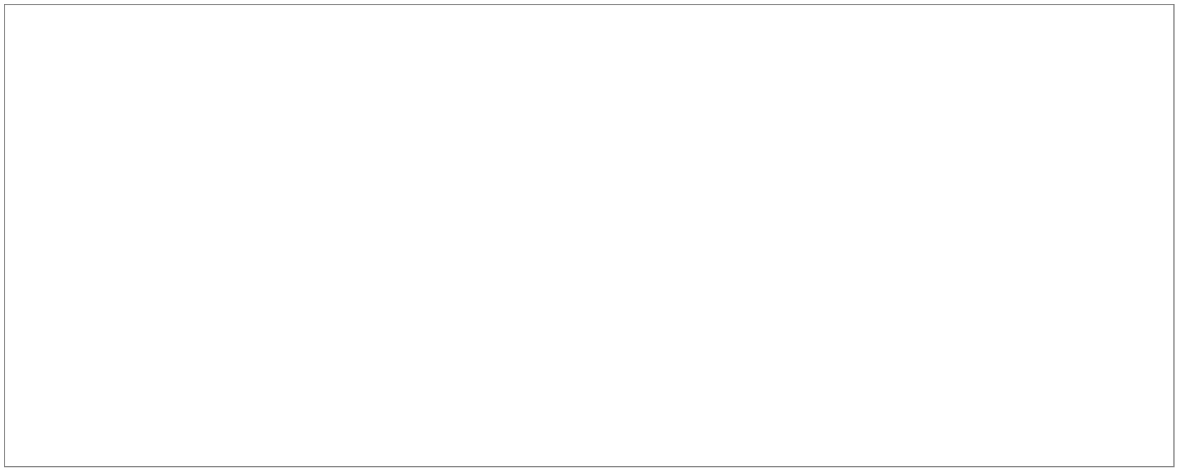
HEALTHCARE OUTCOM PREDICTION PROJECT

Abstract:

Machine learning (ML) is a powerful tool that delivers insights hidden in Internet of Things (IoT) data. These hybrid technologies work smartly to improve the decision-making process in different areas such as education, security, business, and the healthcare industry. ML empowers the IoT to demystify hidden patterns in bulk data for optimal prediction and recommendation systems. Healthcare has embraced IoT and ML so that automated machines make medical records, predict disease diagnoses, and, most importantly, conduct real-time monitoring of patients. Individual ML algorithms perform differently on different datasets. Due to the predictive results varying, this might impact the overall results. The variation in

prediction results looms large in the clinical decision-making process. Therefore, it is essential to understand the different ML algorithms used to handle IoT data in the healthcare sector. This article highlights well-known ML algorithms for classification and prediction and demonstrates how they have been used in the healthcare sector. The aim of this paper is to present a comprehensive overview of existing ML approaches and their application in IoT medical data. In a thorough analysis, we observe that different ML prediction algorithms have various shortcomings. Depending on the type of IoT dataset, we need to choose an optimal method to predict critical healthcare data. The paper also provides some examples of IoT and machine learning to predict future healthcare system trends.
Keywords: IoT; ML; health prediction system; classification; prediction; supervised learning



1.Introduction Health prediction systems help hospitals promptly reassign outpatients to less congested treatment facilities. They raise the number of patients who receive actual medical attention. A health prediction system addresses the common issue of sudden changes in patient flows in hospitals. The demand for healthcare services in many hospitals is driven by emergency events like ambulance arrivals during natural disasters and motor vehicle accidents, and regular outpatient demand [1]. Hospitals missing real-time data on patient flow often strain to meet demand, while nearby facilities might have fewer patients. The Internet of Things (IoT) creates a connection between virtual computers and physical things to facilitate communication. It enables the immediate

gathering of information through innovative microprocessor chips. It is worth noting that healthcare is the advancement and preservation of health through the diagnosis and prevention of disorders. Anomalies or ruptures occurring below the skin periphery can be analyzed through diagnostic devices such as SPECT, PET, MRI, and CT. Likewise, particular anomalous conditions such as epilepsy and heart attack can be monitored [2]. The surge in population and the erratic spread of chronic conditions has strained modern healthcare facilities. The overall demand for medical resources, including nurses, doctors, and hospital beds, is high [3]. In consequence, there is a need to decrease the pressure on healthcare schemes while preserving the quality and The IoT presents possible measures to decreases the strain exerted on healthcare systems. For instance, RFID systems are used in

