JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 2, 2022, p. 1024 - 1043
https://publishoa.com
ISSN: 1309-3452

Importance Of Big Data And Cloud Computing Techniques In Modern Scenario

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ABSTRACT

In the 21st century, the biggest issue is produced in terms of storage, processing, and sharing of computing resources with the enhancement of techniques. This issue is resolved with the amalgamation of big data and Cloud Computing techniques. Big data techniques help in handling new datasets efficiently Whereas Cloud Computing techniques provide an online storage model where the concept of virtualization is used. The combination of cloud computing and big data has set a new standard for future educational institutions and corporations. Users are capable to work according to their convenience by using Cloud Computing environments, while big data environments provide useful insights and information to them. This paper introduces big data along with various machine learning methods and Cloud Computing concepts. It also discusses the relationship between big data and cloud computing platforms, as well as the issues they pose.

Keywords— Big data, Cloud Computing, machine learning, resources, model

I. INTRODUCTION

With the Rapid growth of computational applications in various fields, the amount of information is increasing every second and almost doubling every year. In earlier days, we had landline phones but Now we have smartphones that are making our life smarter. Apart from that we were also using the bulky desktop for processing and storing MB of data but now we can store data on the cloud, as well as nowadays, self-driving Cars have come up Which have sensors that record every detail related to the size of the obstacle, distance from the obstacle and many more, based on the details, self-driving Cars decide how to react at a particular situation. During this decision-making process, a lot of data is generated for each kilometer. nowadays, we have smart air conditioners that monitor our body temperature and outside temperature with the help of sensors, accordingly these air conditioners decide what should be the temperature of the room. Social media is also an important factor in the evolution of big data. Nowadays, everyone is using YouTube, Instagram, Facebook, and Twitter. Such social media platforms produce a lot of data in the form of users' personal information such as name and age, as well as each image we like or react to, produce data. If people are sharing videos on Facebook, or YouTube, it also generates a massive volume of data. The most difficult aspect is that the data is not structured and is also large in size. Nowadays, the advancement in cloud computing, data science, and data storage has allowed for the mining and storage of big data[1]. Cloud computing refers to the capacity to provide pay-as-you-go computing services over the internet. In the case of cloud computing, people can keep and retrieve their data and information on the internet. Cloud Computing provides parallel processing, virtualization of resources, accessibility, integration with data storage, and data security which help to eliminate the cost required to invest in hardware, utilities, or building Large data centers. Cloud Computing provides the way to isolate the hardware and share the resources which will help in the analysis, computation, and management of data[2].

II. BIG DATA

Big data is a collection of large data sets that are both enormous and computationally complicated. Table I represents the existing definitions of big data.

TABLE I. DEFINITION OF BIG DATA

Reference	Author's Name	Definition
[3]	Havens et al.	The loading of big data cannot be restricted to the local storage devices.
[4]	The People's Republic of China's State Council	Big data can be categorized on the basis of large volume, fast access speed, and multiple types.
[5]	Fisher et al.	Big data is difficult to manage in a direct manner.
[6]	batty	Big data are huge in size and excel spreadsheets with around 16000 columns and 1 million rows cannot accommodate such a massive amount of data.

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 2, 2022, p. 1037 - 1036
https://publishoa.com
ISSN: 1309-3452

We'll use the example of Spotify, the world's most popular audio streaming subscription service, to better grasp the concept of big data. As per the report published by Marie charlotte gotting, on 10th February 2022, Spotify had 180 million premium customers in the fourth quarter of 2021, up from 155 million in the fourth quarter of 2020. All the subscribers generate a tremendous amount of data. With regard to Spotify, data such as frequently played songs, countless likes, sharing, and browsing history can all be classified as big data. Spotify analyzes this big data for suggesting songs to its users. In the case of Spotify, there is a recommendation system that works as a filtering tool to collect data and then filter the collected data by using some algorithm. Such a recommendation system accurately predicts what users would like to hear next. Spotify keeps its users engaged by using big data analytics, and by doing so users do not have the need to go on searching for different songs because Spotify readily provided a variety of songs to its subscribers as per their taste.

A. 5V's of Big Data

Big data are characterized by five v's which include volume, velocity, variety, value, and veracity.

1) Volume: The volume of data is related to its size which is much bigger in contrast to earlier data sizes. As per the report released by Statista Research Department on 14 Feb 2022, Facebook has 2,912 million users worldwide in the fourth quarter of 2021 which remain active. The number which represents the number of users is increased tremendously and gives rise to a large volume of data.

