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Research Paper

Survey on Big data analytics in Healthcare Domain

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Abstract

These days, amount of data in different formats is increasing rapidly due to the use of different technologies and increasing use of Internet. In previous decades, data even if it is large, its format and sources are limited but now-a-days, massive amount of data is collected from different sources in different formats. This concept gave rise to new concept called "Big Data" which is a present trend to deal with the data. Analytics is one more crucial topic under big data which deals with the analysis and its integration with business process. Many books, tools, sub topics were raised from the "Big Data" where it takes a large amount of time to understand and to start to work with it. Hence, we are going to give a review on "Big Data", "Big Data Analytics" and its tools briefly. Here, Healthcare is taken as example to get the brief understanding on "Big Data and Analytics". This paper, we have also reviewed various big data frameworks with respective to data sources, application area, analytical capability and made study on various papers by presenting their methodology, tools, advantages and limitations.

Keywords: *Big data; Big Data Analytics; Health analytics; Tools.*

1. Introduction

In 1990s, data was measured in TERABYTES, which is used to be stored and accessed from databases using the tools ORACLE, SAP etc. Data is accessed using the key value and the data was available in a particular format which can be analyzed easily. Tools were developed to access those databases.
In 2000s, data was stored and accessed from access, excel, etc. The key values were on a dilemma, where the keys are applied upon some instances. The data was measured in TERABYTES, and the Internet came into existence. The data is transferred between systems in above said formats. Tools and plugins are developed to analyze the data present in these formats. Since the data is transferred between systems and key values are not there, the data started to move into different formats depending on the technology or tool being used.
In 2010s to present, data moved widely between machine to machine and machine to human where not only the formats differed but the size and content changed from system to system. The data here is being measured in EXABYTES. The different sources of data can be classified into the following types:

- Multimedia-which includes photos, videos etc. from the Internet.
- Mobile devices-which includes geospatial data, metadata about phone calls, messages, data gathered by mobile applications and internet usage etc.
- Business specific information includes the data gathered in a particular area like medical, government or other business.

All these described in Fig. 1. The Data analysis became the most tedious and hectic task to complete. This gave rise of the word called "Big Data" which became the buzz word now-a-days.

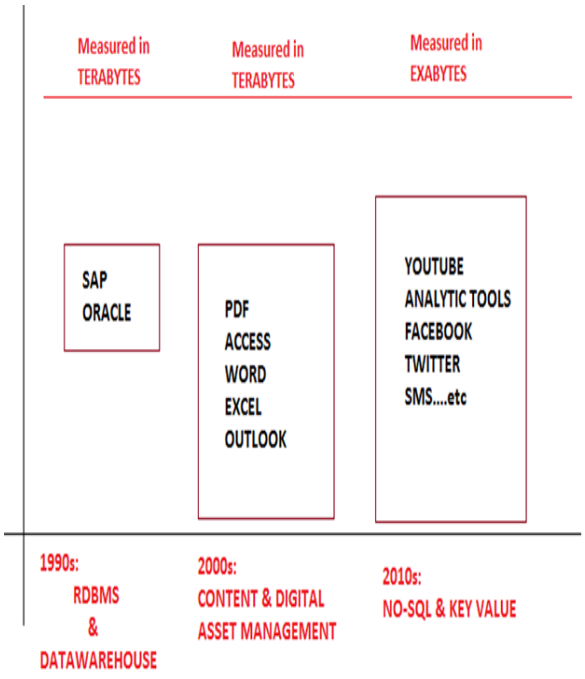


Fig. 1: Data Evaluation and rise of Big data sources.

From the following Fig. 2 demonstrates that here are dissimilarities displays in the quantity of data kept in disparate segments by means of produced & reserved data i.e. checking of data that remains in text or number format, audio, Images, video contrast from one business to another business [1]. Areas belonging to Insurance, Health care and Banking are accountable for

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text/numeric data. Media and Communication square measure extremely chargeable for video and audio style of information. The subsequent Fig. 2: Variations probable in producing and development of knowledge by exploitation sorts like video, audio etc. in numerous sectors [1].