medical facilities to decrease medical expenses and elevate healthcare provision. Notably, the cardiac impulses of patients are easily monitored by doctors via healthcare monitoring schemes, thus aiding doctors in offering an appropriate

diagnosis [5]. In a bid to offer steady transmission of wireless data, various wearable appliances have been developed. Despite the advantages of the IoT in healthcare, both IT experts and medical professionals worry about data security [6]. Consequently, numerous studies have assessed the integration of IoT with machine learning (ML) for supervising patients with medical disorders as a measure of safeguarding data integrity. The IoT has opened up a new era for the healthcare sector that enables professionals to connect with patients proactively. The IoT with machine learning evaluates emergency care demands to make a strategy to deal with the situation during specific seasons. Many outpatient departments face the problem of overcrowding in their waiting rooms [7]. The patients who visit hospitals suffer from varying conditions, with some requiring emergency medical attention. The situation is further exacerbated when patients with emergency care needs have to wait for a lengthy queue. The problem is aggravated in developing countries with under-staffed hospitals. Many patients commonly return home without receiving medical treatment due to overcrowding at hospitals. Yuvaraj and SriPreethaa created a wearable medical sensor

(WMS) platform made up of different applications and utilities [8]. The authors comprehensively analyzed the application of WMSs and their advances and compared their performance with other platforms. The authors discussed the advantages brought about by the applications of these devices in monitoring the health of patients with conditions such as

cardiac arrest and Alzheimer’s disease. Miotto et al. proposed a monitoring system that relies on a wireless sensor network (WSN) and fuzzy logic network [9]. Specifically, the researchers integrated micro-electromechanical systems (MEMS) set up with WSN to create a body sensor network (BSN) that regularly monitors abnormal changes in patients’ health. Notably, the authors developed a clinical data measuring system using devices such as a microcontroller, pulse, and temperature sensor [10]. Additionally, the proposed system was integrated with base station appliances to remotely regulate the pulse and temperature of patients as well as convey the patient’s data to the medical practitioner’s phone. Notably, the system can send an SMS to both the

patient’s relatives and medical experts in emergency scenarios [3]. Therefore, the patients can acquire a remote prescription from medical practitioners using this system. Moreover, the IoT application has made it possible for hospitals to monitor the vital signs of patients with chronic conditions [11,12]. The system uses such information to predict patient health status in different ways. IoT sensors are placed on the patient’s body to detect and recognise their activity and to predict the likely health condition. For example, the IoT sensors system monitors diabetes patients to predict disease trends and any abnormal status in patients. Through the health prediction system, patients can receive suggestions of alternative hospitals where they might seek treatment. Those who do not want to visit other facilities can choose to stay in the same facility but face the possibility of long waiting queues or returning home without treatment. Rajkomar et al. [13] proposed a Zigbee Technology-hinged and BSN healthcare surveillance platform to remotely monitor patients via clinical

sensor data. In particular, they utilized standards such as Zigbee IEEE 802.15.4 protocol, temperature signals, spirometer data, heart rate, and electrocardiogram to assess the health status of patients [14]. The acquired data are then relayed via radio frequencies and displayed on visual appliances including desktop computers or mobile devices. Therefore, the proposed platform could monitor attributes of patients including temperature, glucose, respiratory, EEG (electroencephalogram), ECG (electrocardiogram), and BP (blood pressure), and relay them to a database via Wi-Fi or GPRS. Once the sensor data are offered to the Zigbee, they are conveyed to a different network, permitting their visualization on appliances such as emergency devices and the mobile phones of doctors and relatives [10]. Accordingly, the integration of IoT with machine learning eases the Forecasting 2021, 3 183 management of healthcare in patients by enhancing the connection between patients and doctors. The IoT offers systems for supervising and monitoring patients via sensor networks made up of both software and hardware. The latter includes appliances such as the Raspberry Pi board, blood pressure sensors, temperature

sensors, and heart rate sensors. The software process entails the recording of sensor data, data cloud storage, and the evaluation of information stored in the cloud to assess for health anomalies [15]. Nonetheless, anomalies usually develop when there exist anonymous activities in unknown body parts. For instance, the heartbeat tends to be elevated when seizures occur in the brain [16]. As a result, machine learning techniques are applied to integrate the heart rate sensor with Raspberry Pi boards to display abnormal results via either an LCD or a serial monitor. Due to the vast volume of data, cloud computing is applied to

