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Transforming m-Health with Artificial Intelligence and Big Data Analytics for Enhanced Healthcare Systems

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Abstract:

Using patient monitors and mobile devices, m-health aims to transform healthcare. Over time, m-health systems have merged AI and big data analytics to improve patient care. From EHRs, medical images, and written papers, the healthcare industry generates a mountain of complex, unstructured data. Accessing and analyzing data becomes harder with frequent mobile app use. Another high-level overview of how AI and big data analytics improve m-health systems follows. Best big data, AI methods, and data source frameworks are examined. To identify and address specific issues in m-health resource allocation and planning, this research applies these techniques. The paper introduces the AIHealthX paradigm for big data analytics-based mobile health solutions. By improving m-health data administration and evaluation, this approach aims to transform healthcare systems. Study findings define AIHealthX's future, which integrates AI and large data analytics. Integrating AI and big data analytics into this unified approach could improve healthcare outcomes and mobile health. The purpose of this article is to improve mobile services for patient monitoring and healthcare delivery to create more efficient health ecosystems.

Keywords: Artificial Intelligence; m-Health; Big Data Analytics; Healthcare Systems; Mobile Health Solutions; Electronic Health Records.

1. Introduction

The study concerning the way public and private sectors are utilizing mobile technologies for health monitoring and treatment (e.g., cellphones, PDAs, etc.) is known as "mobile health."[1].Mobile phones' two most important features—voice and short messaging service (SMS)—are required to carry out the procedure. Approximately 40,000 mobile applications with a focus on healthcare are accessible globally, and there are over 500 m-health initiatives in development[2]. There are medical gadgets that are built for mobile devices that can specifically measure things like heart rates, blood pressures, glucose levels, sleep pattern, and brain activitys.

Along with simpler operations and services, it makes use of more complex ones, like the General Packet Radio Service (GPRS), mobile-based technologies of the third and fourth generations, GPS, and Bluetooth. Among the many types of healthcare-related big data are medical images, prescription and note files, MRI scans, CT scans, laboratory results, pharmacy paperwork, insurance EPR files, and data pertaining to administrative tasks.

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Worldwide, healthcare communities are showing a growing preference for +is. Nevertheless, knowing which computational approaches are necessary for this approach and which framework would be most suited is lacking[3]. Big data analytics includes analyzing large amounts of data from many sources. All of these data sets have unique formats and styles[4]. The study can use data mining and artificial intelligence (AI) and other analytical approaches to look at the data.

By using analytics for big data to enormous datasets from multiple sources, anomalies may be found. A few years prior, big data transformed mobile health [5]. Major worries persist about M-health and large-scale data analytics. Healthcare subjects like m-health, AI, and big data analysis are receiving innovative research. Improvements in mobile monitoring app medical data evaluation [6]. The study examined how the patient's sickness evolved in relation to key events using environmental momentary assessment (EMA) along with experience sampling techniques (ESMs). These real-time apps offer advice and self-administered tests to reduce memory. Mobile devices can secretly record user actions, according to new research [7]. With actigraphy, geolocation, and m-health integration, modern cellphones can track patient activities. M-health apps can remotely monitor many physical and mental health issues [8].

The patient able to self-report their health by means of a mobile health app that makes use of a variety of sensors.To find out how active the user is while recording, the authors of suggested a smartphone app that uses inertial sensors to identify human movement[9]. Additionally, their technology captures the user's galvanic skin response and heart rate signals to ascertain their emotional state.As far as m-health is concerned, the following are some of the more recent proposals: An enhanced ability to distinguish between structured and unstructured data supplied by various mobile and information sources[10]. With the use of 5G mobile health, health data was intelligently implemented and converted. If study wants to see which techniques are the most persuasive in getting people to modify their behavior for the better in terms of comfort and health, the study needs to do this study [11].

Medical imaging and other relevant diagnostic data can be better understood with the use of next-gen mobile imaging devices that are built and transmitted with strong, accurate, and encrypted data analytics. This work aims to address the specific challenges of mobile health by proposing a strategy that leverages AI and big data analytics (BDA) [12] to aid users in gaining insights and making plans. The primary goals are

- To include all relevant information on data sources, techniques, AI algorithms, and big data frameworks in your analysis of that AI and BDA are improving m-health systems.

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- To develop strategies for successful data management and interpretation, it is necessary to investigate the issues presented by the heterogeneous and unstructured nature of healthcare data.
- To improve healthcare delivery efficiency by integrating AI and BDA to find out how to best allocate resources and overcome certain problems in m-health.
- To introduce the AIHealthX model, a fresh strategy for m-health that uses AI and BDA together to improve data analysis and healthcare solution creation.