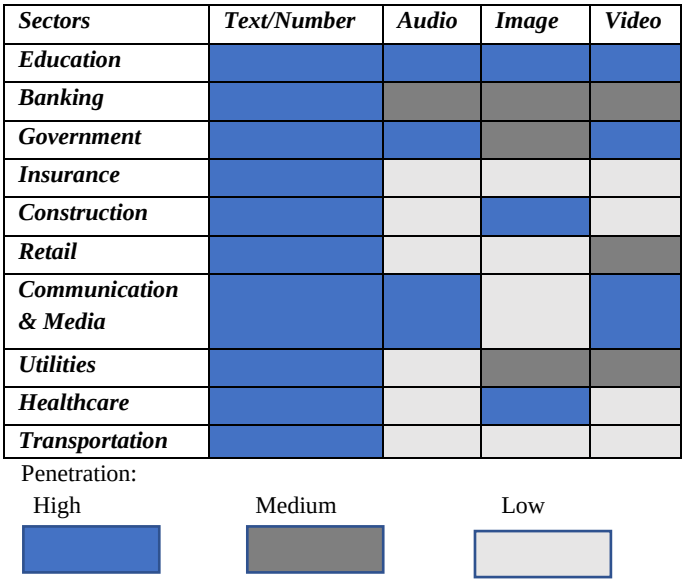


Fig. 2: variations of data in different sectors

1.1 Big data

In 1998, John Massey have given the term or the title 'Big Data' which is seemed in Silicon Graphics(SGI) Slide Deck [2].
Big Data can be outlined in terms of 3 "V's":
Volume - It defines the quantity (huge amount) of data.
Variety - It defines dissimilar kinds of data. Its bases include various types of data like organized, semi-organized and unorganized.
Velocity - It describes the wave of data. Data formed quickly, processed and analyzed.
Big data came with many opportunities like financial services, Government, social/Web, Healthcare, Retail [3].
Here are four sorts of Big Data is as shadows:
Structured Data- This type of data is stored in specific formats. Here storing, processing and accessing of data can be done easily.
Semi Structured Data- Data which is stored in structured formats without any specific model. Here the storage is easy but accessing using the key values is missing.
For ex: XML files.
Quasi Structured Data- Data which is in between the structured and unstructured formats.
For Example: RL. URL has segments divided by "/" which shows the path of the webpage but cannot be identified from a large amount of data with any reference.
Unstructured Data- Data which doesn't have any format and doesn't have any inherent structure.
For Ex: images, videos, Image oriented comments happening on public interacting spots like Facebook, tweet etc.

1.2. Big Data Analytics

A procedure of exploring huge and wide-ranging data sets to expose unknown correlations, different supportive information which will ease organizations to generate several business choices. Based on the data that's generated, varied kinds of Big Data Analytics are as follows [4]:

1.2.1. Structured Analytics

The huge amount of data that is generated from commercial and technical research fields. RDBMS, OLAP will manage this type of data.

1.2.2. Text Analytics

Text analytics is additionally referred to Text mining. It is a process of extracting helpful information from massive text. In this type of analytics, Text is used for storing the information which includes documents, data belongs to social media and communication via Email.

1.2.3. Web Analytics

It is also called as Web mining. This is primarily used to retrieving, extracting the data from Web content.

1.2.4. Multimedia Analytics

This is used to extract exciting knowledge and semantics arrested in hypermedia data, which includes images, audio, and video has grown rapidly. It shelters several topics like Multimedia annotation, Auditory summarization, Hypermedia indexing and recovery.

1.3. Techniques for Examining Big Data

1.3.1. A/B Testing

This is a method where numerous test groups are compared by one controller group to discover what are the modifications to be improved for a particular given variable. For instance- Response percentage of advertising o marketing.

1.3.2. Classification

It is mainly used for data mining. This technique is used to recognize various groups of new datasets and allot into previously defined classes.

1.3.3. Crowd Sourcing

It is a way of gathering data submitted by massive cluster of individuals or community. it's sometimes through network media like net.

1.3.4. Data Mining

It is the process of analyzing data from different viewpoints and summarizing it into useful information.

1.3 Impact of Big data on Health care

For IBM, Health has been the primarily criteria of business application. Watson's ability to know queries, and to ransack via 300 million sheets of data and it offers exact replies in only seconds. These results facilitate a medical practitioner treating a patient to think about all prior cases, related texts.

• Based on the Medicinal and Laboratory accounts and also self-reporting of crucial constraints from the patients, patient's conditions can be easily monitored.
• In the situation of patient observation and organization, several hospitals began to apply big data analytics to reduce cost per patient in the case of chronically ill patients and to avoid unnecessary admissions into hospitals.

