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Data Visualization Techniques

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ABSTRACT

Data visualization is a very important field in Data Science and Computer Science. Data visualization is mainly used to reveal patterns, trends, and analyze data using datasets and reveal hidden relationships in data. In this paper I have defined data visualization and concepts, understanding theory and then going through data visualization using examples and algorithms. We have discussed here 4-dimensional data visualization and algorithm related to it. Data Visualization is very important in technology because it is very easy to present complex data. There are various ways to represent data in form of Maps, Images, Charts and Graphs. This paper highlights data visualization concepts, techniques and it's effectiveness [1].

Keywords: Data Visualization, Datasets, Charts, Graphs, Analysis of data

1 Introduction

There is a long history of data visualization. In our primitives it includes maps on walls, paintings of primitives, tables with numbers which include rows and columns. These are some examples of data visualization in primitives. Data Visualization is a presentation of data with the objective of giving the viewer with the proper understanding of data, it's contents, and the information of relationship of data points with the data [2]. It is a transformation process of numbers, concepts and objects into a form which is easily understandable to human. Information means processes, concepts, and data relationships. Visualization of data includes the ratios and relationships with other numbers. It not only includes understanding numbers but also understanding the trends, relationships and patterns in the data set. From the point of view of viewer, data visualization includes comparison, measurements and detection and all this is increased with providing necessary information and interactive techniques from multiple techniques and multiple views [3].

In Multi-dimensional Data Visualization, there are graphics, graphical attributes and entities. While analyzing the data we have following parameters to be considered: image, solid, surface, glyph, polyline, line, point. Different attributes to be considered are location, style, relative motion/ position, and color/ intensity [4].

There are some special characters like symbols '@' or 1,2,3, relational, and various units such as approximate dense, spatial quantity, meters and inch. We can say that the data is correctly analyzed if the data visualization is done accurately and the analyzed data is sufficient for the quantitive analysis. With the correct data visualization user can properly analyze the data and interpret the results based on their requirement [5].

A single picture is worth thousand words, specially when we are trying to analyze the data from the picture. The Visual insights are very useful when we are trying to analyze relationships in hundreds of variable to identify the significance among them. We must create useful data visuals and techniques when we are representing the data [6].

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For analyzing the data we require sufficient graphics presentation and use Hierarchical representation, 2D area plots, temporal data and multidimensional data. Using all these techniques we can demonstrate data visually. Large data sets uses advanced analysis to easily understand visualization [7].

Data Visualization is one of the best ways for displaying huge data in a way that is accessible and understood by everyone. Big organization generate massive data on daily basis. This has led to huge availability of data on net and on web. It is very complex and unstructured data which is complicated for users to explore and analyze the data. The ability to analyze the data is very important to scientific research [8]. Data Visualization focuses mainly on development, design and use of graphical presentation of data. Using this data the decision makers can take decision easily with the help of data visualization [9].

Users can discover hidden pattern in their data, form various opinions and comprehend the data. Data visualization is also known as Scientific visualization and Information visualization. The senses like smell, taste and touch can be presented visually [10].

Data visualization is the data that can be used as solution or answer many graphical user interface and interactive graphical user interface. These are constructed on the memory architecture. With the broad range of employees that use business analytics, they enable the users to search solution without making them available. Data Visualization techniques are Charts, Bar charts, Pie Charts, Images, maps, Bubble charts and Line charts [11].

2 Literature Review

Data visualization is a information technique which may help to figure the wrong data points and trouble in data. The exploration of data has lot of uses like data mining and other applications in health industry. For the best results data visualization gives quicker data exploration and supplies more efficiently results where the algorithms are used. Information Visualization concentrates mainly on data deficient 2D or 3D object, there are measure representations of non-figurative information into an forcible screen. There are many other methods which include the histograms, line plots and graph charts [12].