2) Variety: In, day-to-day life, we deal with different kinds of data. These data come from a variety of places, including MP3 files, video, JSON, CSV, and many more which are in structured, unstructured, or semi-structured formats. In a structured format, such as a table we have a proper schema for our data but in the case of a semi-structured format, the schema is not defined properly. In an unstructured format, there is no concept of schema. Fig. 1 shows the big data's 5 V's.

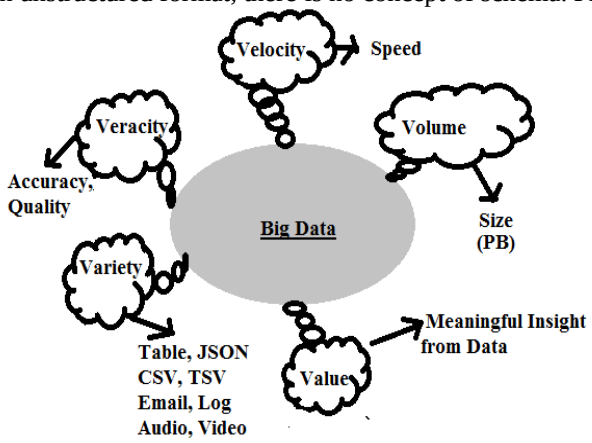

Fig. 1 Big Data's 5 V's

3) Velocity: Velocity is defined in term of growing speed where data increased exponentially for example YouTube, which generate a vast amount of data moving quickly [[7], [8]]. Table II represents the number of users in India who had used social media networks by February 2022.

TABLE II USERS IN INDIA AS OF FEBRUARY 2022 AS PER STATISTICS OF KEPIOS ANALYSIS

Application	Count
Facebook	329.7 million
YouTube	467.0 million
Instagram	230.3 million
Facebook Messenger	122.5 million
LinkedIn	83.00 million
Snapchat	126.0 million

4) Value: Value defines the mechanism to bring the correct meaning out of the data.

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5) Veracity: Veracity identifies three major factors of data which include quality, correctness, and trustworthiness of data[3]. At the time of data collection, we can find out that our data has a lot of inconsistencies due to the loss of some data packages. We can try to fill up these missing data and try to perform mining again. Finally, we have reached a good insight after processing the mining data.

III. MACHINE LEARNING IN BIG DATA

Machine learning allows computers to comprehend computational mechanisms without having to be explicitly coded by the programmer, allowing them to perform better [9]. Machine learning is based on statistical algorithms that can process vast amounts of data from a variety of sources. The data sets are so huge in the age of big data that dealing with them becomes tough with the help of traditional data processing tools and models. Due to the complex nature of data sets, some traditional machine learning techniques become unsuitable to satisfy the requirement of real-time processing and storage for big data. Thus, due to the unsuitable behaviour of traditional machine learning techniques, there is a requirement for some new methods which use the power of parallel computing and distributed storage to analyze and deal with big data[10].

A. Methods of Advanced Learning

In this section, we describe a few contemporary learning methods that are critical to overcoming the big data challenge, with an emphasis on learning rather than a single algorithm.

1) Representational Learning Method: Nowadays As data sets with high dimensional features become more common, extracting and organising useful information from them becomes more difficult. Learning through representation [11], [12] provides A potential technique for extracting relevant insights from data when developing classifiers or other predictors was provided, and it performed well on a variety of dimensionality reduction tasks [13]. Representational Learning seeks to capture a large number of alternative input configurations, allowing for statistical and computational efficiency improvements[11]. Selection of features, extraction of features, and distance metric learning are the three types of representation learning[13]. To propel the multidomain learning capabilities of representation learning forward, In recent years, new techniques such as automated representations learning[14], baised symbol learning[12], start crossing representation learning[13], and also other similar techniques[15] have been introduced.

2) Deep Learning: The concept of deep learning is introduced by Igor Aizenberg in the year 2000 which deal with algorithm inspired by the structure and function of the human brain. In contrast to Shallow structure learning architecture which is the traditional learning technique, deep learning focuses on unsupervised and supervised strategies which help to automatically learn hierarchical representation[16]. Deep belief networks[16], [17]and convolutional neural networks[18], [19]are two approaches that are proposed over the past decade and these two approaches show great promise for future work[20].

