

Redefining Healthcare Practices with Big Data Analytics-Its Challenges And Future

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Abstract- Big data analytics has become the principle essence of almost every sector in today's life such as health-care, business and many other industries. Recent innovations in technology have completely changed the way our daily life operates as rapidly evolving advancements are leading to never ending thirst for bigger use of knowledge towards quality life. From past few decades, investigators in healthcare science and other medical-related fields are generating complex and high-dimensional data using diverse datasets and thus making these disciplines more data-intensive. Therefore, this is the right time to efficiently use the dig data analytics in healthcare and medical research to improve medication and patient care. Although big data analytics is accompanied with certain drawbacks and challenges when compared with prevailing conventional techniques but on the other side of the coin, big data is the integral part of various researches like in human genome, which holds the promising future for next generations. Big data makes it possible to obtain a consolidated data related to patient's health which finally enables to analyse and predict the consequences more precisely. Therefore, all these benefits of applying big data in healthcare may aid in improving the clinical operations, financial processes in medical sectors with digitized record maintenance, development of new drugs and early disease detection. Big data revolution has widened the horizons of healthcare and biomedical science as it provides open information pool about patient's previous health records for better diagnosis & assessment in future and thereby enhancing the clinical practices with effective medical services.

Keywords- Big Data Analytics, Healthcare, Medical Research, Biomedical Science, Architecture, Hadoop, HDFS (The Hadoop Distributed File System), Genome Analytics, Health Insurance Portability and Accountability Act (HIPAA)

I. OBJECTIVES OF RESEARCH

1. To study the overall impact and applications of big data analytics in healthcare systems.
2. To explore goals, architecture, methodology along with concerned challenges, opportunities and futuristic scope of big data application in healthcare sciences.

II. RESEARCH METHODOLOGY

This study is based upon Exploratory Research Technique. The secondary data is collected from different credited sources like international journals, reports, published articles and surveys. Collected data is analysed to reach the conclusion.

III. INTRODUCTION

Big data term has gained huge popularity from past couple of decades especially in science and other spheres. The data which exceeds the processing efficiency of traditional database systems can be termed as big data. Formerly, three Vs (volume, velocity and variety) were considered as the main characteristics of big data analytics. But with the progression of time and advances in data processing, storage and other system capabilities, big data now can be described with 6 V's. These 6 Vs are Volume, Velocity, Variety, Value, Variability and Veracity^[1]. Big data mainly focuses on correlated patterns to extract useful information. Big Data Analytics can be descriptive, predictive and prescriptive analytics^[2]. Big data is one of the most powerful resource in managing business operations and is also benefiting the modern lives in many ways. Similarly, big data application in healthcare and biomedical science plays important role in management of health related data and utilising important information in future for the patient benefit. In healthcare, big data may be referred as the electronic data sets which are difficult to manage using traditional methods, software/hardware. Smart Healthcare Devices like wearable sensors are also continuously generating huge amount of data in real time. Therefore, managing such data can be effectively performed with Big Data Analytics. Furthermore, some of the important categories of big data in Healthcare are genomic & clinical statistics, behavioural patterns, case sensitive data, administrative, data related to patient response and personal health information. In similar way, considering the fact that volume of health related data is predicted to rise noticeably in coming years, it has become more important to encounter privacy, security and infrastructure related challenges. For this purpose, healthcare providers should use the sophisticated technologies in appropriate manner to get potential benefits. This paper explores the purpose of implementing big data

analytics in healthcare and describes the involved architectural framework. Big data comes along with many challenges. Big data methodology, potential benefits and applications also discussed in this paper. Furthermore, special emphasis is given on challenges, futuristic scope and opportunities related to big data analytics in healthcare & medical science.

IV. BIG DATA ANALYTICS IN HEALTHCARE- GOALS, ARCHITECTURE AND METHODOLOGY

As this is the era of big data in information technology, either it is banking sector or a grocery store, different sectors have embraced big data to improve their profits. But when coming to the incorporation of big data in healthcare, it was accompanied with many obstacles. Due to this, healthcare industry was straggling behind other line of businesses^[3]. Presently, many forces as a whole are triggering the need for big data in healthcare sciences. Consequently, holding huge potential, overall goals of Big Data Analytics in healthcare are^[4]

1. Profiting and improving each element of healthcare including providers, payers, patients and management.
2. Personalizing the patient care along with reduced cost but at the same time focusing on improved outcomes with smarter decisions.
3. Taking the right action for improving any medical disorder to right patient on right time taking the benefit of data.
4. Identification of high risk patients in order to ensure their treatment effectively on right time.
5. Developing algorithms predicting the inpatient time in upcoming years.

