated nano camera and sensors to collect data from these fruits. Suppose the data acquired by grapes and oranges are sent over the Internet to a laptop. In that case, the laptop will begin analyzing the data with the cloud platform and sophisticated data analytics software. The laptop will now graphically display grapes and oranges on the left. It's most likely because the machine (laptop) hasn't learned enough. On the other hand, if the laptop can graphically depict how many of them are now ripe, unripe, or raw, the computer (laptop) has learned enough and has become more intelligent.

To achieve commercial and machine learning value, storing, processing, analyzing, and being able to reason out utilizing IoT data necessitates a large amount of computing and financial resources. Here are a few examples:

- Machine learning for IoT is being used by businesses to perform predictive capabilities on a wide range of use cases, allowing them to acquire new insights and increased automation possibilities.
- Many sensors record speed, temperature, airflow dynamics, fuel consumption, operating mechanisms, and other parameters on an Airbus aircraft nowadays. All data collected by IoT devices is transmitted over the Internet to cloud platforms such as Microsoft Azure, IBM Watson, and others. Useful data is supplied back to the machine, i.e., the airplane, using advanced data analytics software.

Using this information, the machine may learn to find solutions to problems quickly, extending its life and improving its interpretation.

VI. MAJOR MACHINE LEARNING TECHNIQUES IMPLEMENTED IN IOT

After finally discussing machine learning, learning the latest trends, Internet of Things, smart devices, and that a device not necessarily requires an open network and a network is enough. Now let's learn the ML techniques (Saqib, Sha, & Wang, 2018, July) that support IoT:

- **Artificial neural networks:** This learning technique, also known as neural networking, is a form of learning technique. It's a learning algorithm that's based on the form and functionality of biological neural networks. Different calculations are organized in terms of an interconnected collection of artificially constructed neurons. This aids in the connectionist approach's processing of data. Modern neural networks are all non-linear statistical methods that are utilized in data modeling. They are mostly used to model complicated interactions between inputs and outputs, as well as to uncover data patterns.
- **K-means algorithms:** This solves a common node clustering concern with linear complexity and easy implementation. The K-means algorithm is used to handle various node clustering issues. It chooses K nodes at random to serve as the initial centroids for the various clusters. It uses a distance function to designate

each node with its closest centroid. The centroids are then recalculated using the current node memberships. If the convergence condition is confirmed to be valid, it comes to a halt; otherwise, it returns to the previous stage.

- **Inductive logic programming (ILP):** This is a way to govern a learning system using logical programming to represent various input instances, hypotheses, and background information. An ILP system can derive a hypothesized logic program if we encode any known background knowledge with specified sets of instances that comprise a logical database of the facts. This includes both positive and negative cases, and any programming language can be used to describe the hypotheses.
- **Clustering:** This is a method for grouping diverse observations into different clusters (sets), so all of the observations that belong to the same cluster are similarly based on some pre-determined criterion. However, all of the observations taken from distinct clusters are different. Various clustering approaches make various assumptions about the data structure. This is commonly described and then assessed using some similarity measures. It is a way of learning that is not monitored.
- **Bayesian networks:** This type of probabilistic graphical model uses a directed acyclic graph to describe a set of random variables with all of their conditional independencies. It can, for example, depict the probabilistic correlations between different ailments and their signs. If we are aware of the ailments, this network can quickly assess the likelihood of several ailments being present.
- **Decision tree learning:** A decision tree is used as the prediction model in decision tree learning, a form of ML technique. This model connects observation pertaining to an object to various conclusions about the object's desired value.
- **Association rule learning:** This technique identifies new and intriguing relationships among all the variables in massive databases.
- **K-nearest neighbors:** KNN algorithm is a supervised learning technique that uses the labels (also known as output values) of neighboring data samples to classify a data sample (also known as a query point). Essentially, this algorithm classifies the K types of clusters in such a way that the distance between them is kept to a minimum. This is a broad categorization algorithm of some sort.

VII. INTERNET OF THINGS AND ML IN DIFFERENT SECTORS

The Internet of Things (IoT) connects various businesses, including manufacturing, healthcare, building, and so on.

- **In farming**

Farming (Liakos, Busato, Moshou, Pearson, & Bochtis, 2018) is one of the most basic human activities. As a result, the human race will be happier and healthier. The adoption of IoT and machine learning in farming is also accelerating, with the total linked devices predicted to rise.

Each interaction between farming processes and farmers is becoming increasingly driven by data in modern farming. Even analytical tools provide the appropriate data at the appropriate moment. Slowly but surely, machine learning is offering the drive for the farming industry to expand and automate. It aids in the discovery of patterns and the extraction of information from massive amounts of structured and unstructured information.

- **In manufacturing**

Machine learning may make use of data that businesses already gather through sensors (Jamwal, Agrawal, Sharma, Kumar, Kumar, & Garza-Reyes, 2021). Industry 4.0, or the fourth industrial revolution, is being driven by the Internet of Things (IoT).