3) Distributed and Parallel Learning: As we know the collecting of a large volume of data is known as big data where we have to apply some methods to find out useful insights of data. In this context, A natural technique to scale up a learning algorithm is to use distributed learning by allocating the learning process among several workstations[21]. Classical learning differs from distributed learning in that there is a requirement for data is collected in a database for central processing, however in the case of distributed learning, the learning is dispersed. [22]. The most important factor in the selection of distributed computing is the management of a big volume of information. The practise of accumulating data into a single workstation is avoided with distributed learning, and saves energy and time. In recent years, various distributed machine learning algorithm such as decision rules[23], stacked generalization[24], meta-learning[25], and distributed boosting[26] has been proposed.

4) Transfer Learning: In a traditional machine learning algorithm, the hypothesis depends upon the concept of similarity where data for both training and testing is collected from the same feature space.if there is heterogeneity in collected data then the hypothesis is destroyed. To solve the problem which is produced due to heterogeneity, transfer learning is used. Transfer learning allows for different domains, tasks, and distributions, which can aid in transferring information from one or more source tasks to a target activity[27], [28]. Transfer learning allows applying knowledge intelligently to solve new problems fastly.

5) Active Learning: Most of the time in real-world applications, we can collect a massive amount of data that is unlabeled. By picking the most critical cases as a subset for labelling, active learning helps to tackle this problem[29]. By using a few labeled instances, the active learners aim to minimize the cost and achieve high accuracy[30]. By using labeled samples via query strategies, the learner can obtain satisfactory classification performance as compared to conventional passive learning[31].

6) Kernel-Based Learning: Kernel-based learning is based on a breakthrough in the design of efficient nonlinear learning algorithms, this is a very strong strategy for increasing computational capability[32]. Kernel-based learning map the samples from their high dimensional space into an unfathomably large feature space, where the kernel function calculates inner products. [33].

JOURNAL OF ALGEBRAIC STATISTICS
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IV. CLOUD COMPUTING

Cloud Computing is the process that provides on-demand computer services delivered over the internet. Such computer services delivered over the internet is in the form of pay as you go basis. For example, if we have a storage device with a storage capacity of 500GB then we are not able to store more than 500 GB but if we are using Cloud Computing then we can take the advantage of the cloud and store a large amount of data on cloud servers with the help of internet.

A. Types of Cloud Computing

Cloud computing is categorized into the deployment model or service model.

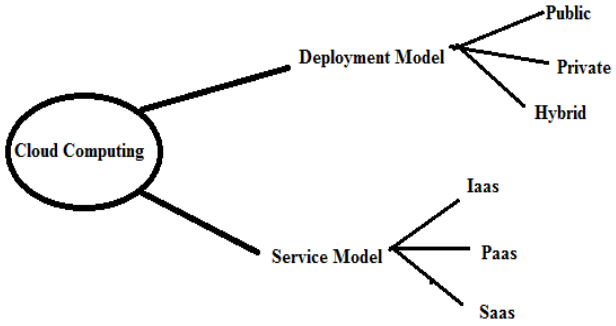

Fig. 2 represents the Deployment and Service Model

1) Deployment Model: The deployment model provides a virtual computing environment where users have the option to store and access the infrastructure. In order to understand, the concept of the deployment model, consider an example of vehicles. Suppose, we have three types of vehicles, bus and own car, and taxi. If we choose to travel by bus then we observe it is accessible to everyone. The passenger pays for the seat which he or she occupies and pays for the time that he or she travels in it, the cost is very less here. A similar concept is followed in the public cloud. In the public cloud, the user pays for how long he or she uses it. On the other side, the private cloud is much similar to the car which is owned by a single person for traveling purposes. In the owned car, a single person has to pay a huge amount upfront and the cost here is very huge. If we want to get the best of both types that are public or private cloud consider a hybrid cloud. Its concept is similar to renting a private taxi where the user wants the comfort of their own car and still doesn't want to pay a huge amount, he or she simply has to pay for the time spent using the services.

a) Public Cloud: A public cloud environment is based on a pay-per-use model where reachability is only possible through the internet[34]. Some of the major players of public cloud providers are AWS, Microsoft Azure, IBM blue cloud, and sun cloud.

b) Private Cloud: Private cloud platform is managed by a single company and can be on-premise or off-premise. Some of the major players of private cloud providers are AWS and VMware.

c) Hybrid Cloud: A hybrid cloud provides the functionality to use the best of both public and private clouds. for example, if we consider Federal agencies, they use the private cloud when they have to store sensitive information, otherwise, if they have to share data sets, they can use the public cloud.