Below is an overview of the research that was conducted. In Section 2, the research methodology and literature that were used are reviewed extensively. In Section 3, the problem statement and Preliminaries are described. Information on the study's methodology, data collection, and analysis processes are complete in 4th Section. The analysis of the outcomes is detailed in 5th Section. In 6th Section, the primary findings and future endeavors are discussed and references are given in Section 7.

2. Related work

Table 1: Related Works

Reference	Proposed Idea	Techniques Used	Outcomes	Limitations
Yang et al. [13]	Influential usage of big data and AI in healthcare	Big Data Analytics(BDA), Artificial Intelligence	Enhanced healthcare delivery, improved decision-making	Data privacy concerns, ethical implications
Shafqat et al. [14]	Big data analytics and enhanced healthcare systems	Data Mining, Machine Learning and Predictive Analytics(ML-PA)	Optimization of healthcare processes, improved patient outcomes	Data quality issues, interoperability challenges
Rayam and Rehab[15]	Internet of Things for better mobile health applications	Internet of Things and Sensor Technology(IoT-ST), Data Fusion	Enhanced remote monitoring, personalized healthcare services	Connectivity and security vulnerabilities
Istahati et al. [16]	Artificial Intelligence(AI) based on Mobile Health Solutions	Machine Learning, Natural Language	Enhanced patient engagement,	Technical complexity,

	in the Health 4.0 Era	Processing, Mobile App Development	proactive health management	user adoption challenges
Renugadevi et al. [17]	Smart Healthcare Materials Revolution in BDA	Smart Materials, Data Analytics, Internet of Things (IoT)	Improved healthcare resource utilization, proactive maintenance	Cost implications, interoperability issues
Ramesh et al. [18]	A mobile health application system's AI-based dynamic prediction model	Artificial Intelligence, Predictive Modeling, Dynamic Systems	Real-time health predictions, personalized interventions	Model complexity, data variability
Srivastava et al. [19]	Implementation of AI in Medical Devices for Distant Medical Treatment	Artificial Intelligence, Internet of Medical Things (IoMT), Telemedicine	Remote healthcare accessibility, improved diagnostics	Connectivity issues, regulatory compliance
Saif-Ur-Rahman et al. [20]	AI and digital health improve LMIC primary health care delivery: A systematic review	Artificial Intelligence, Digital Health Technologies, Primary Healthcare	Enhanced healthcare access, improved population health	Resource constraints, data quality in low-resource settings

There have been a number of studies that have focused on the possibilities for healthcare decision-making and delivery that big data and AI offer. Research by Yang et al., for example, shows how big data analytics can help healthcare systems run more smoothly and provide better results for patients. In a separate study, Shafqat et al. investigate how the internet of things (IoT) can be used to enhance mobile health apps with the goal of providing remote monitoring and customized services. Patient involvement and proactive health management are the main topics of another study by Islahati that focuses on AI based solutions of mobile health in the Health 4 Era. In their pursuit of better resource use and preventative maintenance, Renugadevi and colleagues investigate the smart healthcare materials revolution in big data analytics. For mobile health application systems, Ramesh and Srivastava present a dynamic prediction model based on artificial intelligence (AI), with an emphasis on tailored interventions and real-time health predictions. The systematic research by Saif-Ur-Rahman delves at the potential of digital health and artificial intelligence to enhance primary healthcare service delivery in low- and middle-income nations.

3. Preliminaries

Big Data and AI's Importance in m-Health. It emphasises how technology may enhance healthcare and aid patients. It discusses the growing role of knowledge in healthcare, the benefits of AI and BDA in mobile health, the difficulties and possibilities of integrating advances in technology into healthcare systems, the position of data-driven choices regarding treatment, and the essential to adapt to the ever-changing healthcare industry. This section discusses how technology has transformed healthcare reform, advancing medical research and patient care, to prepare for debates about mobile health and BDA.

4. Proposed Methodology

Mobile health could be revolutionized by merging AI and big data analytics. EHRs, MRIs, and written records are difficult to manage and comprehend. This approach addresses it. The article investigates the benefits associated with mobile health systems with AI and big data analysis. We discuss data sources, methodologies, AI algorithms, and big data frameworks. AIHealthX seeks to improve healthcare systems by simplifying mobile health data management and analysis.

This model integrates artificial intelligence with massive data analysis tailored to m-health applications. In order to improve healthcare outcomes and promote innovations in m-health, the results highlight the complimentary integration of massive amounts of data with AI, which serves as a roadmap to future development. The paper lays forth a strategy to use m-health systems' AI and analytics skills for big data to enhance the delivery of healthcare and patient monitoring using mobile solutions. In conclusion, the recommended strategy highlights the revolutionary power of AI and massive data analytics to revamp M-health systems and enhance healthcare delivery with cutting-edge technical answers.

