Data Science and Analytics

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Preface

According to Kitchin (2014), big data is defined as huge volume of structured and unstructured data. Boyd and Crawford (2012) have defined big data as cultural, technological and scholarly phenomenon while Fan, Han and Liu (2014) have defined big data as the ocean of information.

Five Vs of Big Data

While the term "big data" is relatively new, the act of gathering and storing large amounts of data is characterized by five Vs (Jeble, Kumari, & Patil, 2016):

Volume – Organizations collect data from a variety of sources, including business transactions, social media and information from sensor or machine-to-machine data. In the past, storing it would've been a problem – but new technologies (such as Hadoop) have eased the burden.
Velocity – Data stream in at an unprecedented speed and must be dealt with in a timely manner. Radio Frequency Identification (RFID) tags, sensors and smart metering are driving the need to deal with torrents of data in near real time.
Variety – Data come in all types of formats – from structured, numeric data in traditional databases to unstructured text documents, email, video, audio, stock ticker data and financial transactions.
At Statistical Analysis System (SAS), two additional dimensions are considered when it comes to big data:
Veracity – In addition to the increasing velocities and varieties of data, data flows can be highly inconsistent with periodic peaks. Is something trending in social media? Daily, seasonal and event-triggered peak data loads can be challenging to manage. Even more so with unstructured data.
Value – Today's data come from multiple sources, which make them difficult to link, match, cleanse and transform data across systems. However, it's necessary to connect and correlate relationships, hierarchies and multiple data linkages or data can quickly spiral out of control for social and economic outcomes.

Big data and business analytics are conceived to provide a platform for academicians and practitioners to identify and explore the solutions to various problems in society, environment and industry using advance analytic tools. Business

analytics is the process of converting data into insights (Xavier, Srinivasan, & Thamizhvanan, 2011). It is "the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions." With the increase in the availability of data, analytics has now become a major element in both the top line and the bottom line of any organization. However, the rate of absorption of analytics in decision-making is slow. This is due to the fact that there are several ambiguities in the definition and scope of analytics (Jeble, Kumari, Venkatesh, & Singh, 2019). An effective use of analytics must grow with time and experience in most individuals. There is much more in analytics besides descriptive data collection and reporting. By 2025, there will be an increasing need for more data analytics to be involved in business. Effective performance management analytics is an integration of IT-based solutions, management accounting applications and analytical methods. Therefore, descriptive, predictive and prescriptive analytics are essential for any business.

Use of analytics in better decision-making has evolved since past. In the late 1960s, technology-based analytics had been the base of the decision support system (Jeble, Kumari, & Patil, 2018). Later, in 1987, scanner panel data were used to analyze decision-making in retail shops which was further followed by OLAP, a software analytical tool. In 1990, Enterprise Resource Planning system became the prime use for analytics in company. This led to the evolution of analytics using internet, e-commerce, mobiles, sensors and software analytical tools. With time big data predictive analytics has been used in decision-making in different streams. Analytics in big data has been useful in improving the visibility and coordination (Dubey et al., 2018). Businesses can have better decision-making capability with the use and better understanding of data analytics (Agrawal, 2014).

Why is Big Data Important?

The importance of big data doesn't revolve around the availability of data but the purpose of data. One can take data from any source and analyze them to find answers that enable (1) cost reductions, (2) time reductions, (3) new product development and optimized offerings and (4) smart decision-making. When big data are combined with high-powered analytics, managerial decisions can be performed such as

- Determining root causes of failures, issues and defects in near real time.
- Generating sustainable solutions for any stream.
- Recalculating entire risk portfolios in minutes.
- Detecting fraudulent behavior before it affects any organization.

Application of Big Data and Business Analytics

Big data have been in use by government institutes for forecasting weather patterns, discovering seismic activities that predict earthquakes and preparing descriptive reports. It has been in use by the economists to stimulate economic growth. Big data mining is the patterns in the data that are normally not looked

by the users. These unlooked data also lead to several important information which can make decision-making smooth.

Big data are used in health insurance for predicting customer dissatisfaction through speech to text data from call center recordings (Devenport & Dyche, 2013). Several retail banks have focused on exploiting big data at times of financial crisis for doing a better job.

LinkedIn has used big data and data scientists to develop product features and product offerings. This has helped the consumers as well as the companies to make decisions about the product.

Google has constantly developed new products and services that have big data algorithms for search. Most of the companies are master's in developing standard reports and multidimensional reports through big data analytics. In many companies, big data are directly focused on products, services and customers. Senior managers have used predictive analytics as the next step in data analytics.