2) Service Model

a) IaaS: IaaS provide the user with basic computing infrastructure based on the pay-for-what-you-use model. Under this model, the controlling power to manage storage, network resources, and services is in the hand of the cloud providers and the users will get virtual machines as per their business needs. To understand this briefly, we are consider the situation where you rent a house and the owner says to you, "Use it anyway you like and pay me this rent." So you pay the owner for the house, and when you get inside, you notice that it only has a bed and a table; aside from that, you'll need to put in your kitchen utensils, set up the house the way you want to use it, and then you'll be able to use it; this is the definition of Iaas, which means that only the infrastructure is provided to you. You can choose or change the architecture in whatever way you wish. In the Iaas model, users are free to manage their data, applications, runtime, middleware, and operating system.

b) PaaS: In this model, the providers provide the user with the runtime environment/platform for developing and managing the application as per their requirements. in this model, the users are free to manage data and applications. Apart from this runtime environment, middleware, operating system, servers, storage, virtualization, and networking are managed by the vendor who provides this platform.

c) SaaS: In this model, the cloud provider manages the software application on a pay-as-you-go pricing model. The user only has control over data and other parameters like applications, runtime, middleware, operating system, virtualization, server, storage, and networking are under the control of the cloud provider.

V. RELATIONSHIP BETWEEN CLOUD COMPUTING AND BIG DATA

Nowadays, most people are using Facebook and Instagram are examples of social media sites. Likes, comments, shares, and postings on such social media networks can generate a tremendous amount of data. The storage and management of generated a large amount of data give rise to the concept of big data. In a traditional storage system, only a structured form of data is stored, but in the current scenario most of the data is unstructured, and to store such unstructured data, there is the requirement of Big Data Architecture along with the concept of cloud computing. Cloud computing provides distributed storage environment where the concept of data splitting is used. If you want to store a large amount of data at the local level through the manual process, it will take a huge amount of time, but it becomes easy to do this with the help of cloud computing and the users situated at remote locations are able to manage or access the source of data. Cloud Computing provides access to big data resources in an easy and cost-effective manner to utilize resources at the time of supply and demand, it also provides big data handling with the reduction in the use of solid equipment[35]. In a Big Data environment, Apache Hadoop is considered a handler for managing a significant sum of unstructured data. Hadoop is a distributed platform that can help to scale the performance in terms of cost. Suppose one user wants to access the service, the user submits is request to the data server. First of all, the data server performs job analysis with the help of the name node and then broadcast the message to the data nodes. The data node uses the resources of the data server and provides the services to the user. Both the cloud and big data can assist businesses boost return on investment. The concept of the cloud can help to reduce the cost which is spent on the management of software and the concept of big data can help to reduce the investment cost.

VI. CHALLENGES IN CLOUD COMPUTING AND BIG DATA

1) SLA Violation: The term SLA is related to the written agreement signed between the users and the service provider. Whenever, the user requests services, the provider has to set up a check whether the services are provided as per the SLA agreement or not. If yes, go on smoothly, otherwise, if there is a violation of SLA, it will raise security issues in upcoming years.

2) Power Consumption: In Big Data Architecture, whenever a data node is migrated to another data node due to under, overutilization of resources, at that time, due to the migration there is a consumption of extra power supply. Sometimes the buffer of the data node is already full and the newly migrated node has to wait for a few seconds. Such a delay of a few seconds also consumes some amount of power. Power consumption is one of the important issues in big data and cloud environments.

3) Computational Complexity: In the 21st century, due to a large number of users, a lot of requests are generated. Such requests give rise to the concept of a huge volume of information. If the data is generated in a large volume, it will increase the computational complexity.

4) Storage Capacity: Due to the big data environment, it is possible to generate a large volume of data. Such a massive volume of data is not stored in our traditional storage devices such as hard disks, and pen drives because most of the time it is in an unstructured format. In this scenario, cloud storage plays a major role with its fault tolerance feature.

5) Data Ownership and Privacy: As we know, Cloud Computing provides an open environment where users can access the data at remote locations. Such user interaction with an open environment, give rise to the security and privacy issue. If both Cloud Computing architectures and big data architectures are practiced together, it will give a proper solution to this problem. Both architectures not only affect the cost factor but also helps to provide fast access to data without any fault appearance.

VII. CONCLUSION

In the Modern era, big data and Cloud Computing develop an integrated model which provides distributed storage of structured, unstructured, and semi-structured data. Cloud Computing along with big data commence a new stage for storage of data and for processing of unstructured data. Cloud Computing provides distributed environment for big data which brings significant growth, and opportunities for various sectors. This paper covers a brief review of the big data environment along with Cloud Computing. It covers a wide range of machine learning algorithms as well as the issues that large data and cloud environments present.

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