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Mobile Health

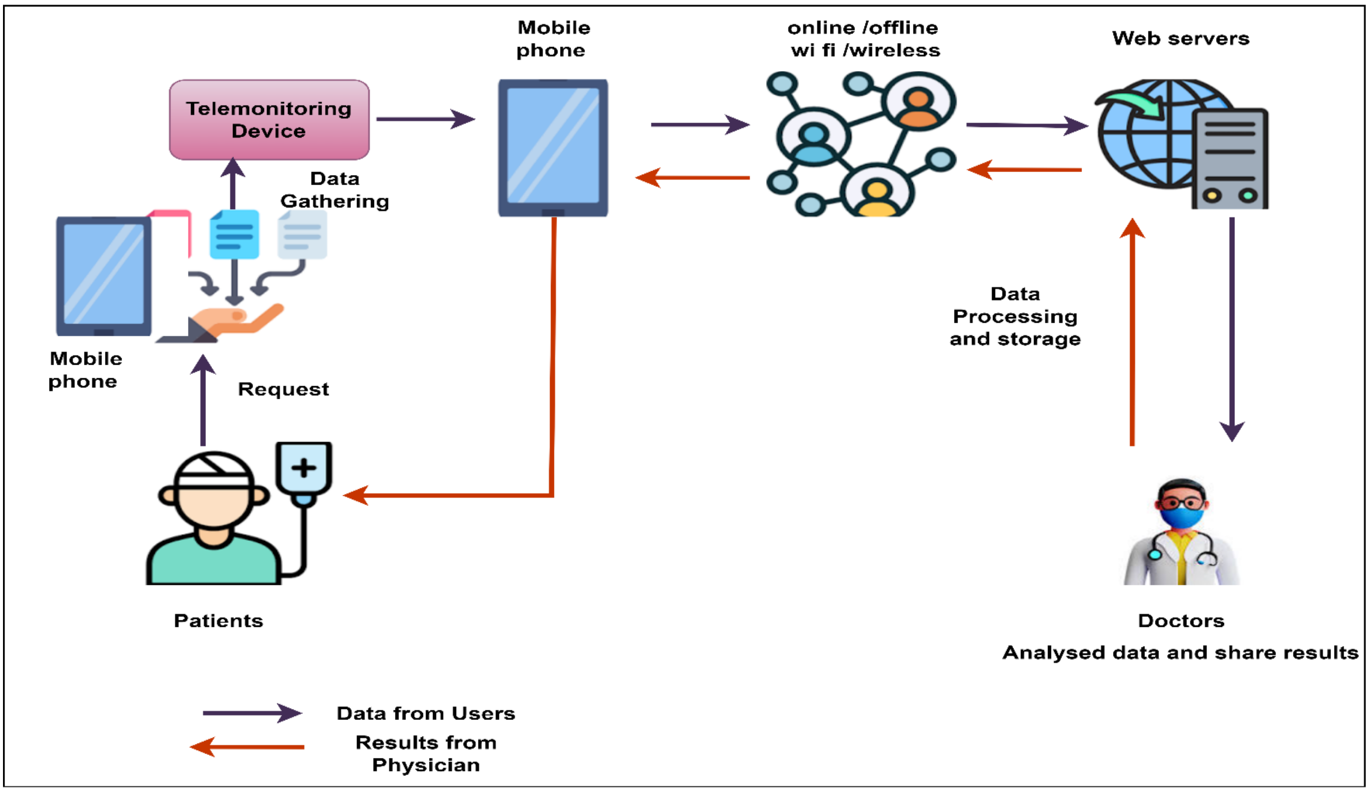

Fig 1. Illustration of the m-health scenario

In fig1, The emerging discipline of mobile health (m-Health) seeks to enhance healthcare delivery by integrating portable gadgets, medical-based sensors, and mobile phones. It includes healthcare management apps, apps pertaining to medicine, and apps pertaining to general health and fitness. Wearables, embedded systems, position trackers, or legacy-based sensor devices are just a few examples of the technologies that M-Health is developing with the hope of improving healthcare practices. Additionally, it delves into embedded technologies in healthcare, such as ubiquitous computing and wireless-based communication, to enhance the maintenance of health-based claims and to reach various rustic regions. The capacity to capture, store, retrieve, and send data to deliver real-time, individualised informatics is only one of several benefits offered by M-Health. In healthcare systems, it has the potential to monitor health status, improve patient safety, and enhance the quality of care. The smart device category is seeing its popularity rise as a result of its data collection and remote assistance capabilities. By experts predict that 2.87 billion people around the world will be using smart mobile devices. Affordable cellphones are equipped with all the features and capabilities needed to handle health-related apps, including the connectivity that is essential. Countries are increasingly investing in m-

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health as a means to promote wellness rather than costly medical intervention and hospitalization, raise health literacy levels in communities, and assist individuals in making informed decisions about their own health. In the medical field, mobile sensors like gyroscopes, accelerometers, microphones, and cameras have many potential uses.