Big data not only allow knowledge discovery efforts but also need to promote them. The sooner the business executives understand the value of knowledge discovery the better competitor they become. This can lead to high-level innovations and high rewards.

Big Data and Business Analytics for Decision-Making

In the current era, world is challenged with demanding customers, high competition, short product life cycles, rising costs of labor and materials, unemployment and unsustainability. Globalization is making it even more challenging as blurring boundaries among countries create level playing field for selling products and services across the globe. Firms need to make operational, tactical and strategic decisions based on available information. In addition to traditional decision support systems, big data provide additional tools to arrive at decisions.

Big data can provide valuable competitive intelligence (Jeong et al., 2016), help in dramatic cost reductions, substantial improvements and development of sustainable goals for the world.

Objectives

Data science and business analytics will bring together researchers, engineers and practitioners and encompass wide and diverse topics of application in almost every field. It will also invite the participation of scholars, analysts and data scientists to present their ideas, concepts and proof of works indicating application of big data and business analytics.

Target Audience

The primary target audience of this book includes researchers, academicians and data scientist from a variety of disciplines interested in analyzing and application of big data analytics. A secondary target audience consists of data analysts, students and scholars pursuing advanced study in big data.

Organization of this Book

This book is organized into eight chapters. A brief description of each of the chapters follows:

Chapter 1 authored by Aarti Mehta Sharma identifies that analytics is the science of examining raw data with the purpose of drawing conclusions about that information and using it for decision-making. It also looks at the pairing of visualization tools with different measurements of data. Before the formal written language, there were pictures which shared ideas, plans and history. Visualizations in the form of bar charts, scatter plots or dashboards are essential tools in business intelligence as they help managers to absorb information and take apt decisions quickly. Dashboards in particular are very helpful for managers as multiple charts and graphs giving the latest information about sales, returns, market share, etc. keep them up to date on the latest developments in the company. There are a number of visualization software in the market which are easy to learn and communicate the analyzed data in an easily understood form; the leading ones being Tableau, QlikView, etc. with each one having its positives.

Chapter 2 authored by Hiral R. Patel, Ajay M. Patel and Satyen M. Parikh takes the fundamentals for multimedia big data computing, feasibility study and salient features of multimedia big data and explore the technical problems and challenges to be addressed. It focuses on methodologies and approaches that are available from the perspectives of multimedia big data computing life cycle. Multimedia data are real-time unstructured, heterogeneous and multimodal as per the qualitative requirement. It has vast scope to mine model, learn and analyze the service provided by multimedia. An advance-level storage-related mechanism is also needed for efficient parallel processing, transmission and presentation. The multimedia data in form of videos are easily understood by human compared to textual data, but it's more complex task to make it understandable to machines.

Chapter 3 authored by Gauri Rajendra Virkar and Supriya Sunil Shinde reviews that predictive analytics is the science of decision-making that eliminates guesswork out of the decision-making process and applies proven scientific procedures to find right solutions. Predictive analytics provides ideas on the occurrences of future downtimes and rejections, thereby aids in taking preventive actions before abnormalities occur. Considering these advantages, predictive analytics is adopted in various diverse fields such as health care, finance, education, marketing, automotive, etc. Predictive analytics tools can be used to predict various behaviors and patterns, thereby saving the time and money of its users. Many open-source predictive analysis tools namely R, scikit-learn, KNIME, Orange, RapidMiner, WEKA, etc. are freely available for the users. This chapter aims to reveal the best accurate tools and techniques for the classification task that aid in decision-making.

Chapter 4 authored by Shakti Ranjan Panigrahy reviews the information of 300 customers in Anand districts of Gujarat, India. Cluster analysis techniques were presented to analyze the data. At the end, it was found high quality, better service, convenient location, presentation of food in parlor and restaurants and zero time delivery are playing key roles for getting customers for the food.

Chapter 5 authored by K.S.S. Iyer and Madhavi Damle presents an analysis of the method in advance predictive analytics. Varied or different domains are put together to establish a fine-tuned technique of "Random Point Process" (RPP) and "Product Density" (PD), two techniques in stochastic modeling, which can be used for advanced predictive analytics. This formulation arises from these techniques being used in different fields like energy requirement in IoT devices, growth of cancer cells, cosmic rays' study, to customer equity and many more approaches.

Chapter 6 authored by Samir Yerpude addresses a paradigm shift observed in the last decade where transactional marketing is taken over by relationship marketing. Customer relationship management (CRM) has been an integral part of a business strategy in the current era. CRM integrates product sales, product marketing and, most importantly, customer service in a seamless manner to generate value for the organization as well as for its customers in short a win–win situation. Profoundly, CRM needs to be a part of the top management agenda and driven top-down instead of an IT initiative. Industrial revolution 4.0 is characterized by cyber-physical systems. Internet of Things (IoT) is the digital technology for the present and future. IoT primarily aids in gathering real-time data and transmitting the same over the internet to a central repository for consuming the same in business models. Real-time customer data analytics can be performed by customer-centric organizations to enhance CRM.