Architectural Framework of Big Data Analytics in Healthcare

Big Data Analytics in Healthcare involves distributed processing implemented over miscellaneous nodes. But now, it also incorporates some open source platforms like Hadoop/MapReduce accessible on the cloud which persuaded the practice of big data analytics in healthcare. Recent big data analytic tools differ from traditional analytic tools because they are

1. Extremely complicated
2. Varied skill application demand
3. Programming concerted

Execution of big data application goes through three main processes involving architectural framework as mentioned below^[5]:

1. Obtaining the raw data: Data may be extracted from various sources like external (government forces, laboratories, pharmacies, insurance companies, HMOs), internal (computerised health records, CDSS i.e. clinical decision support systems), varied formats (flat files, relational database tables, ASCII codes and text), diverse geographical locations, multiple database applications (transaction processing system application, other databases). In addition, sources and data types may also include data generated from web, social media & healthcare devices, big transaction data, biometric and human generated data from physician notes and other documents.
2. Processing the extracted big data: Various approaches may be adopted to transform the extracted raw data such as distributed application software (Middleware), ETL (extract > transform > load), Enterprise Data Warehouse, Traditional format CSV and Tables.
3. Analysis of big data using big data platforms and tools: In this step, decisions are made according to the input approach and distributed design. Later on, it is followed by tool selection and analytical models. The tools that may be used for Big Data Analytics in Healthcare are Hadoop Distributed File System (HDFS), Hive, Zookeeper, H Base, Cassandra, Avro, Mahout.

Afterwards, final steps of Big Data Analytics application in healthcare may include checking the certainty through queries and survey reports, OLAP (Online Analytical Processing), data mining and visual representations. Hadoop (Apache Platform) is an open-source distributed platform for data processing and is one of the most outstanding big analytics tool. It belongs to NoSQL, CouchDB, MongoDB technologies. Hadoop may potentially help in data organisation and analysis. However, its installation, configuration, administration and finding appropriate skill workers for Hadoop may be challenging.

Implementation Procedure

Currently, it incorporates four main steps which are practical and hands on. These are:

1. Conceptualizing the statement and describing the significance of project.

2. In the second step, development of proposal is considered, where problem is addressed along with its importance. Also, some previous information is collected and use of big data analytic approach is justified.
3. In this step, the methodology is fragmented into propositions, selection of variables, Collection of data, ETL and transformation of data, to selection, conceptual model, analytic techniques, Association, clustering, classification, results and insights.
4. Finally, deployment is done through evaluation, validation and testing.

V. APPLICATIONS AND BENEFITS OF BIG DATA ANALYTICS IN HEALTHCARE

Big Data Analytics approach supports in overall growth of the sector. Some of the potential applications of Big Data Analytics in Healthcare are ^{[1][6]}

1. Designing and manufacturing medical devices: This may be accomplished by utilising the computational methods of big data.
2. Personalized patient care: This has now become a data driven approach. Moreover, it has led to a patient centred model in healthcare, as patients also participate actively in caring themselves. Therefore, big data has facilitated the personalized patient care.
3. Prevention and control in public health diseases: Analysis of public health data helps in identifying risk factors and disease outbreaks within a specific population through social media platforms. This may further help in creating awareness among people and hence preventing and controlling various diseases.
4. Clinical operations: Usage of Big Data Analytics may also help in determining the methods for diagnosis and treating patients in cost effective and clinically relevant ways.
5. E-platforms for consultation and diagnosis: Future is heading towards a smart Healthcare system offering a consultation and tele diagnosis to the patients which may help in real-time patient care with minimal adverse effects.
6. Pharmaceutical companies and medicines: Big Data Analytics may potentially assist in drug delivery (through analysing the patient related data immediately when required) and thus helping to offer evidence based medicine.
7. Medical education, research and development: Some of the potential uses of big data approach in the field of medical education maybe the identification of correlated data, deciding overall picture and regulating medical programmes, curriculum analysis and performing a gap

- analysis to find out possible disparities. Similarly, in research and development, predictive modelling, statistical tools, algorithms and analysis of clinical trials may help in deciding the risk-free medication and products before they reach in the market.
8. Analysis of clinical outcomes: Analysing the clinical outcomes may help in improving them for other and making efficient operational, clinical decisions through predicting the health risks on time.
 9. Smart Healthcare System: Application of big data in Healthcare may help in advancing and ameliorating various fields in Smart Healthcare System such as digital hospitals, telemedicines, smart healthcare devices.
 10. Genomics Analytics: Genomic data plays a crucial role in maintaining the complete patient record. Applying genomic and clinical data together, cancer treatment may become more easier than before.
 11. Fraud detection: Preventive Modelling and advanced analytics systems may successfully help in identification, prevention and predicting the fraud related risks and thereby minimising the fraud.