AI-powered smartphone M-health model with BDA

The procedure of BDA in healthcare has the potential to transform patient care and the means clinical decisions are completed. This is a reference to the enormous and intricate health-related computerized databases that contain things like prescriptions, clinical notes, imaging data (CT and MRI), laboratory results, pharmacy paperwork, insurance records, and electronic protected record information. Scientists have come up with a lot of different ways to handle this kind of data, but nobody really knows which computational methodology framework is best. Big data is mainly categorized into two types: organized data and disorganized data. Organized data has a set format and length, whereas unorganized data does not. Medical records, prescriptions, and information gathered from at-home monitoring and treatment systems are all examples of organized data. The aim of BDA is to facilitate decision-creation in real time by calculating substantial totals of data in a variety of forms and from a variety of sources.

In fig 2, The collected data can be examined using a diversity of analytics methods, with data mining and AI. Through the analysis of massive amounts of data from several datasets and their origins, big data analytics is able to spot outliers. A norm that has gained widespread acceptance and implementation in practice is the digitization of all clinical and medical evaluations, which produces massive amounts of data and records. Computerized medical records that detail a patient's mental and physical health are known as electronic health records (EHRs). By improving access to patients' medical records and facilitating quicker data retrieval, healthcare big data has become an integral part of contemporary healthcare systems. EHRs and EMRs can better store medical and clinical data, saving money and improving service quality.

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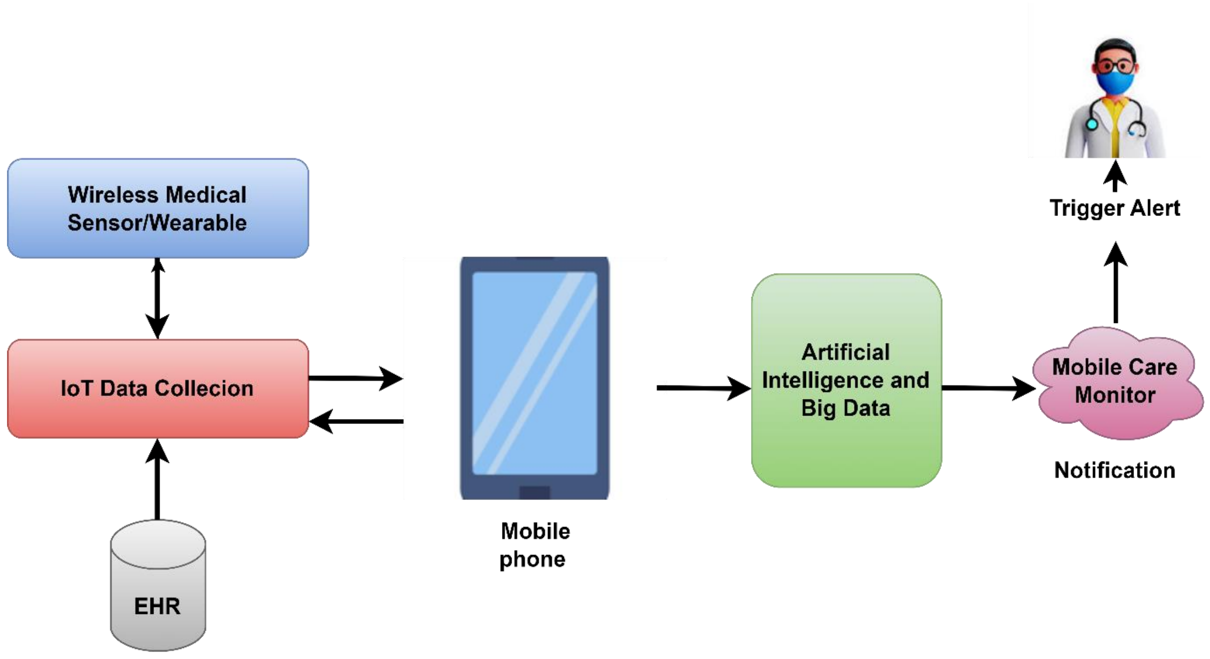

Fig 2. AI-powered smartphone m-health model with big data analytics

Proposed AIHealthX Architecture

The suggested solution introduces the AIHealthX framework, a mobile health model that uses AI and big data analytics. The system has three main components: a solid foundation for artificial intelligence along with big data analytics, telemonitoring tools as well as mobile devices to collect patient medical data, and the ability to provide perspectives to the mobile care monitor. The architecture format allows healthcare organizations to service AI as well as big data for actual time decision making by handling huge, heterogeneous datasets from several sources.