Chapter 7 authored by K. K. Tripathy and Sneha Kumari addresses that Rural Development constitutes of lot of big data related to rural employment with special reference to the world's largest public works and wage employment generating poverty alleviation programme – Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA)The concepts of MGNREGA are novel and innovative though the programme continues to suffer from various rigidities depicted from the data. This drives us to the objectives of our research. The study has explored literature and big data on rural development with special reference to MNREGA, the upcoming challenges in rural employment with special reference to MGNREGA, identify gaps in existing literature and pave out future research direction for academicians, researchers and policy maker.

Chapter 8 authored by Jorge Tarifa-Fernandez, Almudena Martínez Aguilera and José Felipe Jiménez-Guerrero concludes and presents the critical importance and value of digital technologies which have led companies to remain competitive. Despite the benefits, the transformation of a firm into a digital-based one requires it to choose a set of digital technologies. In this sense, there may be multiple combinations of digital technologies by means of which firms can obtain their digitalization. Thus, each firm should decide which combination best fits its needs.

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Foreword

The world has generated data in every field giving rise to big data. There is plenty of data everywhere and data storage is becoming critical at present. The importance of big data doesn't revolve around the availability of data, but the purpose of data. Researchers, academicians, policy makers and practitioners are consistently driving ways to find out the application of big data. With so much of data, it is time to understand the big data and how analytics can help in better decision making and manage things. Application of Big Data and Business Analytics at present needs to be explored among academicians, practitioners, policy makers and researchers. The book will have academic and managerial implications to manage the decision-making process. This book explores a number of perspectives on how big data and business analytics can help in better decision making. The book can be an asset for the readers at the present time. The authors from different countries and universities have made a contribution in organizing their research ideas into research chapter meeting the scope of the book. The chapters in the book have been selected carefully, providing a fine balance between trends in big data analytics and it's application in different streams. The chapters have diverse themes in application of big data analytics.

The chapters selected have been classified into Themes like data visualization, multiple aspects of data analytics, predictive analytics, application of data analytics in industry, agriculture and service sector followed by the challenges in digital technologies. The chapter on Customer Segmentation Using RFM Analysis: Real Case Application on a Fuel Company establishes and presents a real case application of RFM analysis on customer segmentation for a Fuel company with possible strategies for the company are generated. The chapter on Applications of Big Data Analytics: A Boon for the Food Industry analyses big data with technologies like machine learning and artificial intelligence to get faster and more personalized experiences generating an opportunity for the food industries to reduce food loss and gain better returns on investment by going for a digital transformation. The chapter on Big Data for Sustainable Rural Development with special reference to MGNREGA addresses the application of big data related to rural employment with special reference to the world's largest public works and wage employment generating poverty alleviation programme – Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) on Rural Development. The authors have done an appreciable work in presenting the applications of big data and business analytics in different managerial decision making. The application of big data can be seen in descriptive, predictive and prescriptive analytics.

All the chapters are topical. The chapters are well-balanced covering the application of big data and business analytics by academicians, researchers, industrial experts, policy makers and practitioners. This book will bring together researchers, engineers and practitioners and encompass wide and diverse topics of application in almost every field. It will also invite the participation of scholars, analysts and data scientists to analyze the application of Big Data and Business Analytics by the contributors from different countries. The book paves a way for the readers to understand how big data can be efficiently utilized in better managerial applications. Dr. Sneha Kumari, Dr. K. K. Tripathy; Vaikunth Mehta National Institute of Cooperative Management and Dr. Vidya Kumbhar, Symbiosis International (Deemed University) have done a commendable job as book editors in making the application of big data analytics research available for a wide audience.

Dr. Lt. Col. Anupama Munshi
Veteran, Faculty and Researcher, India

Dr. Lt. Col. Anupama Munshi (retd) is a doctorate in Management with 17 years of experience in Indian Army in handling big data of entire gamut of Human Resource Development functions , Human Resource Management and Industrial Relations. She has dealt with the application of big data in decision making in the Army. She is an expert in application of big data in designing & implementing training programs to enhance efficiency & motivation levels. She has also applied the big data for imparting teaching and training to officers of Indian Army as well as officers of other armies in subjects like Quality control, Logistics & Supply chain management, Transport management, Tendering and procurement for Defense supplies. She is the First Lady Officer of Indian Army to command an Independent Food Inspection Unit for providing logistics support to a specialized brigade and was first officer of Army Service Corps to be awarded General Officer Commanding in Chief's Commendation card for outstanding service. She has also worked as a Professor in Symbiosis International Deemed University, Pune and is the visiting faculty for many renowned Management Institutes in Pune. She is consistently involved in researches of application of big data in the Indian Army.