To design data with the help of diagrams and diagrams and the data is usually logical or special, we need scientific visual techniques such as charts and graphs etc. governing standards of perception. There is a strong motivation to keep asking about low-cost and innovative ways of imagining the details that are sent in detail. The visual scheme should benefit from the hand-crafted methods where the power to help designers make changes from their practice. Recognition should be able to present a variety of information and should be interactive and allow for effective communication. Using coding data and site coding in the diagram with the ability to control the visibility of layers as desired by developers [13].

3. DATA VISUALIZATION TECHNIQUES:

Data visualization is the presentation of data. There are basically two types of data visualization static data visualization and interactive data visualization. In interactive data visualization the users can give the format of data and how to should be displayed is designed by the users [14].

Some of the common Data Visualization Techniques are:

3.1 Line Graph:

Using line graph we can show the relationship between different data points. It is mainly used to analyze the data over a period of time [15]. A line graph or line chart displays the numerous variables.The data points are summarized using the connected line segments that are straight. It is same as a scatter plot and the points to be measured are ordered by their x-axis value and then later joined using a straight line [16].

Example of Line chart or Line Graph:

Evolution of bitcoin price from April 2013 to April 2018. We get this data from the website: CoinMarketCap Line Graph can be used to display the evolution of Variables [17]

For example:

An example is an evolution in the baby name (three baby name) frequency in US from year 1880 – 2015. This graph works good for less number of data. For large amount of data, the graphics gets unreadable &cluttered. Such type of chart is called a spaghetti chart [18].

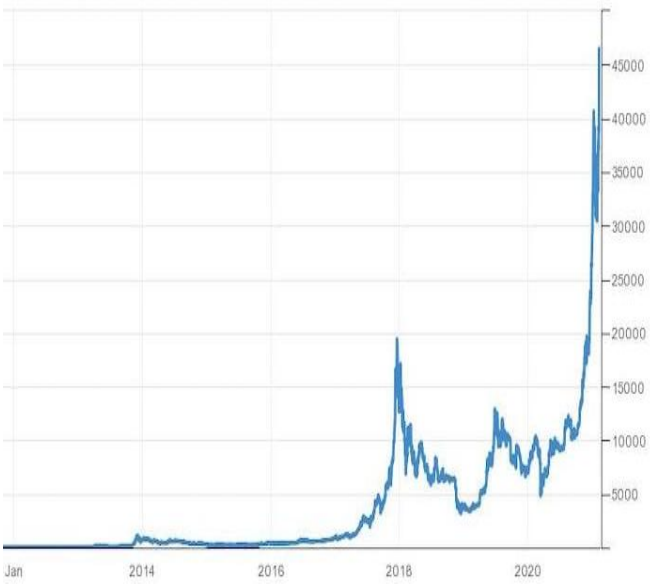

Fig. 1 Evolution of bitcoin price in US dollars

3.2 Bar Chart:

A bar chart sums up a collection of categorical data. Continuous data can be converted into categorical data using auto-binning. The data is represented using bars, these bars represent categories. The height of bar is proportional to accumulation of values which represents data. Examples of categories include age group and geographical locations. The bars can also be colored or they can be split into different data like categorical data, this allows us to see the representation from various categories into different bars or batch of bars in bar chart [19].

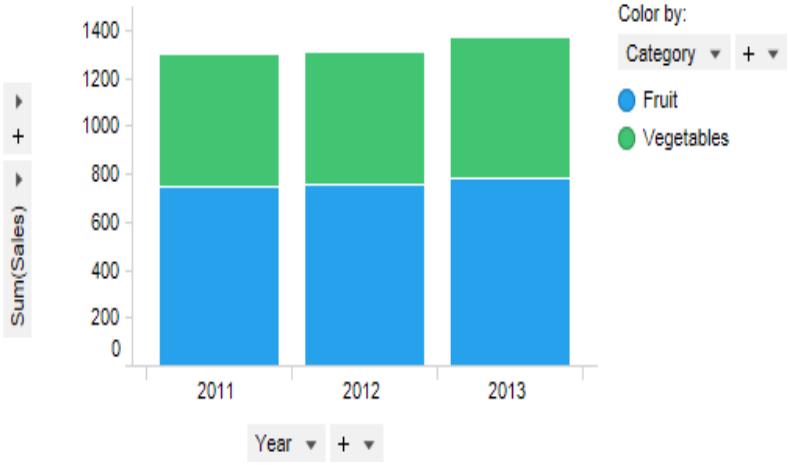

Fig.2 The bar chart represents the total volume of sales for vegetables and fruits in last three years

