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Challenges and Opportunities in Big Data Applications over Smart Healthcare Services

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Abstract:*The eon of Big Data has arrived. Big data was the noted slogan of the year 2012. Before everyone realizes and appreciates what big data is it went out of thehill? In the current era, most of the enterprises are flooding in flooding data.The increase in usage of mobile devices, medical data analysis, Web analytics, social websites and other types of emerging technologies is creating a new path for the research in big data analytics. With data in hand, one can start the analysis, butwhere do you begin? And which type of analytics to be followed is most appropriate for your big data environment? This survey paper contributes towards Widespread Data Analytics Outline for improving the efficiency and effectiveness of healthcare services. In this paper, we investigate the recent progress and breakthroughs of big data applications in these health-care domains and summarize the challenges and opportunities to improve and advance big data applications in smart healthcare services.*

Keywords: *Big Data, Data Analytics, Challenges and Opportunities, Smart Healthcare Services.*

1. INTRODUCTION

The data outburst is gearing for healthcare application domain while stimulating challenges for Researchers and Scientists throughout the globe. Rather, big data outburst is providing exploration opportunities to grip insights of healthcare data for future interventions. The Data is also growing exponentially due to the outburst of machine-generated data like data records, web-log files, etc., and from growing human engagement within the social network like facebook, twitter, linkedin, etc.,[1]. In 2004, Wal-Mart claimed to have the largest data warehouse with 500 terabytes storage. In 2009, eBay storage amounted to eight petabytes. Before proceeding with the further discussion, one should know how much is equal to how much bytes.
Table 1 – conversions

1KB (Kilobytes)	1024 Bytes
1MB (Megabytes)	1024 KB
1GB (Gigabytes)	1024 MB
1TB (Terabytes)	1024 GB
1 PB (Petabyte)	1024 TB
1EB (Exabytes)	1024 PB
1ZB (Zettabyte)	1024 EB

A research study was made by IBM which says that IBM [3] estimates 2.5 quintillion bytes (2.5 exabytes) of data are created every day from a variety of sources. Futuristic analysis by CISCO says that the projected increase of global internet traffic in the middle of 2015 and 2016 alone is more than 330 exabytes, which is almost equal to the total amount of global IP traffic generated in 2011 (369 exabytes)" which is an unrespectable increase.

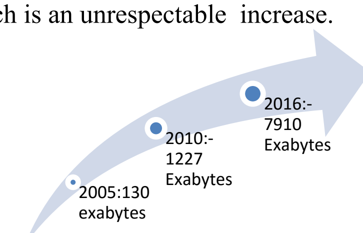

Figure 1 - Growth of data

Bigdata is typically highlighted by 6 V''s

1. Volume: Storage of excessive data. Where the massive volume of data is stored.
2. Velocity: Rate at which data is flowing. Data is flowing in at extraordinary speed.
3. Variety: combination of data formats (text, images, audio, video, etc.)
4. Veracity: uncertainty of data
5. Validity: correct data and accurate for the intended use.
6. Volatility: how long is data valid and how long should it be stored.

Before getting into big data analytics, we will understand what is data science, big data, and big data Analytics.

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Table 2 – Study of Data Science, Big Data, and Data Analytics

	Data science	Big data	Data Analytics
What is what	Processing to extract knowledge or insights from data. Simply related to data cleansing and analysis	extremely large data sets that may be analyzed computationally to reveal patterns	Reveal patterns and decision making in business moves on the right timeline.
Usage	Web search, advertisements	Mobile data, medical data	Health care, Government,
Skills required	Working with unstructured data, in-depth knowledge of SAS and R, python and Hadoop	Creativity and business skills	Mathematics, machine learning skills, and data visualization skills

Technologies Transforming Global Healthcare Solutions

Technologies like machine learning and big data help service providers to diagnose and prescribe proper medication in advance. Personalized diagnostics or a complete course of medication is the current scope of machine learning.

Data analytics offers several opportunities that support healthy behaviors. Health analytics help healthcare providers engage and support individuals outside the clinic. Analytical tools guide patient's behavior, rather than simply tracking it, giving individuals specific instructions to develop and maintain healthy behaviors. Significant advances have been made in this field for curing and managing diseases, extending life expectancy and improving the overall quality of life. If you think all is good, you are partially right; actually, new challenges are often presented often. The average life expectancy of humans is increasing; long-term health conditions demand continuous monitoring and ongoing treatment. These demands put additional pressure on already stretched healthcare systems and ever-increasing costs. The need of the hour is a solution for streamlining and lowering the costs of healthcare monitoring and delivery as well as improving the overall quality and making it accessible and convenient to patients.