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Dr K. K. Tripathy has a PhD from Department of Management Studies of Indian Institute of Technology Delhi on "Micro-finance Management and Its Impact on Rural Livelihoods"; master's in Economics and Bachelor of Law (LLB). He is an Officer of Indian Economic Service (IES), Government of India. He joined the IES in 1999. Prior to joining the IES, he also worked as an Executive Magistrate in the Government of Odisha after joining the Odisha Administrative Service in 1998. He is presently the Director of the Vaikunth Mehta National Institute of Cooperative Management – a National Institute of Ministry of Agriculture and Farmers Welfare, Government of India. During his 21 years of public service, he has served in the Ministry of Human Resource Development, Ministry of Agriculture and Farmers Welfare, Ministry of Rural Development, Ministry of Food Processing Industries, Planning Commission and United Nations Development Programme. He has published around 70 research articles and has attended several international and national conferences. His areas of research are rural development, microfinance and agriculture.

Dr Vidya Kumbhar has a PhD in Computer Studies from Symbiosis International (Deemed University). Her area of specialization includes data science and analytics, software development, big data handling, spatial data mining, spatial decision support system and agro-informatics. She is also associated with different

institutes for various educational-related assignments. She has worked on software development projects in National Informatics Centre, Pune, and currently working on different research projects funded by government and private organizations. She has published various research papers in national and international journals and conferences. She is also a reviewer for national and international journals indexed in Scopus and Web of Science.

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Chapter 1

Data Visualization

Aarti Mehta Sharma

Abstract

Analytics is the science of examining raw data with the purpose of drawing conclusions about that information and using it for decision-making. Before the formal written language, there were pictures which shared ideas, plans, and history. Most of the knowledge that we have of our ancestors is from these pictures drawn on caves or monuments. In today's world, visualizations in the form of bar charts, scatter plots, or dashboards are essential tools in business intelligence as they help managers to absorb information and take apt decisions quickly. Dashboards in particular are very helpful for managers as multiple charts and graphs giving the latest information about sales, returns, market share, etc. keep them up to date on the latest developments in the company. There are a number of visualization software in the market which are easy to learn and communicate the analyzed data in an easily understood form; the leading ones being Tableau, QlikView, etc. with each one having its positives. This chapter also looks at the pairing of visualization tools with different measurements of data.

Keywords: Analytics; visualizations; decision-making; data; tableau; QlikView; measurements; dashboards; business intelligence; bar charts; scatter plots; analysis; forecasting.

Introduction

The application of Data Science has immensely benefited corporates by driving productivity, encouraging faster and better decision-making, enabling smarter hiring, and thus increasing net revenues. It has benefited customers by giving them faster access to all kinds of information, communication platforms, and services in the form of search engines like Google and Bing, flight ticket booking websites like makemytrip.com or goibibo.com, or social media apps like Facebook, twitter, etc.

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The widespread use of Enterprise Resource Planning systems, the internet, and various mobile applications by industry and individuals has given rise to a mind-boggling volume of data in the form of numbers, text, visuals, videos, etc. In today's world where we are generating data continuously to the tune of 2.5 quintillions of data (2,500,000,000,000,000,000 bits) in the form of text, images, and speech, it becomes more imperative to have tools which can mine these data, analyze these data, and share it within organizations so that they profit from it. On the heels of this digital influx has been the exponential growth of the field of data science. The US Bureau of Labor Statistics (2019), in its *Occupational Outlook Handbook* has ranked the top jobs needed for the coming decade. The graph in Fig. 1 shows the jobs that are projected to grow the fastest for 10 years up to the year 2028 in the United States:

As is clear from the graph in Fig. 1, out of the professions listed, the eighth fastest growing job in the United States is for that of a statistician or a data scientist. The demand is expected to increase by a phenomenal 31% between the years 2018 and 2028 as organizations are going to want statisticians to extract and interpret the continually increasing stream of digital data that are being generated. In an interview with Dan Kopf (2018), *Hal Varian, Google's chief economist* expresses concern about the huge gap in the supply of data scientists. One of the reasons that there is such a huge supply demand gap for data scientists is that while there is an immense generation of data, there are very few people who can extract the data, make them ready for analysis, analyze them, and draw insights to help business from them. The problem of drawing insights from data gets intensified when managers at senior levels do not have the time or inclination to sift through the mounds of data at their disposal or even go through the analysis conducted on it. The reason they are not being used is that they are difficult to understand, and thus, they are not used for decision-making. It is here that data visualization steps in as a savior. This stream of data science shows data, trends,