According to Figure 3, the most important components of the AI-based engines that are a part of the AIHealthX framework include the stream analysis module including its AI-based reporting technology. While the stream analysis module is responsible for handling data queries, the AI-based report management system is responsible for generating complete insights and analyses on the patient's current wellness. In order to identify diseases, detect irregularities in the system's information streams, and extract relevant properties using electronic health records (EHRs), this method makes use of the capabilities of artificial intelligence by utilizing these skills. The information is retained in the big data processors once the processing is finished so that it can be analyzed and improved upon at a later time. Despite the fact that it has a lot of benefits, the AIHealthX framework does have some restrictions. As outcome of budgetary constraints and a lack

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of familiarity with technology, accessibility may be restricted for a sizeable percentage of the population.

A dependency on technologies additionally dangers, such as the loss of information and breaches of user privacy. These hazards emerge from the dependence on technology. The framework is not capable of totally replacing human judgment, and there are still issues about privacy and security, despite the fact that it makes it easier to make decisions in real time and improves the efficiency of mobile health programs when it comes to making decisions. According to a summary, the grouping of AI and BDA in the AIHealthX framework results in a considerable enhancement of m-Health capabilities, which in turn supports conclusion making in real time and increases the delivery of healthcare. It is possible that it will be the focus of future research endeavors to validate artificial intelligence models and evaluate the clinical value of these models inside mobile health systems.

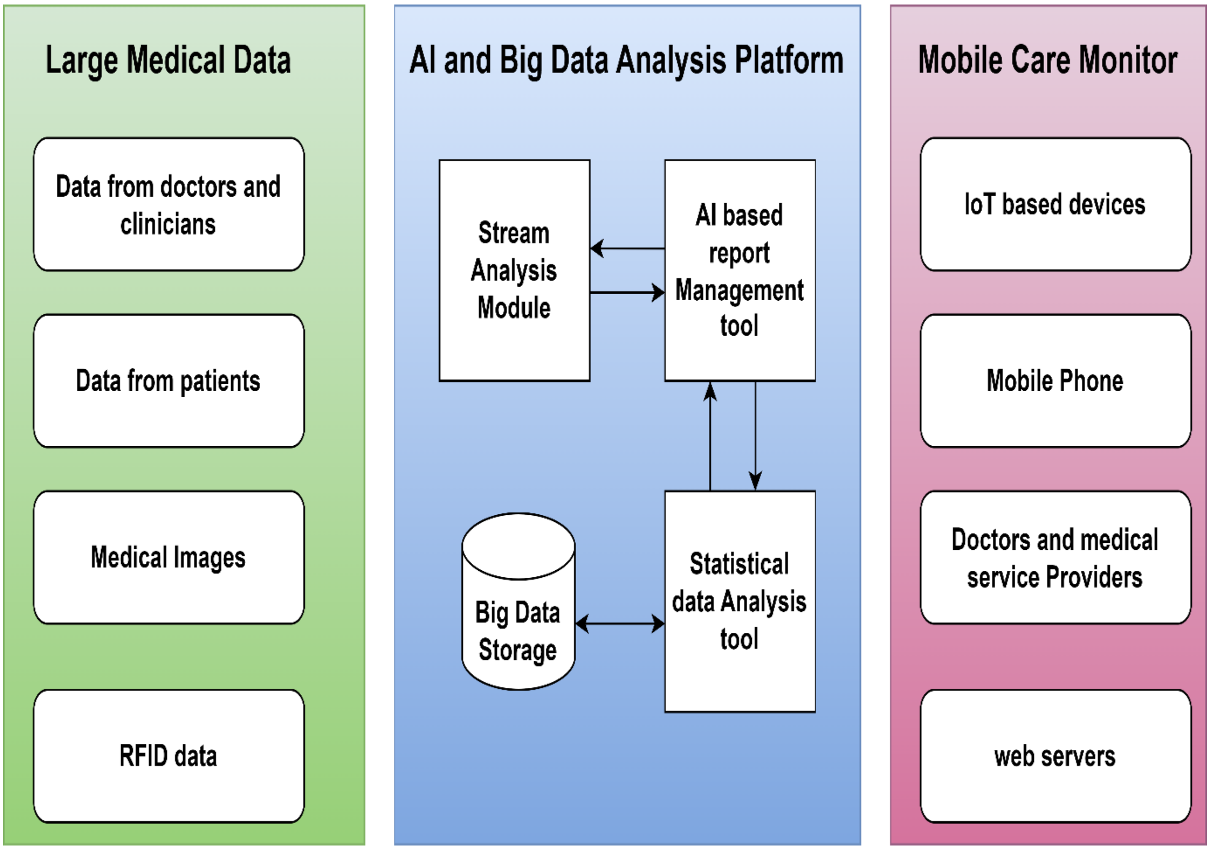

Fig 3. Architecture of the proposed AIHealthX

Furthermore, the investigation of the application of intelligent agents has the possible to significantly enhance the capabilities of the AIHealthX framework in terms of revolutionizing the management of healthcare delivery.