II. CHALLENGES OF BIG DATA:

The challenges [3] include capture, store, search, sharing, transfer, analysis and visualization. Challenges can be viewed in 3 dimensions 1.data 2.process and 3. Management.

Data challenges

1. Volume: How to deal with the size of big data?
2. Variety: How to handle multiple data types, formats, etc.,?
3. Velocity: How to react with information overflow with in a period.
4. Veracity: data reliability, data quality, data availability: How can we handle uncertainty, missing values, etc.,? How good is the data? How broad is the analysis? How sufficient is the sampling resolution? How timely are the readings? How well understood are the sampling biases?
5. Data discovery: How to find good quality or relevant data in the data flood?
6. Data Assumptions:Is any assumptions made? How the assumption is relevant to data processing.
7. Data comprehensiveness: What are the implications of uncovered data?
8. Data Scalability: How far data scaling is done?

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Process challenges

9. Data capture: how data is captured from different sources?
10. Data Arrangement: how data is brought into the line from different sources?
11. Data Transformation: when and how data should be transformed original form data to data suitable for analysis?
12. Data modeling: what technique or Modelling or simulation is used?
13. Data visualization: how data is visualized? Is that a normal person can understand the output?

Management challenges: data privacy, security, governance and ethical issues.

14. Data privacy: how data privacy is preserved? What Level of privacy?
15. Data security: How secure is my enterprise data? How my data is used?
16. Data ethics: what legal issues are in my data? What about my ethical concern?
17. Data governance: how quality is my result? Any risk in applying any model?

BIG DATA CHALLENGES IN SMART HEALTHCARE

18. Understanding knowledge from complex heterogeneous patient sources. Leveraging the patient/data correlations in longitudinal records.
19. Understanding unstructured clinical notes in the right context.
20. Professionally supervision large volumes of medical imaging data and mining potentially useful information and biomarkers.
21. Investigating genomic data is a computationally serious task and uniting with standard clinical data adds additional layers of complexity.
22. Taking the patient's behavioral data through numerous sensors; their various social interactions and communications.

III.LEVELS OF BIG DATA

Big data analysis can be done in 4 levels

1. Educate: it deals with data assembly and business interpretations
2. Explore or discover: identify the relevant data from data source and spot the business needs and challenges.
3. Engage: use statistical modeling or any analytical technique to make some insights out of bigdata
4. Implementation or Execute: Deploy the analytics for more big data initiatives

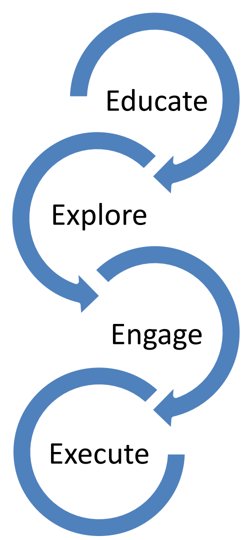

Figure 1 – Levels of Analytics

IV.SMARTHEALTH CARE FRAMEWORK

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In our smart health care Framework, we have been focused on some of the primitive Key Components of this framework.

1. **Sensing component**: this component has been used for sensing the patient information by fixing sensing devices inside the patient's ambient i,e healthcare institution, hospital, home. The sensors continuously monitor and collect a huge volume of data signifying the patient's dynamic signs, which is communicated to a dedicated data center. This will enable query processing in real time and various big data analytics.
2. **Big Data Center:**This is a data center that is responsible for the storage and processingof data from various sensors
3. **Surveillance Center:**Clinicians access and make inquiries on patient data in the observation center. Based on the types of data analytics and queries, alarms may be generated and sent to the Surveillance center (if necessary).
4. **Healthcare Systems:**Depending on the types of generated alarms, clinicians in the observation.Center may decide to approach other healthcare systems for consultation. Other healthcare systems will then respond to the clinicians' request.
5. **Control Applications:**Depending on the provided information (from the big data center component) combined with the clinicians' and specialists' medical knowledge (from the healthcare systems component), the clinician in the observation center may decide to send some decisions to the control/actuation component, which could involve invoking an alert/reminder, informing a care giver, or configuring a smart device. Finally, necessary measures will be conducted on the patients based on the invoked control applications.