store the information and enhance data analysis [17]. Various open-source cloud computing platforms are compatible with the Raspbian Jessi and Raspberry Pi board [18]. These devices utilize machine learning algorithms to assess the stored data to recognize the existence of any anomalies [19]. Therefore, the application of machine learning in IoT helps in predicting anomalies resulting from unrecognized activities in different body parts. It is paramount to note that machine learning is an artificial intelligence (AI) discipline. The primary

objective of machine learning is to learns from experience and paradigms. In contrast to classical techniques of simply generating code, big data are input to the generic algorithm and analysis conducted using available data [20]. Big data allow the IoT and machine learning systems to easily train a system by applying simple data for predicting medical anomalies. The accuracy of predictions is directly proportional to the quantity of big data trained [21]. Therefore, big data enhance the prediction ability of machine learning techniques utilized in healthcare prediction platforms. Fortunately, patient load prediction models are based on machine learning for prompt patient load information sharing among hospitals. In a hospital, the historical data are captured and used to forecast the future patient load to ensure adequate preparation. IoT devices with embedded machine learning methods are used to train a classifier that can detect specific health events such as falls among elderly patients. The clustering algorithms can effectively identify abnormal patterns of behaviour among patients and send out alarms to healthcare providers. Similarly, the daily activity of a patient is monitored through daily habit modelling with IoT microchips.

The information is utilised for detecting anomalies among older adults. This paper intends to

analyse the most well-known ML algorithms for the classification and prediction of IoT data in the healthcare sector. We have analysed their working while comparing them based on different parameters. The study further compares existing literature, highlights their features and shortcomings, and discusses possible gaps in each approach in order to select appropriate algorithms for building an efficient prediction model. From this research, we find that K-Nearest Neighbor (KNN) may be the most popular algorithm for classification and prediction task. However, it could take a long time to predict the output in real-time applications. Therefore, some researchers have claimed that combining Long Short-Term Memory Neural Network (LSTM) with recurrent neural networks (RNN) might improve the prediction performance. In this research we are addressing the following question: How can IoT data with machine-based algorithms develop a better healthcare prediction system? The rest of the paper is organized as follows: Section 2 discuss the ML models and classification. Section

3 discusses the most recognisable ML algorithms that are used for variety and prediction application. Section 4 discusses ML algorithm applications. Section 5 describes the use of the IoT and ML in the healthcare sector. Finally, Section 6 concludes the paper with further research directions.

6.Conclusions:

The healthcare sector is one of the most complex in terms of the level of responsibility and strict regulations, which makes it an important and vital sector for innovations. The Internet of things (IoT) has opened up a world of possibilities in the healthcare sector and could be the solution to many problems. Applying the medical IoT will bring about great opportunities for telemedicine, remote monitoring of patients' condition, and much more. This could be possible with the help of ML models. In this article, we summarised the most powerful ML algorithms, listed some ML applications in the healthcare field, and analysed IoT and machine learning in the healthcare system to predict future trends

Author Contributions: Conceptualization, A.A. and B.A.; methodology, A.A.; formal analysis, A.A., B.A. and W.H.; investigation, A.A., B.A.; resources, B.A.; writing—original draft preparation, A.A., B.A.; writing—review and editing, A.A., B.A., W.H.; supervision, W.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: The authors would like to acknowledge that the journal Forecasting waives the APC of the article, thanks to the journal.

Conflicts of Interest: The authors declare no conflict of interest

Coding:

```
x <- c(580, 7813, 28266, 59287, 75700,

87820, 95314, 126214, 218843, 471497,
```

936851, 1508725, 2072113)

```
# library required for decimal_date() function
library(lubridate)

# output to be created as png file
png(file ="predictiveAnalysis.png")

# creating time series object
# from date 22 January, 2020
mts <- ts(x, start = decimal_date(ymd("2020-01-22")),
frequency = 365.25 / 7)

# plotting the graph
plot(mts, xlab ="Weekly Data of sales",
ylab ="Total Revenue",
main ="Sales vs Revenue",
col.main ="darkgreen")

# saving the file
dev.off()
```

Output: