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Big Data and Cloud Computing Concerns and its Impact on Computer Graphics and Visualization

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Abstract: The world is undergoing massive scientific and technical discoveries that have a significant impact on humans. One of these discoveries is Big Data where massive volumes of data created every minute via a wide range of platforms. Through the use of computer analysis, these large amounts of data reveal specific trends and patterns. Massive issues arise when a user's privacy is violated as a result of the process of analyzing data in order to gain information that could be useful to the user. It's terrifying to think about how such sensitive groupings of data could be exploited. By exploring many studies on the subject of Big Data concerns, significant focal places where complications arise when dealing with large amounts of data have been identified. Data management, integrity and reactive security implementation, data storage and analysis, and cloud storage are the primary problems. On the other hand, some sectors that have been enriched by the rise of big data and cloud computing, such as computer graphics and visualization, have been investigated. The important role of infographic in representing information visually was discussed in the context of big data.

Keywords: Big Data, Computer Graphics, Visualization, Cloud Computing, infographic.

1 Introduction

The human race evolved by seeking various methods to record the history of each civilization as a way of leaving footprints behind. Without those historical records or sets of data, we won't have an identity that we can refer to like ancestry and such. If we go back in time, the most ancient method of preserving data and analyzing it was through tally sticks (18,000 BCE) discovered in Uganda mid 90's. Throughout the eras of before and after civilization; data has been growing immensely and rapidly in a way that exceeds the expectations regarding the amount of data being produced by the seconds [1].

According to the book Data Divinations which discusses several aspects of Big Data and data strategies, "Big Data is a collection of data sets, some structured and some unstructured, some "on boarded" from physical sources to online sets, some transactional and some not, from a variety of sources" [2]. Data is all around us, it can be recorded, obtained, observed, analyzed such as data collected from search engines, social media platforms, medical records etc.

The procedure of analyzing any big amounts data produced called "Big Data analytics" in which it tackles and secures any information belonging to an organization. Due to the rapid growth of data, comes the heavy weight of securing the data and protecting the privacy of whoever the data belongs to. There's a difference between the privacy of information and security.

Privacy of information means monitoring the authority of how private exclusive information is being utilized and obtained. However, information security defines as sheltering and protecting the belongings of details, knowledge or information from illegal invasion and access. Privacy risk users often come across when surfing the web is transitioning confidential facts that could lead their identity being exposed [3]. There exists many challenges Big Data analytic face regarding the solitude of the data and information. Some of these challenges are real time protection of data and security, auditing, granular access control and provenance (Rossi., B. 2018).

This study is going to discuss the risks of Big Data being in huge uncontrollable amounts of data that require intensive security and privacy measures that protect data from malicious intent to misuse data. This research will analyze the different concerns and risks of the colossal amounts of information as well as methods huge organizations use to protect the data and privacy measurements taken into consideration when dealing with Big Data, and ending with exploring big data impact on computer graphics and visualization.

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Background:

Big Data was first mentioned in the 1940s. It, however, became popular in the 1990s when Doug Laney developed the concept of the 5Vs that surround Big Data. Over the years the internet has grown its popularity with people spending almost 50% of their time on it. It has been a source of information to many people and this has made it have large volumes of data that cannot be controlled at times. It has become so complex that it is quite impossible to control it using simple data application software. Over time Big Data has had various definitions and it currently means the use of analytics to extract and process data [4].

Big Data revolves around four main factors which are referred to as the 5Vs as shown in Figure1. volume, this refers to the quantity of the data that is stored. The volume of the data helps us know whether it can be put in the category of Big Data or not. Velocity, this is the speed at which the data and information are being accessed by the users. In the past the speed was slow but with time and recent technologies being used, the speed has improved by a great deal. Variety, it refers to the many forms that the data can be expressed in. it could be through images, written texts, audio or even video form. Veracity which is the quality of the data that has been retrieved. This is used to measure the accuracy of the collected data. Finally Value, it refers to the hidden meanings and facts in the data which is the real value [5]. *Fig.* **1**

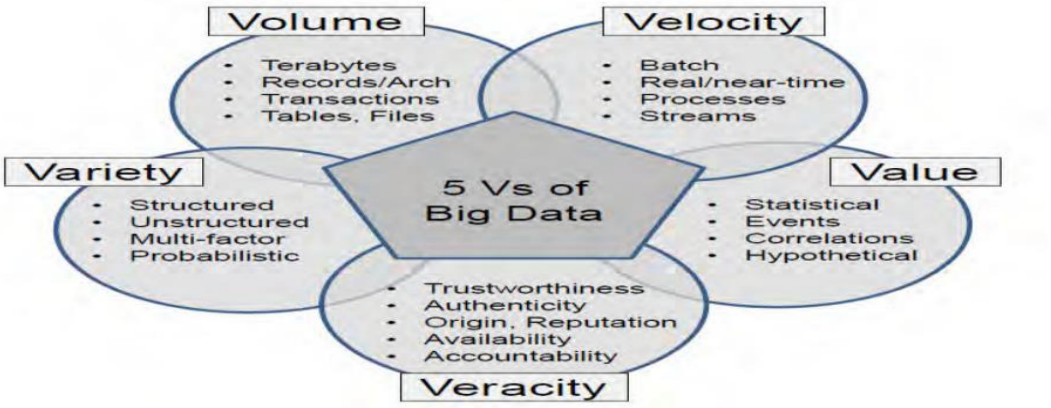

Fig. 1: 5Vs of Big Data [6].

Big Data had grown enormously, it has impacted on almost everyone that uses technology. People rely on the internet more than ever and they can do anything with its help. The internet has provided lots of information that people only need to access a simple device such as a telephone in order to access the information. People use Big Data in their daily lives to save their finances with options such as loyalty cards and the use of coupons all which are found in Big Data. Information about health and fitness is available in the Big Data and this enables people to monitor their general health and avoid foods that may put them at a risk of certain disease. With banking services being online, people use Big Data in their daily lives to make bank transactions with their phones. They are also able to pay for services and products using their credit cards and debit cards after reviewing the people comments on online shops and having the clarity they need on a certain product. Social media interactions would never have existed were it not for Big Data. With information being passed on social media platforms such as Facebook and twitter many people sign up in order to receive the information[7][8].

Big Data is also used by various sectors in their day to day lives which ultimately affect people's daily lives. The government uses Big Data to improve on it efficiency and operations. With Big Data it is able to collaborate and work with ministries under it so as to give its people better services and products. Healthcare systems use Big Data to conduct their research on drugs and diseases among other reasons. This helps them to improve on the quality of services that they offer to patients. The education sector has greatly benefited from Big Data. Students are able to gain more information by using the internet as their main source of knowledge. This has ultimately improved the quality of education as students are able to compare variety of information easily. Other sectors that use Big Data include the manufacturing and retail sectors and international developers [7].

Privacy and security concerns regarding Big Data:

Big Data in in a platform that can be accessed by anyone who has the time and for that reason it raises a big concern on the privacy and security of our lives. Breaches that cause alterations to buy data affect a larger group of people making them go through consequences they were unaware of. For instance, if a bank was hacked and the funds transferred to some other account, the people that would be affected could be many as a bank has many customers. Privacy of an individual cannot be

guaranteed as someone can always be traced when they access Big Data. This makes it quite hard to be anonymous on the internet. Copyright security has been a hard thing to do with the growth of Big Data. People use other researchers work and may even publish it as their own making the original researcher not benefit from his work. Access control is another security concern. People's information can be hacked and used in the wrong ways if they are not careful on the internet [9].

Possible solutions to the problems caused by Big Data's growth:

There are certain solutions that can be utilized to mitigate Big Data's harmful consequences. When time-sensitive material is transmitted over the internet, it should be encrypted. Hackers will have a difficult time gaining control of the system as a result of this. A thorough examination should be conducted before selecting a cloud provider to ensure that they have the most up-to-date security standards. Restriction of access control is another way in which access to particular information is limited to those who have been granted permission. In order to protect data in transit and maintain its confidentiality and integrity, real-time and up-to-date security applications should be deployed[10].

After discussing various past studies on Big Data difficulties and solutions, the conversation came to a close. Cloud systems, data privacy, data management, integrity and reactive security, data storage and analysis are all areas where Big Data and Big Data analytics encounter issues, according to many of the researchers. There is a suggested or already proposed solution for each issue. The most significant and most discussed answer to any problem with data secrecy is to encrypt the data, conduct regular audits, and deploy "machine learning" techniques.

People produce massive amounts of data every minute, and this data can be generated from digital records on any platform. This type of data, referred to as "Big Data," cannot be processed by large computers; instead, cloud services with an infinite number of network servers and advanced algorithms are used. Nowadays, all social media networks analyze data from such platforms in order to deliver better services that satisfy the demands of all users independently. Data processing and storage solutions such as MongoDB and Apache Hadoop arose as a result of this rapid explosion of data. When data processing tools first appeared, they caused anomalies that put data at risk and caused security concerns. The scope of Big Data is expanding by the day. While there are many hurdles in this profession, once a problem is uncovered, solutions are brought to the surface.

Cloud storage:

When it comes to new ways to store Big Data, cloud services are the way to go, since they appear to be the most reliable technique of storing large volumes of data today. The term "cloud" refers to the storage of data in an internet environment. Virtual servers in large networks use the cloud to store and manage data with the help of tools that come with cloud services. Apple iCloud, Google Drive, and Amazon Drive are some of the solutions accessible in the market that many big and small businesses use when they need to store data virtually [11]. Despite the fact that cloud systems are a new technology that many networks rely on, data breaches that compromise security and privacy can still occur through cloud nodes that are freely accessible from one node to the next; this risk concludes sensitive data[12]. As indicated in *Fig.***2**, cloud computing provides four key services: IaaS, PaaS, SaaS, and RaaS.

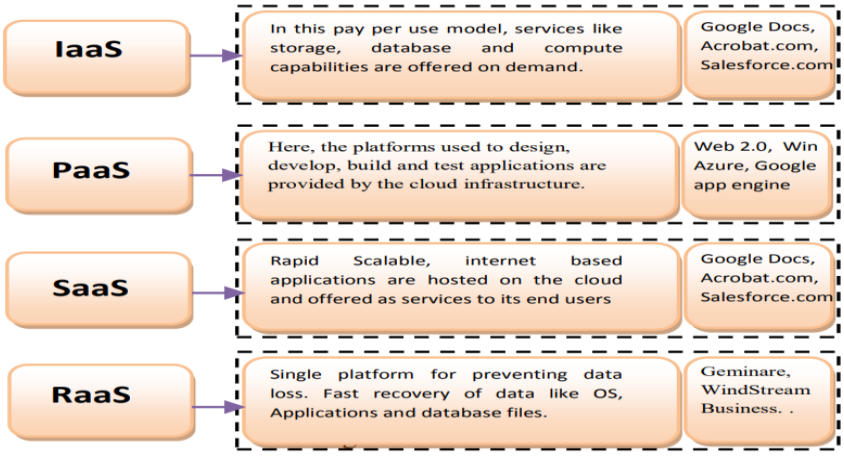

Fig.2: Cloud services [13].

There are concrete problematic areas that need to be addressed when dealing with Big Data:

1) Data privacy

Granular Access Control: The most essential aspect of this access control mechanism is that it ensures data access confidentiality. To keep persons with malevolent intent out, secrecy is essential. Those in charge of data management have more exact control over data, similar to a scalpel, rather than transparent access, which cuts broader than a scalpel and jeopardizes data confidentiality. Controlling access has increased the cost of developing applications. Furthermore, only a tiny set of people could perform the analysis. When types of data that cannot be spread are pushed into a very constrained area to ensure sacred data protection, this process becomes an issue [14].

'Big Data' is a term used to describe a large amount of Through the use of non-characteristic facts, BD allows data subjects to be re-identified. Data that is classed as BD in clusters is comminuted, exposed, and intrusive. Re-identification allows data managers to take a person's own information from their profile and link the facts together, which is extremely intrusive when the managers are infringing the person's privacy. Any individual's data can be processed by self-driving decision-making algorithms that can attach commitments to a person's life, such as job illegibility, health-care insurance, and more [15].

2) Data management

Big Data is collected manually using a number of methods, with careful agreements in place to ensure soundness and precision. This is in contrast to data administration, which is cited as the most difficult aspect of Big Data manipulation. It is necessary to qualify and validate any type of data in order to handle it. Validation is the process of validating data items, as opposed to qualification, which is the process of highlighting missing data. Given the density of BD's volume, it will be impractical to prove all portions of data items: new breakthroughs and developments are necessary to manage the enormous amount of data by qualifying and validating it [16].

When an attack happens, Granular Audit is activated, and the security system is notified in real-time. In reality, real-time notification is not always possible. This method of security monitoring necessitates the gathering of "audit information." There may be a variation in range and granularity, but not in auditing. Individual personal data, for example, is acquired from social media by businesses with access to assistance directly on the internet advertisements tailored to the needs of clients.[14].

3) Integrity and reactive security

Security monitoring in real time: any security system is connected to the manager's device so that the system can send notifications to the devices. Immediate monitoring is always at risk because signals can be ignored, resulting in incorrectly proposed results. This risk cannot be overlooked, and it will only increase as the velocity and amount of data streams in BD increase. The advantage of real-time monitoring is that it allows you to quickly construct a detection processing mechanism for any anomalies based on security scaling analysis results [14].

Solutions for Big Data challenges

Every day, humans generate vast amounts of unsellable digital data. Every day, around 2.5 quintillion bites are produced. The growing expansion of data necessitates the creation of new inventive storage places that can handle large volumes. When there is no platform or media that can handle the massive expansion, a problem arises, and data is generated at any time and in any location. Technology disks have a finite number of bytes per disk, which is four terabytes. If 25K disks are brought together to produce 1 ExByte, this number of disks cannot be combined at the same time by simply joining them together.[16]. Existing networks would be overburdened in their attempts to access and connect with the data. Nonetheless, the currently discovered data storage systems are unable to govern data processing using obligatory performance measures.[17].

Data is a multidimensional entity that clusters into large groups of information that can be picked using features or reduced for analysis. New technologies have lately emerged, such as automated data analysis and the creation of machine learning algorithms to preserve privacy. The capacity to navigate between stored data should be prioritized in order to make the process of representing, discovering, and analyzing data easier. [17].

Structured data, non-structured data, and semi-structured data are examples of data classifications; this data classification must be preserved in any case. If access is not allowed for the aim of forging new connections and merging a range of sources together, Big Data can be put at risk in the hands of vengeful users. Encrypting data ensures that it is safe in any situation and on any platform. To avoid misuse, data should be treated within legal constraints in addition to encryption. End-users must be able to see through security mechanisms to preserve data privacy [14].

Data storage: A method for data storage and processing is to finish the process in the data's location rather than transferring it to another location where it could be compromised, then acquire the result only after analyzing the data, and then transfer.

Data storage is important, but so is the design of the data storage systems. Uplift approaches that analyze data efficiency are employed when data analysis outputs from numerous sources. Furthermore, machine learning technologies can increase the scalability and consistency of pivot data [17].

Logging : Logging is essential for detecting failure or suspect activities. The activity log keeps track of data occurrences and actions. If a system breakdown is noticed, or if the system is hacked, log files provide insight into what transpired during the invasion.[18].

Protecting data and communication: To prevent sensitive data from leaking, all levels of data and analytics output should be encrypted. To protect the secrecy of the data, the transition of the data to another data must also be well-protected. Secure encryption technology helps safeguard personal information [18].

Examine cloud providers: The security of data kept in any cloud service is quite limited. If the security quality and level aren't up to par, the cloud system provider should conduct regular security audits and recommend a course of action. Additionally, by establishing rules and policies, select people will be granted access. [18].

Solutions emerge over time when uncovering concerns and challenges handling Big Data. User's nowadays are more aware of the impact of having all your personal information online and at risk. There are for sure strict security policies when any party documents, saves and takes advantage the user's information, but it never happens without taking consent from the users. Which raises the question of why the users aren't aware of how they're data is being manipulated to produce statistics and results that benefit both parties. Transparency is the ultimate key to keep everything at sight from the company's view and the users view.

Impact of Big Data and Cloud Computing on Graphics and Visualization

Visualization of information, in its wider context, can be traced back to ancient times. Illustrations were used long time ago to visually describe everything people can witness or imagine. The strength of graphics was always well-known to most civilizations to represent information, either fictional or non-fictional. People used graphic depictions to tell their stories, and to show their glories. They used graphics to learn, teach and preach. Effective use of infographics as we know it today can be traced back to the Victorian Era, as shown in the diagram *Fig.* **3** that was created to represent to the British Parliament back then "the causes of mortality of the British Army during the Crimean War." [19] Publishing for sciences became increasingly aimed at the layman in the 20th century, through magazines and newspapers articles, where the need to visualize 'cold' information also increased. [20].

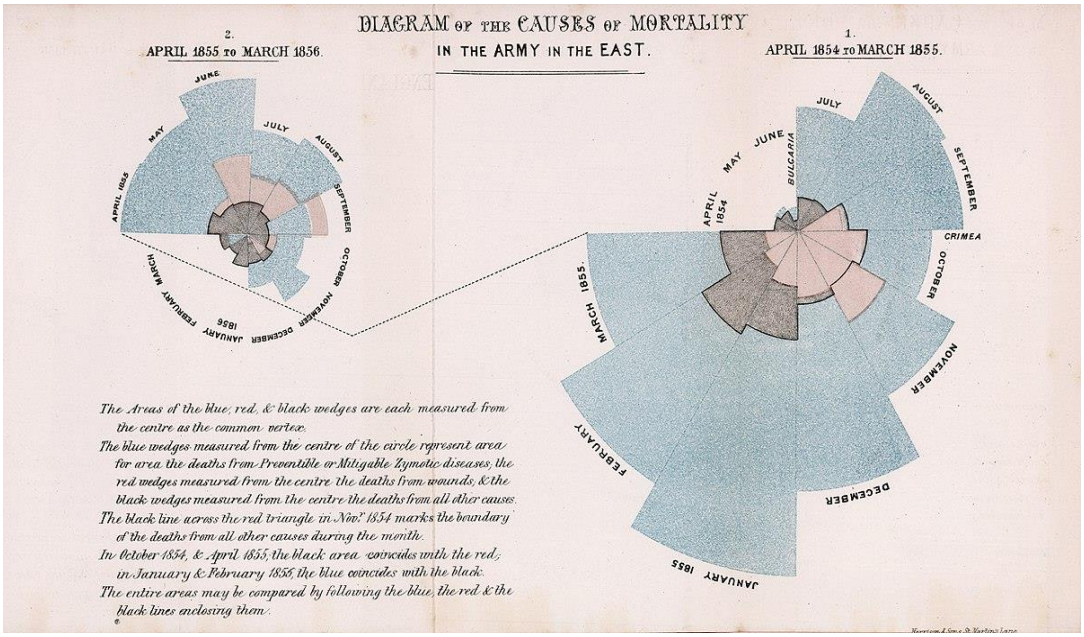

Fig. 3: Diagram of the Causes of Mortality in the Army in the East (Wikimedia Commons).

"A picture paints a thousand words" is a phrase that is widely attributed to Frederick R. Barnard (1846-1896), an English illustrator, who wanted to describe how important are this tool called graphics to describe at a glance a large amount of written information. Regardless, however, to the original attribution of this phrase, it is by no means true, and it is even truer in the age of big data than ever.

Data visualization or infographic are used interchangeably and can be defined as follows: "graphic visual representation of information, data or knowledge intended to clarify and integrate difficult information quickly and clearly"[21]. The importance of data visualization, or infographic is readily understandable. Countless experts in various fields confirm that this tool is indispensable when comes to addressing the audience, particularly with complex information. According to B. I. U. Dur, Human mind is able to visually process information more successfully and lastingly in comparison with processing the same information when being written or verbal. [22] Data visualization is not part of a sole field. In fact, it is interweaved by the collective contribution of various fields, including graphics design, psychology, usability and statistics "with the aim of reducing barriers… to understanding important information". [23]

So, by definition, graphics that represent information must be effective in communicating this information clearly and unbiasedly. Accordingly, it is crucial to efficiently prioritize the information visually and to be clear about what is important and what is not so. At this end, there are known approaches to make infographic effective, such as Edward Tuft's concept known as data-ink ratio [24]. Delving into these approaches, however, would be out of the scope of this paper.

Its undoubtable that no point of studying big data without being able to visualize it. We generate and handle petabytes of data every day in today's society, where everything is recorded digitally, from our web browsing habits to our medical records.

In every aspect of life, big data will be revolutionary. However, simply processing and analyzing the data is insufficient; when data is displayed graphically, the human brain is more likely to uncover patterns. "In 2010, Google CEO Eric Schmidt famously stated that we now create more information in two days than we created from the dawn of man up until 2003." [19]

Infographics were employed in several major fields in the 20th Century. For example journalism effectively used infographics since the 1980s.[25] Moreover, in a variety of industries, data visualization and analytics play a vital part in decision-making. It also opens up new possibilities in the visualization sector, indicating creative thinking for solving the big-data challenge using visual means. It's difficult to visualize such a huge volume of data in real time or in a static format[26]. The display of enormous data sets demands a lot of attention in the Big Data era. The last of the three major phases of the data management life cycle, namely storage, analytics, and visualization, is the most strategic since it is closest to the human perspective. Only by executing tricky and sensible analytics algorithms over the data flood and, at the same time, visualizing the analytic process results in an effective, efficient, and, why not, impressive manner does the vast mine of data become a gold mine. Not unexpectedly, a profusion of tools and methodologies for Big Data visualization have arisen in recent years, both as part of Data Management Systems and as applications or plugins dedicated to data visualization[27]. Two main phases in data life cycle are: data analysis and data visualization, *Fig.* **4** shows different types of software solutions existing and used for that purpose.

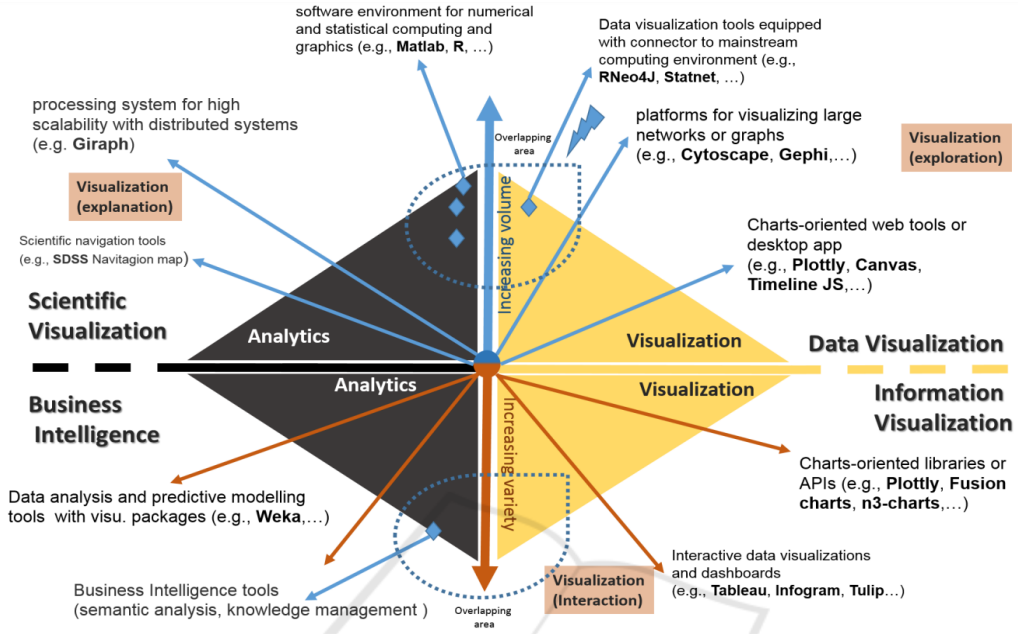

Fig. 4: The Big Data Visualization Solutions[27].