3.3 Scatter Plot:

A scatter plot represents data using dots for two numeric variables. The location of each dot on the vertical and horizontal axis represents individual value of data point. It is mainly used to draw relationships between various variables. Scatter plots use Cartesian coordinates to represent the variables in data set. Scatter plots are also called as scatter charts, scattergrams or scatter graphs [20].

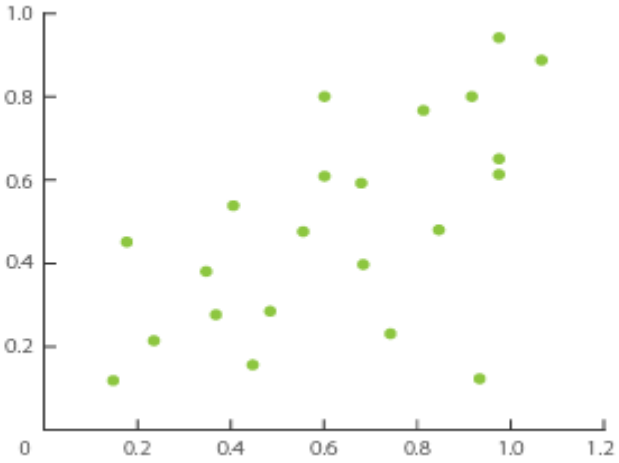

Fig. 3 Example of Scatter Plot

3.4 Pie Charts:

The pie chart is also called "circle chart". A circle chart divides the circular chart into slices or sectors to represent the numeric problems. Every slice is used to represent a proportionate slice of the whole circle. Pie chart is used to represent the composition of the data [21]. Pie charts can be used to replace graphs like histograms, bar graph and line plots. Pie chart contains various sectors and segments in which every sector or segment forms a piece of total data. The percentage of all data is 360^{o}

Following steps are used to draw a Pie Chart:
Step 1: Data Categorization
Step 2: Calculation of data
Step 3: Category Division
Step 4: Percentage Conversion
Step 5: Degree Calculation

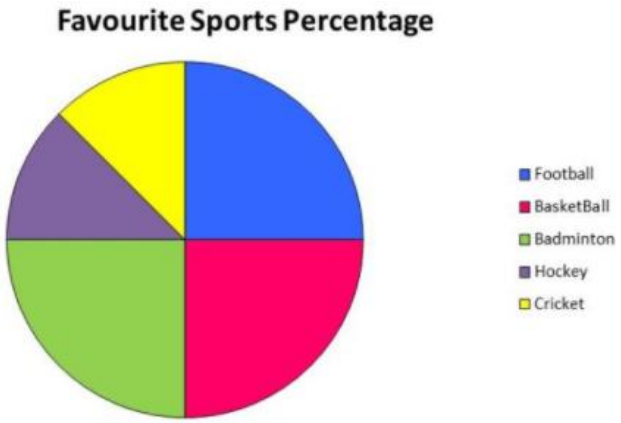

Fig.4 Favorite Sports percentage of children

So, data can be represented using different data visualization techniques like pie chart, line graph and bar chart. Data visualization uses techniques like computer graphics, to show trends, patterns and relationship in various elements of data.Color plays a important role to present the data. Effective colors can be used to classify data among data elements [22].

In data visualization the data is extracted and encapsulated into graphs and charts. Spatial variables like shape, size and position are used to present the important elements in data. A data visualization can perform data transformation and data reduction. It can represent the raw data on the screen [23].