1.3.1. 5 Customs of big data that change healthcare

The following 5 customs will assist to improve quality in addition reduce costs:
Right living- Big Data is used to assist patients to take good decisions regarding health such as exercise, diet etc. to take care of their health.
Right care- With Big Data, results will be improved, health faults will be reduced. By applying big data tools, for each patient, some evidence-based care will be provided.
Right provider- Based on the data, proven outcomes will be generated for patients to obtain the best medical care which helps to tie with the expertise set of providers based on the patient's needs.
Right value- With the methods like fraud eliminating, patient-outcome reimbursement etc., cost will be reduced.
Right innovation- Analyzing trends from current data, beneficial innovation discovery, development will be addressed by innovators. Providers of healthcare can analyze past data of patient, choices that are made by patient in their life style etc.., etc., to offer a broad view of the patient.

2. Health Analytics

It is described as a "way of transforming data into actions through analysis and insights in the context of the health care decision making and problem solving."

2.1. Health Analytics Stages

2.1.1. Descriptive analytics

It is an approach of data-driven. This is used to make informed decisions based on understanding past and current data.
By using this type of analytics, most health care entities make informed decisions based on the data to understanding past and current decisions related to health care. The models that we use in this can classify, illustrate and cumulative data, translating it into helpful information to analyze decisions, results and quality related to health care. Such summaries of data will be represented in terms of reports and graphs.

2.1.2. Predictive analytics

This is some sort of slightly more advanced type of analytics. Based on the past performance, it will predict risk and forthcoming by investigating summarized and historical data related to health.
It also used to find out unseen patterns in massive dimensions of data for grouping data into clear sets which are used to forecast behavior and discover movements.

2.1.3. Prescriptive analytics

This type of analytics will apply when medical difficulties found. Along with the data, it uses knowledge regarding health and applied in several health care areas which includes prescriptions related to options. Prescriptive analytics supports both personalized medicine and evidence-based medicine.

2.1.4. Discovery analytics

It makes use of expertise approximately understanding to discover new tablets, previously unknown and many others. This form of analytics may additionally lead to the invention of previously unknown illness.
Even though, For Popular descriptive, predictive, prescriptive, and discovery analytics, different tools and methods are used, many applications involve all four types of analytics.

2.2. Architectural Framework

The following Figure 3 presents an architectural framework of health analytics, presenting the various mechanisms and how they work collaboratively to empower analytics. Mainly here are 4 significant components.

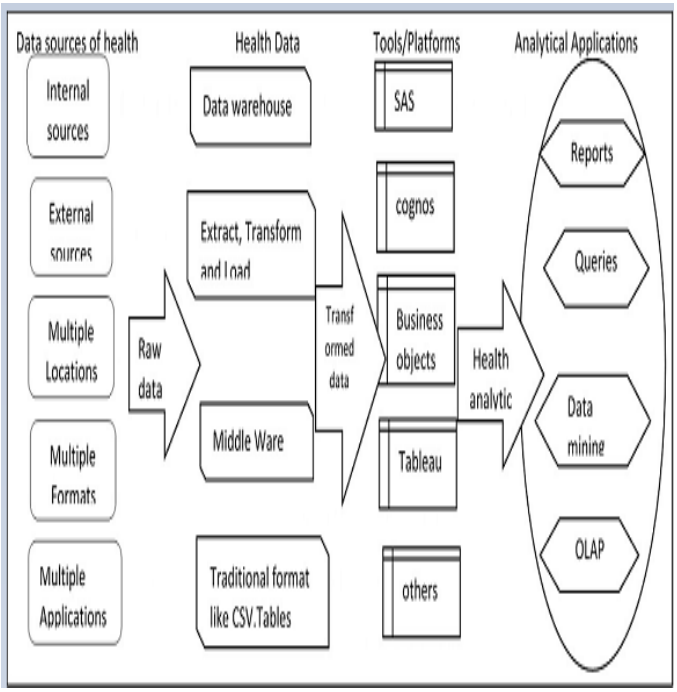


Fig. 3: Architectural Framework of Health Analytics

2.2.1. Health data sources

Sources of data are separated into 2 groups, which are Internal and External data sources from where medical data is accessed. Examples of Internal data sources include information related to hospital. Examples of External data sources contain openly accessible sets of data. Analytics tasks can be applied on various different sources, such as insurance corporations, databases like EHR, WHO etc. on which analytics tasks can be applied. Whatever form (structured or unstructured) of health data needs to be in proper structured, organized form, so that analytics can be applied.

2.2.2. Health data transformation

In this type, data is in raw form which requires processing [7]. Raw data can be cleaned and readied through the process of extract, transform and load(ETL) there after tools will be applied.

2.2.3. Platform & tools

To perform four types of analytics on the cleansed data, suitable tools should be utilized. These tools might series from numerical tools like R to progressive data mining tools like Tableau. User chooses various tools after needs and comparative analysis is done.