Big Data Visualization Tools: there are many various tools for visualizing the big data, the summary of that tools is shown in table 1.

Table 1: Big Data Visualization Tools.

Information Visualization Tools	Data Visualization Tools	Scientific Visualization Tools	Business Intelligence and Visualization Tools
• Tableau • Infogram • ChartBlocks • Plottly • D3.js • Ember Charts • Google charts • FusionCharts • chart.js • Leaflet • Chartist.js • n3-charts • Sigma JS • Polymaps • Processing.js • dygraphs	• Timeline • Canvas • Commetrix • Cuttlefish • Cytoscape • Gephi • Graph-tool • Graphviz • JUNG • Keynetiq • Netlytic • NetMiner • Network Workbench • NodeXL • Pajek • Statnet • Tulip • Visone	• Giraph • SDSS Navigation map	• Weka • SocNetV • Sentinel Visualizer

The task of visualizing a vast data set is difficult, due to that there is continuous demand for having a tools and architecture that can handle the processing of those heavy data. Cloud Computing offers a very rich base that can accelerate the data visualization by using the cloud computing infrastructures: IaaS,Paas, and SaaS. Traditional data presentation methods have hit a few stumbling blocks as data continues to rise exponentially. Users should be able to spot missing, incorrect, or duplicate values using visualization tools and approaches. Limitations such as perceptual scalability, real-time scalability, and interactive scalability are difficult to overcome. The main challenges of big data visualization are: Perceptual Scalability (Human perception and limited screen), Real-time Scalability, and Interactive Scalability. To overcome that challenges, there are some solutions, such as: Data reduction (Sampling, Filtering, Binned Aggregation), Reducing Latency (Pre-computed Data, Parallelize Data Processing and Rendering)[28] .

Computer graphics isn't a thing that can be defined. It is, in reality, a branch of computer science that concerns with how to show images on a computer screen. When the computer era began, computer graphics began with the display of data on hardcopy plotters and CRT screens. Since then, it has progressed to the point that it can now create, store, and manipulate models and photographs of objects. Physical, mathematical, engineering, architectural and abstract structures, natural phenomena, and other fields all contribute to the development of these models. Today's computer graphics is mostly interactive. By employing input devices such as a keyboard, mouse, or touch panels on the computer, the user can modify the contents, structure, and appearance of objects as well as their projected images[29]. The impact of Big Data on graphics and visualization is too obvious these days as we are dealing daily with different types of data representation for big data via: social media, TV channels, newspapers, brochures, leaflets, advertisement…etc. The following are some of the main a usage of Big Data in different applications of computer graphics:

- Entertainment and Advertising
- Scientific Visualization
- Cartography-drawing Maps
- Weather Maps
- Satellite Imaging
- Techniques to analyse video data using Apache Spark/ Hadoop
- Engineering drawings- Electrical, architectural, mechanical, civil, etc.

- Architecture-construction plans, Interior and Exterior
- Sketches

Conclusions

This research re-enforces general information about Big Data, background and its growth while shining a spot light over the main challenges and concerns due to the rapid growth of the Big Data revolutionary movement. Throughout the research process we've gathered common points of interest about where the concerns could occur that several researchers in the field agreed on. We concluded that concerns occur when dealing, storing and manipulating the pieces of data since it's a new evolving field. In addition, solutions are progressing while new methods are being developed to reduce the negative effects of the tremendous increase. Finally, the impact of Big Data on the field of computer graphics and visualization was explored and highlighted the challenges, solutions and the most common used tools

There is obviously room and opportunity to go more into this scientific movement in future work. The future work will consist of examining other worries and difficulties that have a detrimental impact on any user, as well as developing new inventive possible ways to use Big Data and its analytics to our advantage. In addition, the impact of Big Data and Cloud Computing on the field of Graphics and Visualization can be expanded more and also explore it deeply with more focus on: fonts and typography, advertisement, visual effects, digitalization, social media, NFT and others. Further questions for future work, yet to be investigated, were asked by Veszelszki Ágnes: "Can an infographic be used as a source for further work? To what extent can big data be compressed? When big data becomes less data, will that still be the same information?" [20]

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