Mastering Data Visualization with Tableau

Empowering business decisions with Tableau

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Prof. Praveen Malik

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Dedicated to

To my late mother, ***Smt. Nirmala Awasthi****, and my loving family and wonderful children.*

– Dr. Arpana Chaturvedi

To my late father, ***Sh. Tejpal Singh Malik****, and my loving family and wonderful children.*

– Prof. Praveen Malik

About the Authors

- **Dr. Arpana Chaturvedi** holds a Ph.D. in Computer Science, where she proposed security solutions for DigiLocker and UIDAI. Throughout her 32-year tenure, she has extensively contributed to fields such as IT, security, AI, and ML, supported by her numerous published papers and patents. As a Microsoft Certified Power BI Data Analyst Associate, Dr. Arpana Chaturvedi has significantly impacted the academic growth of undergraduate and postgraduate students. Her proficiency spans a variety of programming languages including Java, Python, C, and C++. Additionally, she imparts knowledge across diverse disciplines such as Linux, Data Structure, Oracle, web technologies, Business Intelligence, Data Visualization, Data Analytics, and Advanced Excel. Her teaching method enriches the curriculum by incorporating practical case studies, preparing students to meet real-world challenges effectively.

  Moreover, she ventured into digital marketing and SEO, significantly boosting the digital presence of one institution she was affiliated with for nearly 18 years, where she also developed and managed their website. Her ongoing projects with DST and MSME, along with her research on Ayushman Bharat's impact in UP East Region, demonstrate her active involvement in significant empirical studies. Dr. Chaturvedi's career exemplifies her commitment to blending theoretical knowledge with practical applications, establishing her as a key figure in the educational sector.

- **Prof. Praveen Malik** is a seasoned educator and data analyst with over 19 years of experience in teaching and consulting. As a Microsoft Certified Power BI Data Analyst Associate and expert in MS Excel and Tableau, Mr. Malik has significantly contributed to the academic and professional growth of undergraduate and postgraduate management students. He has developed and taught courses on Business Intelligence, Data Visualization, Data Analytics, and Advanced Excel, integrating real-world case studies and projects. Additionally, Mr. Malik has provided consultancy and conducted numerous Management Development Programs (MDPs) for corporate houses, focusing on advanced data analysis and business intelligence. Passionate about fostering analytical skills and a data-driven mindset, Mr. Malik blends theoretical knowledge with practical insights to create an engaging and impactful learning environment.

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This book, *Mastering Data Visualization with Tableau: Empowering business decisions with Tableau*, represents a fusion of our passion for data visualization and the powerful capabilities of Tableau in the business arena. The journey to create this manuscript has been enriched and made possible by the tremendous support and encouragement from many outstanding individuals.

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Lastly, thanks to you, our readers, who are dedicated to enhancing your business decisions through sophisticated data visualization. We hope this book not only serves as a valuable learning tool but also as a catalyst for innovation and success in your professional journeys.

– Dr. Arpana Chaturvedi

Writing *Mastering Data Visualization with Tableau: Empowering business decisions with Tableau* has been a deeply gratifying journey, and I attribute its success to the unwavering support and encouragement of numerous exceptional individuals.

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– Prof. Praveen Malik

Preface

In the era of big data, the ability to visualize complex datasets has become crucial for effective decision-making. *Mastering Data Visualization with Tableau: Empowering business decisions with Tableau* is designed to equip professionals across industries with the tools they need to harness the full potential of Tableau, one of the leading data visualization software in the market. This book provides a comprehensive exploration of Tableau's capabilities, from basic functionalities to advanced features, ensuring readers can build compelling, insightful visualizations that drive strategic decisions.

Through step-by-step instructions, practical examples, and detailed explanations, this book aims to transform readers from beginners to proficient users of Tableau. Whether you're a business analyst, a data scientist, or someone interested in making informed decisions using data, this guide will help you leverage data visualization to its fullest potential.

Chapter 1: Introduction to Data Visualization and Visual Analytics– Explore the evolution and significance of data visualization and learn how visual analytics plays a crucial role in decision-making. This chapter sets the stage with a historical overview and introduces the foundational concepts that underpin modern data visualization practices using Tableau.

Chapter 2: Getting Started with Tableau Desktop– Begin your journey with Tableau Desktop, covering installation, navigation, and basic functionalities. Learn how to transform raw data into meaningful visual insights through practical, hands-on examples, preparing you for more advanced features and applications.

Chapter 3: Connecting to Data Sources and Data Interpretation– Learn to connect Tableau to a variety of data sources and discover how to interpret and manage your data effectively. This chapter covers the integration of disparate data sources and provides a deep dive into the tools Tableau offers for robust data analysis.

Chapter 4: Basic Data Visualization and Graphs in Tableau– Focus on building your foundational skills in data visualization with Tableau by exploring a variety of graph types and their applications. Understand how to select and create effective visual representations to communicate data insights clearly and efficiently.

Chapter 5: Dynamic Interaction: Parameters, Set, Hierarchies, and Sorting– Delve into advanced Tableau functionalities that enhance interactivity and user engagement in your visualizations. This chapter covers the use of parameters, sets, and sorting to tailor visualizations to specific analytical needs.