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5. Result and Discussion

Dataset study

An EHR dataset [21] prepared using the open-source application SyntheaTM and formatted in JSON is known as the Synthea Dataset Jsons - EHR. Information on demographics, medical history, prescriptions, procedures, and encounters are all part of it. The collection contains information about healthcare providers, synthetic patients, their demographics, medical conditions, drugs, treatments, and healthcare encounters. For healthcare analytics, clinical decision support, healthcare system simulation, machine learning model building, and synthetic patient data analysis, it is an invaluable resource for researchers, developers, and healthcare practitioners. The synthetic data provided by SyntheaTM allows users to investigate and assess potential healthcare scenarios without endangering the privacy or confidentiality of patients. The MITRE Corporation's open-source project SyntheaTM was used to build the dataset, which pays tribute to contributions from a range of healthcare and technology industries. This research would not have been possible without the help of many people and groups in the medical and IT fields who worked on improving and developing the SyntheaTM tool and related materials.

Prediction Accuracy

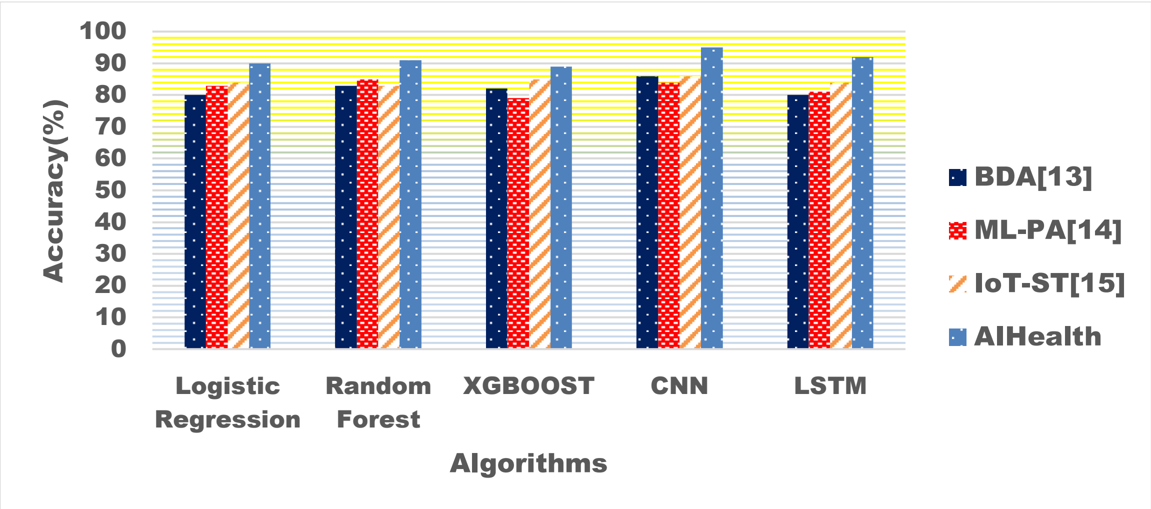

Fig 4. Prediction Accuracy

In fig 4,Different machine learning models and processes, such as logistic regression algorithm, random forest algorithm, XGBoost algorithm, CNN algorithm , and LSTM algorithm, are evaluated using this metric to determine how well they perform in accurately predicting health outcomes or disease risks based on mobile health data. All of the accuracy metrics, given in eqn (4), such as recall, precision, F1-measure, as given in

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eqn (1), and area under the receiver operating characteristic curve (AUC-ROC), are displayed along the y-axis. Higher values indicate greater predicted ability.

$$F1\ Score = 2 \times \left(\frac{Precision \times Recall}{Precision + Recall}\right) \quad (1)$$

where $Precision$ is shown in eqn (2), and $Recall$ is shown in eqn 3.

$$Precision = \frac{TP}{TP+FP} \quad (2)$$

$$Recall = \frac{TP}{TP+FN} \quad (3)$$

$$Overall\ Accuracy = \frac{TP+TN}{TP+TN+FP+FN} \quad (4)$$

where TP is the True Positives, TP is the True Negatives, FP is the False Positives and FN is the False Negatives.