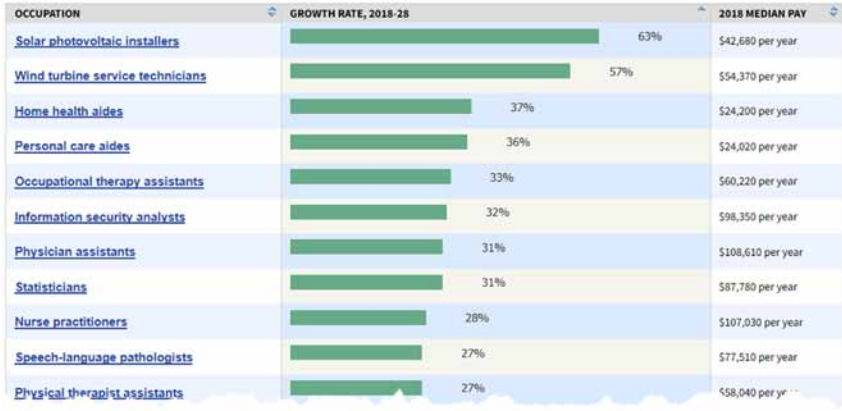

Fig. 1. The 10 Jobs Projected to Grow Fastest in the United States.
Source: US Bureau of Labor Statistics, *Occupational Outlook Handbook*.

relationships, and stories pictorially and through dashboards. It has been proven that the human brain can absorb information faster and better when it is shown pictorially. Researchers (Potter, Wyble, Hagmann, & Emily, 2014) have stated that we human beings react to and process visual data fastest as our brain processes visualzing 13–80 milliseconds as compared to text, where the brain takes more than 200 milliseconds to process text (Hauk, Davis, Ford, Pulvermülle, & Marslen-Wilson, 2006)! As we process visual data better than numerical or textual data, we should employ this ability to enhance organizational effectiveness by processing information through visual mediums.

A 2018 NASSCOM (*National Association of Software and Services Companies*) report (Zinnov, 2018) *Talent Demand and Supply Report AI and Big Data Analytics* says that presently there are 3,70,000 jobs in data analytics, and there will be a demand of another 2,30,000 jobs in the field of Artificial Intelligence (AI) and Business Data Analytics in the year 2020. The report interestingly points out that 70% of these jobs demand visualization skills and in particular the ability to work on popular platforms like Excel, Tableau, QlikView, Power BI, etc. This shows that while data analysis is delivering value to corporates across domains, and its use is becoming widespread within organizations there is a need for simplifying the analysis to make it more usable to a larger audience.

In order to understand the efficacy of visualization, the following example is considered. Recent reports cite the fact that through the years 2018–2055, India's working-age population, i.e., people between 15 and 64 years of age, is becoming more than those dependent on them, which is children below 15 years and adults above 65 years of age. Given below are data which have been drawn from the *Indiastat* (https://www.indiastat.com/demographics-data/7/population/217/age-group-wise-percentage-of-population/12977/stats.aspx) database in the form of a table, and this is followed by the same data in the form of a graph (Thakur, 2019). This dataset is particularly fascinating as there has been a lot of discussion on the India's *demographic dividend* (an increase in the working-age population). Over the years, the governments at the center and state have put various measures in place to abolish child marriage and have been encouraging universal education. Hence, it is an apt time to look at the age breakup in India's population, along with the marital status. India can reap dividends from a larger working-age population only if it is healthy, and one of the ways of ensuring good health is by marriages after 18 years of age. Therefore, the data for population breakup and marital status, given in two files, are collated, and the resulting table is reproduced in Table 1.

At a first look, it is easy to see that 17.1% of India's population is below 10 years of age and 9.4% is between 10 and 14 years, it takes time to register the other age groups and their proportion in the population. While this is a compact table, it is very difficult to compare across different age groups, and it is not possible to look at the larger picture. It is easier to get a feel of India's age breakup and marital status by examining the same data in the graph given in Fig. 2.

In Fig. 2, we can easily make out that the largest age category is of people in the 20–24 age group with 10.6% in that age group. As is clear from the above example, a graph or picture gives a better and faster understanding of data. Another example is that of Google Maps. Google Maps is used to give directions to drivers

Table 1. India's Population Breakup and Corresponding Marital Status.