In general, electronic medical record systems (EMR) are not designed to process and handle data of large volumes, velocity and of many varieties. EMR systems are also not designed to handle complex analytic operations such as anomaly detection, finding patterns in data, machine learning in addition to building complex algorithms for predictive modeling. Therefore, data analytics systems are finding their way in the health informatics domain not just for improving patient care outcomes but also to improve the quality of care, reduce costs and improve patient population health. In particular, healthcare analytics provide methods and processes for extracting and transforming raw medical data into meaningful insight, discovery and, knowledge that supports efficient and effective healthcare decisions. Specifically, healthcare analytics goes beyond the linear and descriptive analytics which is mostly driven by the need for reporting quality measures to cover broader and deeper methods to study and analyze the data such as machine learning, non-linear algorithms in addition to the introduction of multi-analysis approaches. In general, analytics techniques can generally be categorized into the following categories [52]:Big Data has immense potential to transform the healthcare industry; big data tools collect billions of data points which can be used for health management in Four key areas:

A. Descriptive analytics:the simplest class of analytics that allows you to crush big data into smaller which measure what has happened, such as frequency, costs, resources.

B. Predictive analyticsis the projection of what might happen in future because they are probabilistic i.e uses the descriptive data to forecast likely outcomes in the future.

C. *Prescriptive* analytics:is done by comparing or making analysis with various information. It predicts what will happen, when it will happen and why it will happen, and then how to take the value of predictivefuture. I.e. Provides the capability to make proactive decisions considering preempting predictions.

D: Diagnostic analysis: is used to understand why certain things happened and what the key drivers are. For example, why is disease infection increasing? Or why are some patients readmitting every month? Conventional techniques for diagnostic analysis are clustering, classification, decision trees, or content analysis.

Uses

- Identify potential localized outbreaks of illness and epidemics
- Improve diagnostic accuracy
- Create personalized treatment plans
- Reduce infection rates
- Provide advanced decision-making support

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Goals of Big Data Analytics in Healthcare

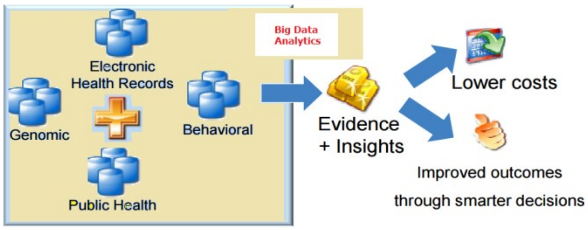

Fig 2.Big Data Analytics in Smart Healthcare

In practice, the design of the SmartHealth framework is aimed at supporting theprocess of modifying and improving the healthcare delivery model in various wayssuch as:

1. Take advantage of the massive amounts of data and provide right intervention to the right patient at the right time.
2. Personalized care to the patient. Improving the personalization of the healthcare process so that individuals can monitor and identify their risk factor identification, preventative intervention, and treatment, and enables patients to live independently while being taken care of, that has a significant positive impact on their psychological state, and subsequently on their physiological state.
3. Potentially benefit all the components of a healthcare system, i.e., provider, payer, patient, and management.
4. Relying on sensing-based screening and assessment technology in home and community environments to reduce the physical pressure on the environment of hospitals and turn it into an electronic flow of information.
5. Changing the medication process from a reactive model to a proactive and preventative model that can significantly minimize the expenses of hospital admissions for acute events.
6. Enabling better management of clinical workloads and allowing the healthcare system to prioritize the patients with the highest need effectively.
7. Supporting self-care diagnostic processes to monitor vital signs and other various measurements where these data are shared with a physician, in person or using teleconsultation, to perform a diagnosis. Furthermore, diagnosis can sometimes be automated for simple illnesses such as flu.
8. Optimizing the point-of-care tests by reducing the diagnosis time through minimizing the requirement to send samples away to be tested. For example, automatic testing using blood pressure cuffs and digital thermometers can support the physician to review a patient history while a measurement is being recorded.

Analytic Platform

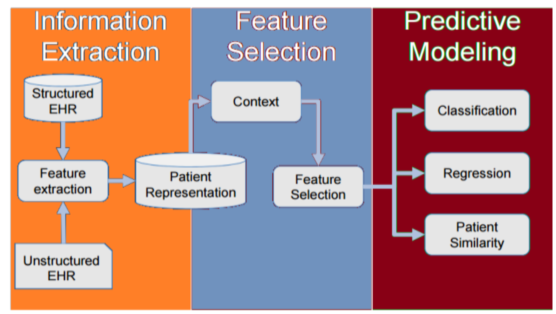

Fig 3. Big Data Analytics Platform in Smart Healthcare

V.CONCLUSION

This paper contributes towards widespread Data Analytics Outline for improving the efficiency and effectiveness of healthcare services. In this paper, we investigate the recent progress and breakthroughs of big data applications in these health-care domains and summarize the challenges and opportunities to improve and advance big data applications in smart healthcare services.

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