Data Quality Assessment

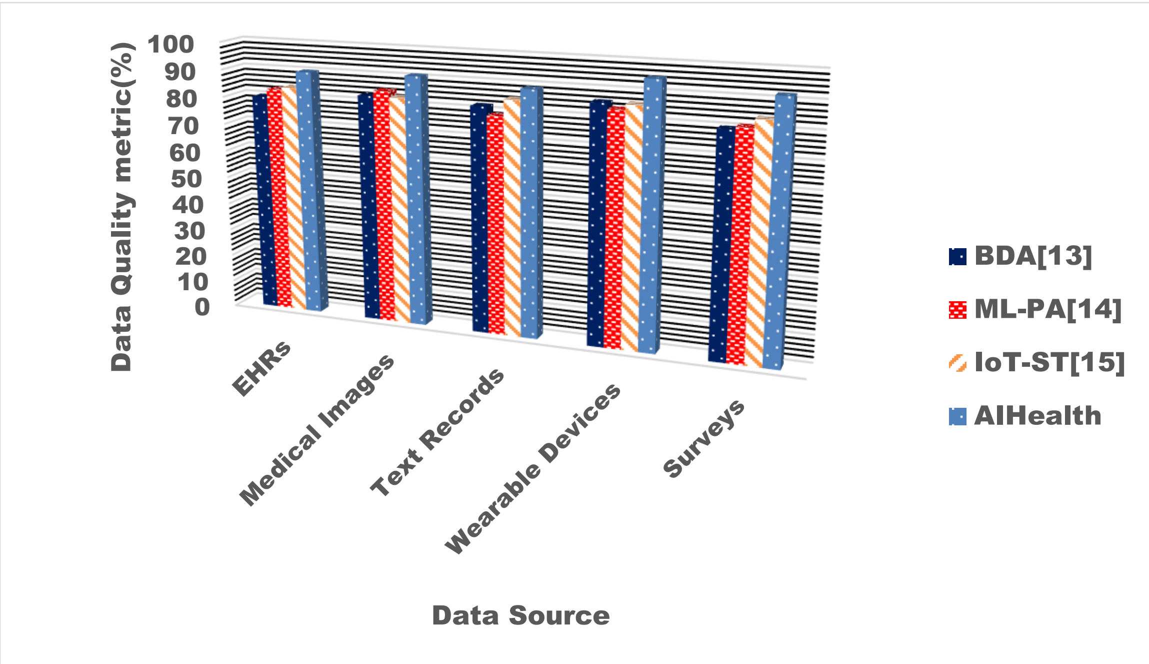

Fig 5. Data Quality Assessment

In fig 5,This statistic evaluates the quality of the many data sources that are incorporated into the mobile health system. These data sources include EHR, medical pictures, records of text, wearable devices data, and survey data. On the y-axis, which indicates data quality metrics , calculated from eqn (5),such as completeness, consistency, and accuracy, greater values indicate that the data quality for each source is higher.

$$Data\ Quality\ Score = \frac{w_1 \times Cm + w_2 \times Co + w_3 \times A}{w_1 + w_2 + w_3} \quad (5)$$

where w_1, w_2, w_3 are the weight assigned to each metrics based on their relative importance. Cm refers to the completeness and is calculated by the eqn (6), Co refers to the consistency and is calculated by the eqn 7 and A refers to the accuracy and is calculated by the eqn (8).

$$Cm = \frac{Number\ of\ fields\ with\ data}{Total\ number\ of\ fields} \tag{6}$$

$$Co = \frac{\text{Number of records without contradictions}}{\text{Total number of records}} \tag{7}$$

$$A = \frac{\text{Number of correct values}}{\text{Total number of values}} \tag{8}$$