3.5 Histogram:

Histogram is mainly used for representing the continuous or discrete data. It provides a visual interpretation for numerical based data by visualizing the data points which fall in specific range also known as bins. It is like a vertical bar graph, but there are no gaps inbetween the bars [24].

For example:
John is a branch manager in a bank. John has been receiving feedback from consumer saying there is long wait time from the client for the customer service. Using this data John decides to visualize total amount of time spent by every customer on waiting period [25].

Customer Wait Time in Seconds (n=20)	
43.1	42.2
35.6	45.5
37.6	30.3
36.5	31.4
45.3	35.6
43.5	45.2
40.3	54.1
50.2	45.6
47.3	36.5
31.2	43.1

Fig.5 Customer wait time data

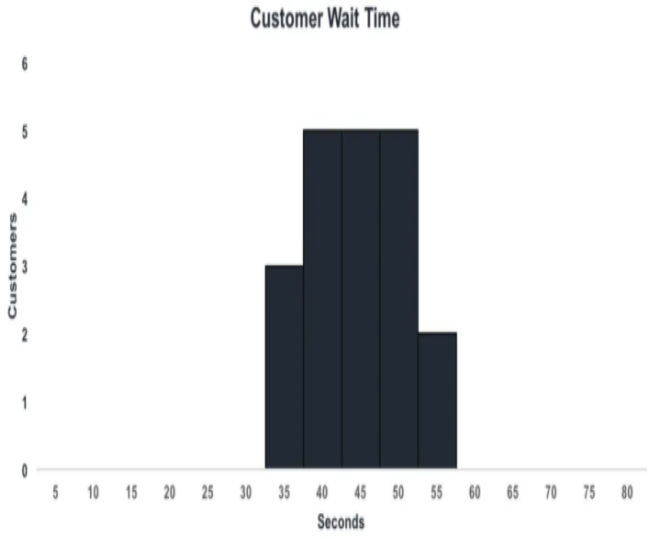

Fig.6 The histogram for the data using 5 bins

3.6 Cartogram:

A cartogram is a data visualization using a map for which the regions are in distorted manner to convey the data of alternate variables. The area will be deflated or inflated according to the numeric value. Cartogram is also known as choropleth map in which regions are colored according to the value of numbers [26].

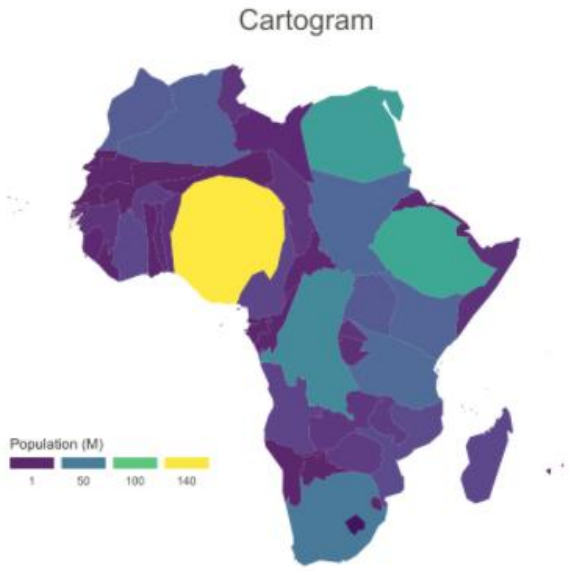

Fig.7 Pictorial representation of Cartogram

3.7 Gantt Chart:

A Gantt Chart is similar to bar chart which gives visual representation of task over a period of time. For project planning Gantt chart is used. It is a very useful way to show that scheduled work is done on specific day [27]. Project Manager and members of team can visualize the start dates and end dates for a project in a stacked bar chart.