Age Group (Years)	Total			
	Never Married	Married	W/D/S	Total
Total				
0–4	8.3	0.0	0.0	8.3
5–9	8.8	0.0	0.0	8.8
10–14	9.4	0.0	0.0	9.4
15–19	9.9	0.3	0.0	10.2
20–24	7.5	3.0	0.0	10.6
25–29	3.4	6.4	0.1	9.8
30–34	1.1	7.1	0.1	8.3
35–39	0.4	6.6	0.2	7.2
40–44	0.2	5.7	0.2	6.2
45–49	0.1	4.9	0.3	5.3
50–54	0.1	3.9	0.3	4.3
55–59	0.1	3.1	0.4	3.5
60–64	0.0	2.5	0.5	3.0
65–69	0.0	1.6	0.5	2.1
70–74	0.0	0.9	0.5	1.4
75–79	0.0	0.5	0.3	0.9
80–84	0.0	0.2	0.2	0.5
85+	0.0	0.1	0.1	0.3
All Ages	**49.5**	**46.8**	**3.7**	**100.0**

Source: Office of the Registrar General and Census Commissioner, India (ON1960; https://censusindia.gov.in/2011census/C-series/c-2.html).

Note: W/D/S: widowed/divorced/separated.

in two ways – one is through text and the other is through pictures. A passenger traveling from Symbiosis, Electronic City, to the airport in Bengaluru could use help by using directions in the form of text as in Fig. 3 or maps as in Fig. 4 (Yes, it takes nearly two hours!!!). No prizes for guessing which is more helpful!

Recently, pop singer Rihanna (source: https://djmag.com/news/rihanna-announces-visual-autobiography) announced that she would be sharing her autobiography through a new medium which was through pictures, thereby coining a new term – visual autobiography. Such is the power of pictures that even autobiographies are going visual! Whether it is stunning portrayals on the migratory route of birds across Europe (https://twitter.com/SteveStuWill/status/1175367233180065792) on Twitter, helping school students learn geography (Holmes, 1996), successfully

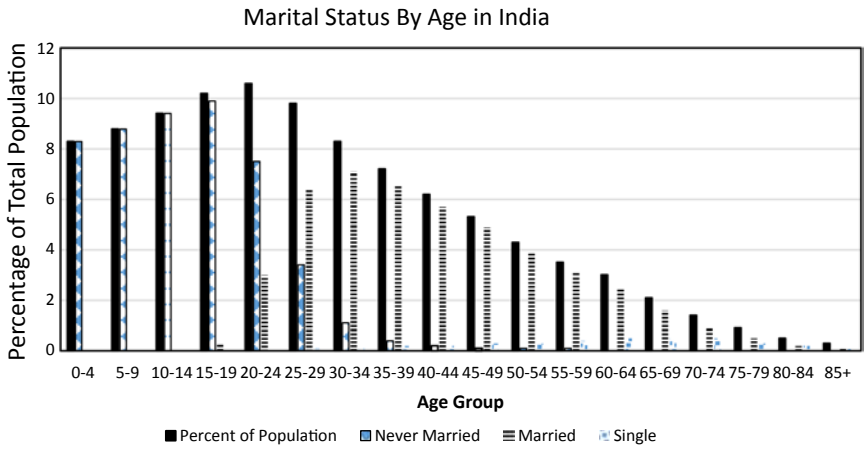

Fig. 2. Marital Status by Age in India. *Source*: Census of India, Indiastat.

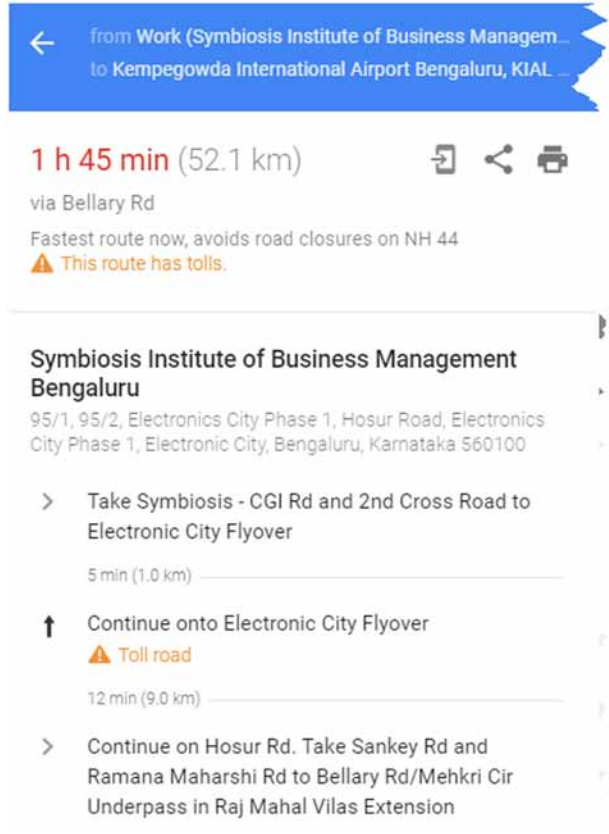

Fig. 3. Directions Given by Google Maps.