2.2.4. Applications of Health Analytics

By means of diverse equipment, 4 sorts of analytics may be accomplished with the context of queries, reports, OLAP. Several reports required for health compliance.

2.2.5. Methodology

Here a real-world practical procedure with main stages is shown as an outline in the following Table 1.

Table 1: Outlining the methodology of health analytics

Stages	Procedure
1.	Concept Design • Create necessity for health analytics. • Define Problem statement. • Describe importance of project.
2.	Proposal • Give summary regarding proposal. • Introduction ▪ Discussion on what is the problem and its importance. ▪ Why health analytics approach? • Background material ▪ Discussion on Problem area. ▪ Past research and projects.
3.	Methodology • Hypothesis expansion • Collection of data from various data sources. • Selection of either dependent or independent variable. • ETL and data transformation. • Selection of tool to implement. • Applying various analytical techniques. • Results that we expect. • Future scope for project and research &limitations. • Implementation ▪ Built conceptual architecture ▪ Execute steps ▪ Data to be Imported ▪ By using several techniques such as reports, queries etc apply analytics. ▪ Gain vision from outputs ▪ Give conclusion ▪ Make knowledgeable decisions
4.	Presentation and Evaluation

3. List of various Tools or technologies

In directive to different types of analytics, this paper is going to present various tools and techniques which would improve healthcare data in the following Table 2.

Table 2: Tools and their characteristics

TOOLS	Characteristics
Hadoop Distributed File System (HDFS)	• HDFS is a Hadoop based cluster for storage of huge data by dividing small parts and store them in distributed nodes.
MapReduce	• Tasks can be distributed onto file system using MapReduce. • It apply techniques of Map and Reduce on gathered information.
Advanced Data Visualization (ADV)	• It can scale its visualization for millions of data points, also can handle different data types. [8]
PRESTO	• It is used to analyze huge amount of data just in seconds or minutes. [8] • It is distributed SQL query engine.
PIG	• PIG is used to create Map Reduce programs using Hadoop. • Pig Latin is a language used for this platform. • It is used to retrieve any kind of data either structured or unstructured.
HIVE	• It is a query language. • It runs on Hadoop framework.
Oozie	• It is open source project. • Varied tasks can have carried out with some coordination.
HBase	• It follows non-sql based approach. • It is a column-oriented approach. • It mainly works on top of HDFS.
Vertica	• It is equivalent to Presto, but it comes with less expensive due to elimination of expensive architecture which is associate with huge amount of data. • It is scalable i.e. it can cover huge amount of hospital's data.
Lucene	• This can be used by the people who knows java development. • It is mainly used for text analytics to discover library of Java projects.
Text Mining	• It is mainly used to analyzing medical records from emergency departments in hospital.
Key Performance Indicators (KPI)	• It mainly concentrates on patients who are susceptible to sick by using significant indicators which are to monitored to identify weakness. • To identify human practice, it can also use EHR data.
Zookeeper	• It is having huge infrastructure. • It adopts both parallel processing and synchronization process.

4. Comparative Research Analysis on Tools and Techniques - A Review.

In the following Table 3, comparative study on various tools and techniques along with their advantages and disadvantages.