With the use of Machine Learning, more organizations are turning their production and sensor data into actionable insights, transforming conventional manufacturing into smart manufacturing. Using this information, the Machine Learning department can assist you in increasing uptime and production speed, final product quality, yield percentage, and production safety.

- **In buildings**

Climate change is a global issue, and countries have begun to mitigate its effects (Qolomany, Al-Fuqaha, Gupta, Benhaddou, Alwajidi, Qadir, & Fong, 2019). Furthermore, decreasing energy use in homes and commercial buildings must improve energy efficiency. Buildings with heating, ventilation and air conditioning (HVAC) systems must manage wasteful energy usage by shutting off devices automatically. The data is fed to the processor of the Smart Building Energy Management system via the Internet of Things (IoT), which may gather and evaluate enormous data on many aspects of a building (SBEMS). Machine learning algorithms must assess and mine the large volume of sensory data collected by sensors to estimate the number of occupants in each room and anticipate

future occupancy to support timely actions and better decision-making.

VIII. CONCLUSION

The machine can learn greatly benefit the Internet of Things or smart devices. The Internet of Things can link several devices and generate a variety of features and data quality. Data may be processed using machine learning to obtain useful insights that can substantially impact our lives. IoT devices may collect large amounts of data and send it via the Internet to machines, allowing them to 'learn' from the data and increase their performance. ML may also accurately predict future events. Machine learning algorithms can create projections and observations and change them to make them even more precise.

REFERENCES

- [1] Chen, X., Tang, S., Lu, Z., Wu, J., Duan, Y., Huang, S. C., & Tang, Q. (2019). iDiSC: A new approach to IoT-data-intensive service components deployment in edge-cloud-hybrid system. *IEEE Access*, 7, 59172-59184.
- [2] Ghazal, T. M., Hasan, M. K., Alshurideh, M. T., Alzoubi, H. M., Ahmad, M., Akbar, S. S., ... & Akour, I. A. (2021). IoT for smart cities: Machine learning approaches in smart healthcare—A review. *Future Internet*, 13(8), 218.
- [3] Greener, J. G., Kandathil, S. M., Moffat, L., & Jones, D. T. (2022). A guide to machine learning for biologists. *Nature Reviews Molecular Cell Biology*, 23(1), 40-55.
- [4] Jamwal, A., Agrawal, R., Sharma, M., Kumar, A., Kumar, V., & Garza-Reyes, J. A. A. (2021). Machine learning applications for sustainable manufacturing: a bibliometric-based review for future research. *Journal of Enterprise Information Management*.
- [5] Liakos, K. G., Busato, P., Moshou, D., Pearson, S., & Bochtis, D. (2018). Machine learning in agriculture: A review. *Sensors*, 18(8), 2674.
- [6] Mahesh, B. (2020). Machine learning algorithms-a review. *International Journal of Science and Research (IJSR).[Internet]*, 9, 381-386.
- [7] Nauman, A., Qadri, Y. A., Amjad, M., Zikria, Y. B., Afzal, M. K., & Kim, S. W. (2020). Multimedia Internet of Things: A comprehensive survey. *IEEE Access*, 8, 8202-8250.
- [8] Ray, S. (2019, February). A quick review of machine learning algorithms. In *2019 International conference on machine learning, big data, cloud and parallel computing (COMITCon)* (pp. 35-39). IEEE.
- [9] Qolomany, B., Al-Fuqaha, A., Gupta, A., Benhaddou, D., Alwajidi, S., Qadir, J., & Fong, A. C. (2019). Leveraging machine learning and big data for smart buildings: A comprehensive survey. *IEEE Access*, 7, 90316-90356.
- [10] Saqib, M., Sha, Y., & Wang, M. D. (2018, July). Early prediction of sepsis in EMR records using traditional ML techniques and deep learning LSTM networks. In *2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)* (pp. 4038-4041). IEEE.
- [11] Senthil Kumar, A., Suresh, G., Lekashri, S., Babu Loganathan, G., & Manikandan, R. (2021). Smart agriculture system with E-carbage using IoT. *International Journal of Modern Agriculture*, 10(1), 928-931.
- [12] Shahriar, S., Al-Ali, A. R., Osman, A. H., Dhou, S., & Nijim, M. (2020). Machine learning approaches for EV charging behavior: A review. *IEEE Access*, 8, 168980-168993.
- [13] Sugiyarti, E., Jasmi, K. A., Basiron, B., Huda, M., Shankar, K., & Maselena, A. (2018). Decision support system of scholarship grantee selection using data mining. *International Journal of Pure and Applied Mathematics*, 119(15), 2239-2249.
- [14] Wexler, J., Pushkarna, M., Bolukbasi, T., Wattenberg, M., Viégas, F., & Wilson, J. (2019). The what-if tool: Interactive probing of machine learning models. *IEEE transactions on visualization and computer graphics*, 26(1), 56-65.



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