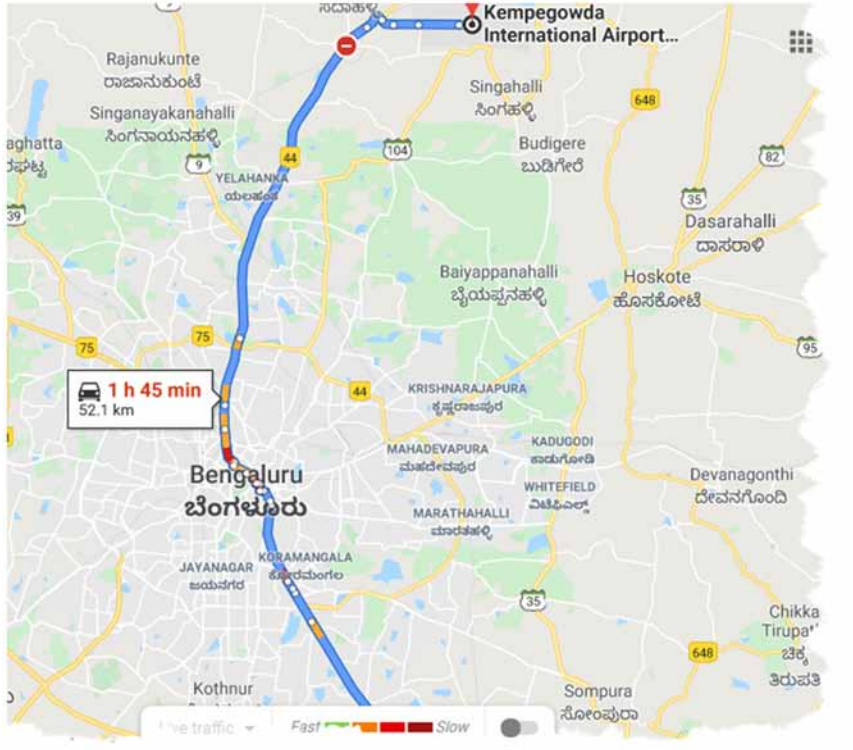

Fig. 4. Directions Given by Google Maps in the Form of a Picture.

planning large projects like urban developments and daily hospital routine (Hahn & Zimmermann, 2011) or a description of how art collections are managed, accessed, and used (Bailey & Pregill, 2014), visualization have moved a long way from simple charts to being a potent tool in revealing patterns and uncovering narratives in a way that is easy to understand and a joy to behold.

Anew field is the geo visualization of consumer data, which is of particular value to corporates. In their chapter, O'Brien and Cheshire (2018) state that as the volume and variety of spatially referenced consumer data grows, there is an unrivaled need for it to be analyzed and communicated. Consumers are interested in knowing what their data say about them, retailers want to exploit data to drive sales, and researchers analyze such data to comprehend social processes. Interactive maps are a proven tool in facilitating data access across these groups. They communicate insights, in addition to providing an interface through which subsets of large and complex databases can be downloaded for further analysis.

All activities and plans are now being "datafied" as most communications are now being recorded as digital data (Cukier & Schönberger, 2013; Van Es & Schäfer, 2017). As the amount of data keeps increasing, the "open data" movement argues that data are a public good and seek to democratize the production

of information and knowledge. The access and reusability of public information keeps governments and corporations on its toes as it allows for active citizen participation. The challenge facing this movement is that data must not only be made accessible but also understandable. Data visualizations are commonly used to make sense of data and to communicate that sense (Kitchin, 2014, p. 106). These publicly available visualizations are being used in diverse fields and in diverse ways – urban dashboards, for instance, *render a city's infrastructures visible and make tangible, or in some way comprehensible, various hard-to-grasp aspects of urban quality of life* (Mattern, 2015). Art projects, however, experiment with the possibilities for visualizing and layering data within the physical environment to create awareness and activate citizen participation around urban challenges (Brynskov, Galsgaard, & Halskov, 2015; Vande Moere & Hill, 2012; Wiethoff & Hussmann, 2017).