For example: Work done by each individual in office everyday keeping track and reports

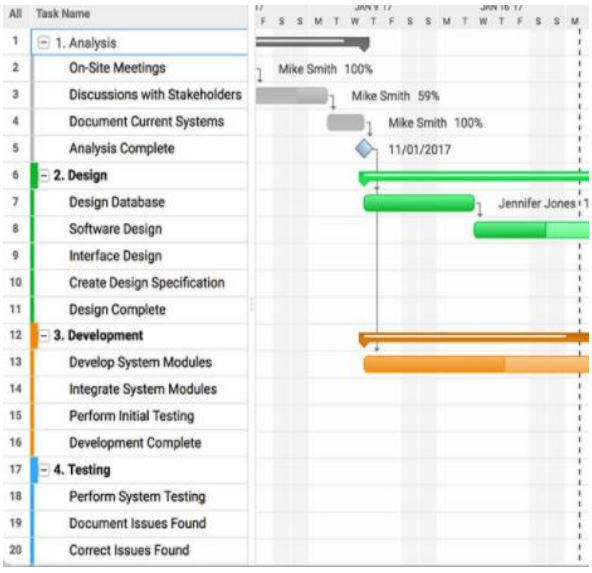

Fig.8 Gantt Chart for Planning in Office work

4 INFORMATION, KNOWLEDGE AND DATA

In data visualization the knowledge, information and data are primary components which are used largely. In different cases they are used to show various levels of truthfulness, abstraction and understanding. For example data visualization is connected to exploring information and data. The main aim in data visualization is to obtain insight to an information space and data mining is related to Information Visualization [28]. This information visualization is used by many companies for their business intelligence solutions, which helps them to take better decision for the products used by their consumers [29].

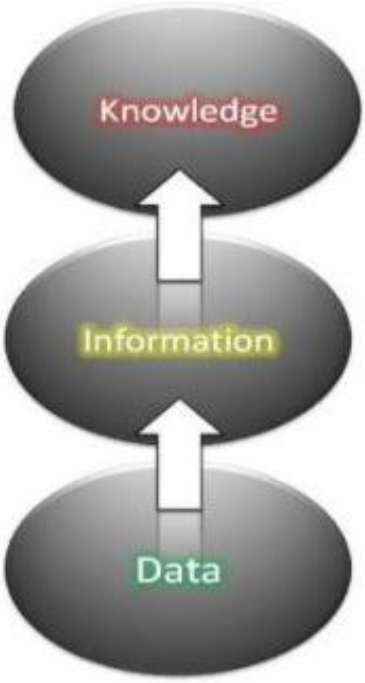

Fig. 9 Knowledge, Information and Data

Designing of information is a science of writing and designing data, in this way content can be used for meeting the goals of data visualization. With shaping the visual language and verbal language we can make communication artifacts that are important in Information designing [30].

Artifacts are representation of basic objects such as homes, cars and clothing which indicatesother person's social beliefs and habits. There is large amount of data and information that persists every day. Representing such a huge amount of data needs a lot of research and the data information should be easily accessible. For such representation we need efficient tool. One such tool is dashboard which is visual and graphical presentation of data. The dashboard was implemented aiming at technology for organizations to design, plan, implement and frame questions to identify relevant work. Data Visualization is used for using quality of information for studies, summing the evidence, interpreting the real time findings [31].

For monitoring the data dashboards are widely popular. Dashboard are widely used for analysis of processes in business. There are different companies like SAP, IBM and TIBCO Spotfire that use dashboards for Information Visualization and (BI) Business Intelligence. Dashboard give powerful and unique mean to represent data. Dashboards fail to visualize data effectively and efficiently due to inadequate information, technology and poor implementation of design [32].

Dashboard design and success contributes to strong communication and product design and clear display of data. Visualization and data are basically cognitive tools which enhance the 'control of span' over a data of business. The tool is used to help people to visualize data, identify patterns, identify trends and to identify if there are any anomalies. Tools help people to identify reason about the data and visualization of data is used to take effective decisions. Business Intelligence use dashboards to review information and data [33].

5 PLATFORMS FOR DATA VISUALIZATION

To automatically create data visualization there are various platforms, these platforms are easy to use and they allow you to create visualizations easily [34].