VI. CHALLENGES AND OPPORTUNITIES

Big data may be considered as a field involving intersection of natural sciences with the social science, commerce, humanity, computing and then executing big data for society ^[6]. Although big data application in healthcare and medical field has brought a revolution in enabling patient oriented services with better care and cost effective treatment. In contrast, many challenges are also associated in applying big data for health care benefits. Some of the main challenges are

1. Difficulties encountered in creating and analysing unorganised data (example- scanned documents, patient progress notes, images).
2. Difficulty in maintaining unified standards for validation, consolidation and data processing because of segmented management departments in hospitals / clinics.
3. As big data does not focus on casualty, therefore it creates difficulty in finding out the exact cause of the condition to offer an effective treatment ^[1].
4. Information security, date of visualisation, maintenance of budget, availability of skilled worker and infrastructure may also be a big challenge in adopting big data in healthcare sector.
5. Application of clinical data and genomic data in genomic analytics adds more complexity in genomic analysis and hence making it more computation intensive.

6. Capturing, categorising, processing and managing the continuously streaming data from smart healthcare devices and sensors is also a big challenge.
7. Collection of data may also involve certain privacy related issues such as confidential data maybe accessible on cloud at various networks.
8. To hold a competitive place in healthcare industry, lots of healthcare professionals are unwilling to share data which again hinders the path of openly accessing patient's data for health related predictions and other benefits.

Apart from these challenges, big data science holds a significant position in providing wide range of opportunities to the medical researchers and scientists with more accuracy. Besides, huge positive impact of research and practice maybe seen on circumventing the issues related to exchange of health information. Additionally, Big data application may give an opportunities to the researchers for studying effective treatment plans and integrating the large amount of data from literature to guide clinical practices, preserving scientific values at the same time.

VII. FUTURISTIC SCOPE AND POTENTIAL

Implementation of big data has reformed the traditional functional and operational ways of governments, educational institutes and business industries. Coming onto the future scope of big data analytics, IDC (International Data Corporation) made out several expectancies. Tools of visual data discovery are expected to grow 2.5 times quicker as compared to the business intelligence market. However, resource shortfall may still persist in future. Consequently, standards, management and search technologies may have a unified platform. Similarly big data analytics solutions are expected to grow rapidly. There will be increased consumer interaction based upon cognitive computing by 2018. Also, by 2019, 100 percent of large organisations may adopt purchasing external data. Data volume is expected to grow 44 times between 2009 and 2020 [7]. Likewise, several latest treatment procedures could be introduced. Big data may shift the paradigm through incorporating new value pathways. Therefore, understanding the potential benefits of big data analytics application in healthcare, it is very important to analyse the past events in order to direct the future strategies towards right way. For successful incorporation of big data in healthcare, real time analysis is the key requirement. Hence, achieving user-friendly and transparent technologies may result in rapid expansion of big data analytics in nearest future.

VIII. CONCLUSION

With the increased demand for big data analytics, healthcare has become a data rich arena. In healthcare, data is mainly obtained from diagnostic and treatment procedures. Also, predictive modelling helps in determining the future strategies and management plans more precisely. Apart from management, big data application in healthcare may successfully help in preventing various diseases. Mc Kinsey Global Institute has also given a prediction that 70-100 billion dollars could be saved by messaging the preventive information to the right people on right time using many technologies such as Hadoop [2]. Big data may significantly enhance the traditional therapeutic procedures via facilitating the adoption of newly developed methods. Evading the privacy related constraints and successfully guiding the clinicians to deliver value based patient-oriented care may ensure bright future of biomedical science and healthcare industry. This can also be achieved through carefully following the guidelines of Health Insurance Portability and Accountability Act (HIPAA) [8]. In addition payers must prioritise effective decision making and isolation of most important practices in order to perk up the expenditure of care. Similarly, providers should ensure consistency and comprehensive data sharing approach avoiding any privacy or security related constraints. Data ownership and security policies should be established to govern clinical and operational data. More emphasis should be given on improved patient care. In the same fashion, special attention should be given to consumer values and helping the partners to get the full benefit of scientific innovations. Stakeholders and healthcare service providers should also set diverse goals to secure a recognised position in competitive marketplace.

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