Visualization is also a great technique to improve an individual's performance. At an individual level when a person visualizes an important event to be happening before it happens – whether it is a sports activity, making a presentation, attending a meeting, etc. in the human mind the event is already happening. That process works out as a success: the person is the winner; she will shoot the ball in the goal. The same idea can be applied to organizations. This method of succeeding by visualizing success can be brought about by scenarios, strategy maps, process maps, scorecards, and organizational cockpits (Kerklaan, 2011). Data visualization has been noteworthy when it comes to making your business widely accessible and more flourished. It helps people to comprehend the essentialness of data through visual guides, for example, business dashboards, trends, graphs, and so on. The compelling use of data visualization enables managers to display high volumes of data in a more user-friendly and easy to understand way. A business dashboard can be a great way to compile various data visualizations to offer an overview of business performance metrics that matter.

Imagine a manager in the top tiers of an organization who is consistently flooded with reports full of data on the corporation, the market, and the products. The manager is required to create a strategy for future operations by bringing other managers into the process, to contribute and share ideas. This is where the process of using visualization tools and dashboards to form a mental model of data is irreplaceable as it lends insight into the data. While visualizations per se are very important in helping to change a company's perception of its position in relation to other actors and events, it is even more important to know which tools and techniques should be used to make visualizations and manage the process. Managers need to understand causality, the importance–priority relationships, as well as trends in the data (K. H. Tan & Platts, 2004). For this, they need to draw in data from all verticals may it be sales, marketing, finance, accounting, etc. An Austrian research describes that while Big Data introduces high amounts and new forms of structured, unstructured, and semi-structured data into the field of accounting, generating insights from these new data sources highlights the need for different and interactive forms of visualization in the field of visual analytics. At times, some departments will have access to tools and some will not. For example, the lack of knowledge and experience regarding new visualization types and interaction techniques and the sole focus on Microsoft Excel as a visualization

tool is identified as the main barrier to drawing insights from accounting data (Perkhofer, Hofer, Walchshofer, Plank, & Jetter, 2017). These accounting data are an input into the larger picture for the formulation of the overall strategy of the organization and needed for the visualization that the earlier manager would need to make. So, whether at the cellular level or at the universal level, the knowledge of tools and techniques needed is imperative. This chapter aims to address this need.

As visualizations are an accessible form of knowledge representation and bring the power of big data into the mainstream, they also act as a bridge between technical and nontechnical roles, enabling more professionals to move into these data-driven roles (Luo, 2017). "A picture is worth a thousand rows of data" (Lurie & Mason, 2007, p. 160). Prior research suggests that visual transformations of data affect the insights derived from the data and impact both the decision processes and outcomes (Bettman & Kakkar, 1977; Lurie & Mason, 2007). For example, a heat map can help users to recognize patterns and identify outliers. Both bar charts and pie charts can not only make it easier to observe data distributions but also make it more difficult to make inferences about trends (Jääskeläinen & Roitto, 2016; Kobsa, 2001; Lurie & Mason, 2007). Data visualization tools select, transform, and present data in visual formats to facilitate the exploration and understanding of the data and convert data into insights (Green, 1998; Lurie & Mason, 2007). It is important to apply the correct tools for analyzing data and showing trends or else incorrect analysis can be communicated. For example, to make sure that visualization improves the efficiency and effectiveness of audits, auditors should be aware of and should successfully address cognitive biases (Arunachalam et al., 2002; Lawrence & O'Connor, 1993). If the graphs are improperly designed or used by audit clients, they might trigger improper biases (Beattie & Jones, 1992; Johnson et al., 1980; Knapp & Knapp, 2012).

While the science of business analytics uses tools and techniques to turn data into meaningful business insights which lead organizations to save on cost, satisfy customers, and increase revenue, it is pertinent to be able to identify the correct tool for showing data, trends, patterns, and forecasts. Should a bar chart be used to show data? Or should it be a histogram? A scatter plot? Before looking into the kinds of graphs used for different scenarios, it is important to understand the different kinds of analytics that are predominantly applied in industry. There are three kinds of analytics – descriptive, predictive, and prescriptive analytics.

- Descriptive analytics describes what is happening, e.g., comparing two sets of data for two periods, i.e., sales data for a quarter against previous year's sales data for the same quarter.
- Predictive analytics describes what might be happening, i.e., learn from experience (data) to predict what will happen in the future to drive better decisions. An example of that is a tool that is used to approve a loan based on many factors like credit risk and past financial history.
- Prescriptive analytics defines what should be done. For example, in the healthcare industry, patients can be treated better by using prescriptive analytics like first noting those who are clinically obese, then adding filters for factors like diabetes and cholesterol levels to determine where to focus treatment.