1.1 Google Analytics:

It is a web based analytics service which is offered by Google. It reports and tracks website traffic. It was launched by Google in 2005. Google Analytics is very popular service used for analytics on web. There is a SDK provided by google which gathers data from Android app and iOS, it can be blocked by firewalls and browser extensions [35].

1.2 SAS Analytics:

SAS Visual Analytics is a platform used for analysis and visualization. It enables you to discover relationships between data and identify patterns in data. Self-service BI, Interactive UI and generating reports are all combined advantages of SAS analytics along with analysis [36].

5.3 Sisense:

It is a (BI) Business Intelligence solution which is used in agile environment. It has tools to manage advanced data analytics and helps business organization to visualize data. It provides relevant trends in business and analyzes disparate and huge data [37]

5.4 Tableau:

Tableau is a very fast and most powerful tool used for data visualization. It is used in business industry to grow insights in their data. It helps to simplify the data in a easy way which is understandable. It creates the data which is understood by people in any level in a organization [38]. Even non-technical users can create dashboards. Data analysis can be done very quickly using tableau tool in the form of worksheets and dashboards [39].

5.5 Zoho Reports:

Zoho reports are business intelligence tools which helps businesses world wide to make sense out of data in their organization. The application has comprehensive analytics and reporting which helps to gain useful insights from the data [40]. Data visualization is the face of data analytics. It gives you a new perspective to look at the data visually. Thus, such data is very valuable for business organizations to grow their business. The platforms help the users to make graphics in a very less amount of time [41].

6 APPLICATIONS

The designs for data visualization are used to help in decision making and they serve as best tools which augment cognition. For the prototyping and building a data visualization one must know how to apply data visualization. Data Visualization involves representing the numbers, rethinking and selecting parameters. Data Visualization has many applications. Various application based tools have been developed for analysis of data in science and medicine [42].

6.1 **Public Health:**For the successful public health surveillance the data must be analysed and represented in a understandable format which is very important. Researchers in health industry need very intelligent and useful tools to visualize the data. For any medical data cloud-based technology, security is very important [43].

6.2 **Energy Renewal:** For calculating the consumption of energy as compared to production is very critical for an optimal solution [44].

6.3 **Environmental Science:** The environmental mangers are responsible to take decisions which are based on very complicated data. For this purpose they require data visualization. Within applied environmental research visualization applications are beginning to evolve [45].

6.4 **Detection of Fraud:** For fraud investigation data visualization is very important in the initial stages. The investigators will use data visualization as a approach for detection, using visualization to see the patterns and detect fraudulent activity [46].

6.5 Decision Making in Library:

The software of data visualization allows the librarians to represent and manage information which is accumulated from different resources. The software for visualization gives them a additional skills to represent data in a compelling and creative way. The software highlights the decisions, purchasing and future needs and objectives of librarians [47].

7 CHALLENGES

There are huge and time varying datasets which create challenge for data visualization because of huge volume. The real time visualization of data can help users to react immediately to any issues which arises. There are different approaches used for data exploration that include animation generation for a time dependant data. Data visualization is a techniques which views the composition of data. Under tight constraints the users differ in ability to visualize the data. It is very difficult to rectify the merit of data [48].

Therefore multiple data visualization algorithms are used in software. But most of these software have never taken and advantages with respect to multi touch interactions and manipulation of new devices with direct capabilities. The structured data, big data , unstructured data has a unique set of challenges which are associated with them [49].

For this reason we must consider different factors like speed, diversity, and size of data. There are different issues like operability and performance for challenges in big data visualization. It is very time consuming to create a data set which is simulated from big data. Decision for which technique to be used for data visualization is also difficult [50].

8 CONCLUSION:

Data recognition is the process of representing data in the form of graphic or graphic images in a clear and concise manner in an effective way. It has emerged as a powerful and widely used tool for analysis and interpretation big and complex data. It has become a fast, easy way to convey ideas in a universal format. It must communicate complex ideas clearly, accurately and efficiently. These benefits are allowed data recognition will help in many areas of learning.

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