Processing Efficiency

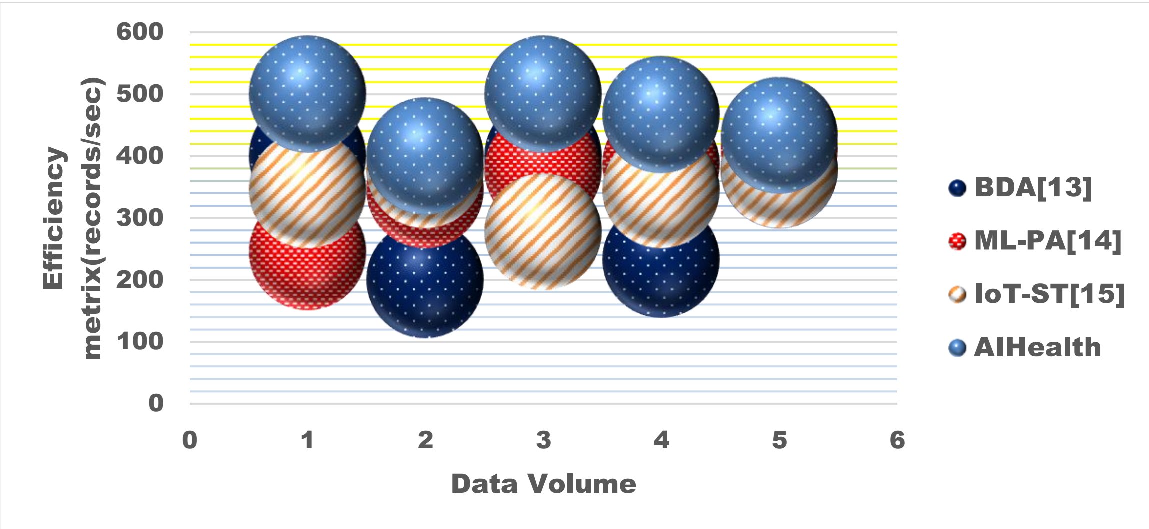

Fig 6 . Processing Efficiency

In fig 6,A variety of data quantities or computational loads, including 1 GB to 10 TB, are taken into consideration throughout this metric's evaluation of the effectiveness of the big data processing pipelines and the inference of the AI model. The throughput, also known as the number of records processed per second, is displayed along the y-axis and is shown in the eqn (9). This is an indicator of how effectively the system is able to handle large-scale data processing activities.

$$Processing\ Efficiency = \frac{Total\ number\ of\ records}{Processing\ Time} \tag{9}$$

Scalability

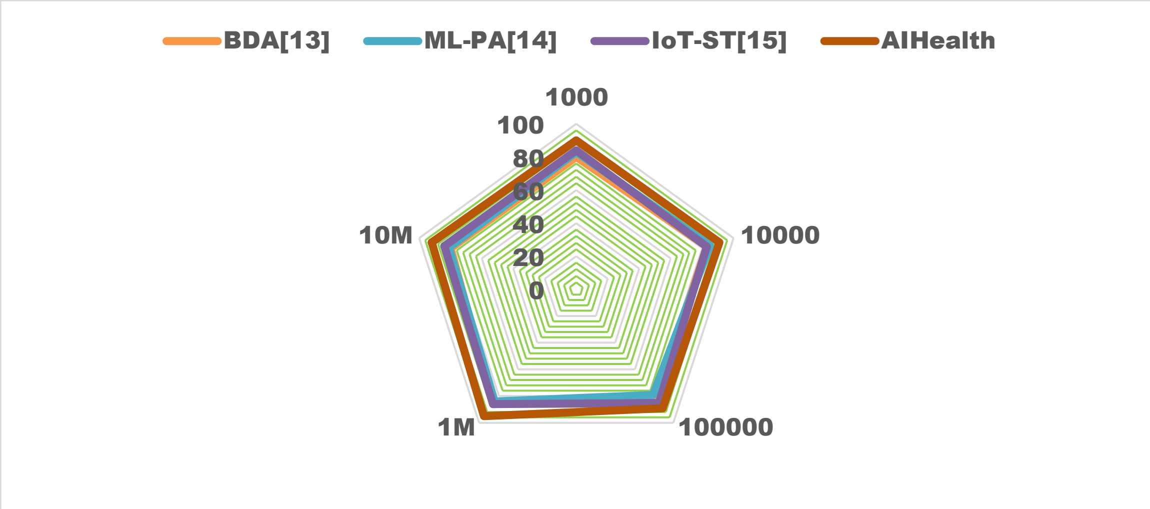

Fig 7. Scalability

In fig 7, Using this statistic, one may determine that well the mobile health system scales and maintains performance under varying user loads or computational needs .The throughput or reaction time of the system is represented as a percentage along the y-axis, and higher values of this axis indicate improved scalability can be obtained from the eqn (10) and performance when the load is raised.

$$Scalability = \left(\frac{\text{Performance at increased load}}{\text{Performance at baseline load}}\right) \times 100\% \quad (10)$$

6. Conclusion and Future work

A major step forward in healthcare delivery has been the incorporation of AI and BDA, also known as BDA, into m-health technology. To tackle the problems caused by the varied and unstructured healthcare information gathered from electronic health records (EHRs), medical pictures, and textual records, M-health systems are integrating BDA with AI. A mix of mobile devices and patient monitoring systems fuels these systems. The study aims to cover all the bases when it comes to mobile health systems in this essay, including the possible benefits of AI and BDA. Appropriate big data frameworks, sources of data, methodologies, and AI algorithms are explored to achieve this goal. By utilizing these technologies, mobile health systems are able to better organize and distribute resources, leading to better healthcare results. Further progress in this field can be achieved by following the AIHealthX model's outlined complimentary techniques of incorporating AI and analytics of big data into mobile health. Possible areas of future study for mobile health system AI and BDA include clinical integration, privacy and security, availability and scalability, and continuous innovation. Focusing future research on these areas could improve healthcare delivery with patient care, which in turn could lead to innovative mobile health systems utilizing AI and business data processing.

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