Table 3: Comparative study on techniques, advantages and disadvantages

AUTHOR	TOOLS/TECHNOLOGIES	ADVANTAGES	DISADVANTAGES/ LIMITATIONS
Prof. Jigna Ashish Patel Dr. Priyanka Sharma[13]	Hadoop. Storm. Spark HPCC	Using advanced tools and machine learning algorithms, significant insights of sample patient information and historical data can be exposed .	Need to solve big data issues and challenges with the help of these tools and technologies.
M Gowsalya, k.Krushitha C.Villiyammai[14]	HADOOP MAP REDUCE Which incorporates Master-slave procedure.	Tool is used to analyze large data set and extract useful insights. This helps the Doctors can effectively allocate resources.	• Can find patients with similar previous conditions and same readmission rate. • The patients are clustered into groups based on the test results &medications.
C Imthyaz Sheriff and Twaseef Naqishbandi[15]	IOT, CEP, BIG DATA ANALYTICS	Time and Money is saved.	Need to solve informatics and analytics needs of healthcare
Haritha Chennamsetty , Suresh Chalasani Derek Riley [16]	Hive	EHR is used to process massive amount of data. Reports can be generated using Hive.	Hive can be run on many platforms like Hadoop cloud computing environment.
S.GOMATHI V.NARAYANI[17]	Big Data	With Big data, Disease is discovered earlier to provide efficient treatment to extend LOS(length of stay)	Need to be summarize some major attributes and methodologies to implement big data in Lupus care hospitals.
Hiba Asri, Hajar Mousannif, Hassan Al Moatassime, Thomas Noel[18]	Implementation of EHR and e-HPA as tools of predictive analytics to detect diseases and outcomes.	Can find Big data solutions in healthcare. With the Implementation of EHR, data will be easily analyzed.	Big Investment is required for companies. Need of high level expertise and knowledge. comparing and evaluating algorithms and techniques used in reality mining and in the implementation of big data solutions in healthcare systems.
Thanga Prasad. S Sangavi. S, Deepa. A Sairabanu. F, Ragasudha. R [19]	Hadoop tool. Components of Hadoop tool: Name node Data node HDFS client	Stage of the diabetes is calculated using proposed system. This is mainly focused for both use of rural and urban neighbourhood.	Using this Hadoop tool, we can apply the predict analytics also.
Mimoh Ojha AND Dr. Kirti Mathur[20]	Hadoop Architecture	Based on surveys done at M.Y.H, EHR and Big data is applied. With this Time and money is saved for patients	Other tools can be used like Cloud computing, Openrefine. Other technologies like machine learning, A/B testing, visualization, search based application can be used for analytics of healthcare data at M.Y.H.
Gauri D. Kalyankar , Shivanand R. Poojara Nagaraj V. Dharwadkar[21]	ML algorithm in Hadoop MapReduce environment are implemented for Pima Indian diabetes data set.	As DM(Diabetic Mellitus) is NCD(Non communicable disease),by using this Predictive Analysis technology, we can predict future occurrences.	Pattern matching will be employed by applying these discovered patterns on testing data set to predict diabetic prevalent and risk levels associated with it.
Ritu Chauhan Rajesh Jangade[22]	Advanced Analytical-Techniques like.. Clinical Prediction Model Time series Data mining Visual analytics for big data Information retrieval	The Big data is providing challenges among the health care practitioners and researchers to retrieve effect and efficient patterns for the future medical diagnosis.	Conflicts with Big data are: Privacy and security. Consistency of Big Data. Processing of Big Data

5. Comparative Research Analysis on Framework, Analytical capability, Area application.

In following Table 4, comparative study on various papers on their framework, analytical capability and application area.

Table 4: comparative study on frame work

AUTHOR	FRAMEWORK	AREA OF APPLICATION	ANALYTICAL CAPABILITY
Jokonya[23]	Big data integrated framework for controlling diseases in Mining Industry.	Disease forecasting and prevention	Predictive analytics
Youssef[24]	Secure health information system framework.	Security and privacy healthcare of data	Map-Reduce
Raghupathi and Raghupathi[25]	Generic Conceptual framework	Generic Healthcare Architecture.	Reports and Queries
Kim et al[26]	Big Data framework for Ubiquitous healthcare system	Personalized healthcare	Map-Reduce programming model

Forkan et al.[27]	Cloud based big data framework for personalized patient care through context aware monitoring aware monitoring	Mining trends and patterns in patient data to support individual centric healthcare services	A two-step learning methodology that includes correlation analysis of context attributes using association rule mining followed by supervised learning strategy
Lin et al.[28]	A cloud based framework for home diagnosis service.	Self-care diagnosis	Formal Concept Analysis (FCA)
Mahmud et al.[29]	Data analytics a visualization fra health-shocks p	Public health services	Predictive modelling, using Fuzzy rule summarization.
Fang et al[30]	Health informatics processing pipeline framework	Decision support system for practitioners	Feature selection and machine learning Algorithms
Sakr and Elgammal[31]	Smart Health Framework	Data analytics for smart healthcare applications	Predictive modelling and pattern matching techniques.
Pramanik et al.[32]	Big Data enabled smart healthcare system framework	Smart system technologies for state of the art healthcare system.	Provisioning smart healthcare services through service oriented infrastructure.
Sarkar[33]	Conceptual framework for secured distributed health information system	Secure healthcare system	Provisioning security constraints and access control mechanisms
Xavier and Thirunavukarasu[34]	Structure Prediction of Proteins using Ensemble Learning.	Drug Design	Distributed Tree Based Ensemble learning Technique

6. Conclusion

In this paper, we have presented what is Big data, Big data analytics and its techniques, Health Analytics and its stages etc. We have also presented various tools and technologies which are available to apply big data analytics. We studied various papers and presented their work. This paper reviews various research attempts in establishing health care frameworks and summarizes their significant results. Research work can be extended by implementing various tools and techniques mentioned in different healthcare domains.

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