Chapter 6: Dynamic Interaction Using Filter and Action on Worksheet– Expand your interactive skills by applying dynamic filters and actions within Tableau worksheets. Learn how these tools can enhance the analytical flexibility and interactivity of your dashboards.

Chapter 7: Advanced Data Visualization and Graphs in Tableau– Explore sophisticated visualization techniques that allow for deeper data exploration and presentation. This chapter introduces advanced charts and analytical tools that enable you to uncover and present complex data patterns effectively.

Chapter 8: Calculations in Tableau– Uncover the power of calculations within Tableau to enhance your data analysis. This chapter provides insights into creating calculated fields and using expressions to refine and enhance your data visualizations.

Chapter 9: Dashboard Design and Story Creation– Learn the principles of effective dashboard design and the art of storytelling with data in Tableau. This chapter guides you through creating compelling and informative dashboards that narrate your data's story effectively.

Chapter 10: Enhancing Dashboards: Sharing and Collaboration– Explore features that enhance the functionality and engagement of your Tableau dashboards. Learn about sharing, publishing, and collaborating using Tableau's rich set of features to make your visualizations more accessible and impactful.

Chapter 11: Integrating AI in Tableau: An Overview– Investigate the integration of AI and machine learning technologies within Tableau. This chapter discusses how AI can automate insights, enhance data processing, and bring advanced analytical capabilities to your visualizations.

Chapter 12: Data Cleaning and Preparation Using Tableau Prep Builder– Focus on the critical steps of data cleaning and preparation with Tableau Prep Builder. This chapter ensures that you are equipped with the necessary tools and techniques to prepare your data effectively for complex analyses and visualizations.

Teacher resources: This book concludes with a section dedicated to practice exercises and multiple-choice questions that test your knowledge and reinforce the skills acquired throughout the book.

Through this structured exploration of Tableau, readers will gain not only the skills needed to effectively use the software but also an appreciation of the strategic value of data visualization in making informed business decisions. Whether you are a business professional, academic, or data enthusiast, *Mastering Data Visualization with Tableau: Empowering business decisions with Tableau* provides the essential knowledge and skills to transform data into actionable insights.

Tableau Files and Coloured Images

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Tableau Files and the ***Coloured Images*** of the book:

https://rebrand.ly/c05b0f

The Tableau files for the book is also hosted on GitHub at
https://github.com/bpbpublications/Mastering-Data-Visualization-with-Tableau.
In case there's an update to the code, it will be updated on the existing GitHub repository.

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Chapter 1
Introduction to Data Visualization and Visual Analytics

Introduction

In the vast realm of information and data, the age-old adage, *a picture is worth a thousand words*, has never been more pertinent. From ancient civilizations using rudimentary plots to chart the stars, to modern businesses harnessing the power of interactive dashboards, data visualization has been an instrumental tool in conveying complex ideas through comprehensible images. As we embark on this journey through the chapter, we will delve into the rich tapestry of data visualization's history, observing its evolution and understanding its enduring significance in a world inundated with data. Join us as we trace the lines, plots, and charts that have shaped our understanding of the world around us.

In the upcoming chapters, we will discuss data visualization and visual analytics principles and practices, using Tableau as our primary tool. Through practical examples and case studies, we will explore how you can harness the power of data visualization to drive informed decision-making in your organization.

Structure

The chapter covers the following topics:

- Importance of data visualization in decision-making
- Timeline of data visualization
- Data visualization tools
- Overview of Tableau
- Overview of Power BI
- Key differences
- Choosing the visualization tools

Objectives

By the end of this chapter, the readers will be able to trace the historical milestones that shaped the field of data visualization and understand the significance and impact of pictorial data representation in various domains. The readers will also learn to trace the historical milestones that shaped the field of data visualization.

After going through this chapter, the readers will have a basic understanding of how to recognize the key figures and innovations that have propelled advancements in visualization techniques and how to set the foundation for exploring modern tools and trends in subsequent chapters.

Importance of data visualization in decision-making

In today's data-driven world, the volume of information we generate and handle is growing at an unprecedented rate. This explosion of data is changing the way we work and live. At the heart of this transformation is the science of data visualization and visual analytics playing an increasingly critical role in decision-making across various sectors.

The process of data visualization represents data graphically to highlight important trends, outliers, and patterns that may go unnoticed in raw, numerical data. It is a vital aspect of business intelligence because it allows decision-makers to see analytics visually, enabling them to comprehend complex concepts and identify new patterns with ease.

- **Enhancing comprehension**: The human brain is wired to understand visual information better and faster than textual or numerical data. This fact underpins the importance of data visualization. It converts large and complicated datasets into an easily interpretable format, enhancing our ability to comprehend and retain information. Thus, decision-makers can grasp difficult concepts or identify new patterns more readily.
- **Prompting action**: Data visualization transcends mere presentation, offering clear insights into patterns and trends that might remain obscured in raw data. By making these nuances visible, it equips leaders with the information they need to make swift, informed decisions, thereby enhancing both the efficiency and effectiveness of business operations.
- **Revealing hidden insights**: A well-crafted data visualization can reveal insights that were not evident or even thought of. This is particularly true in big data scenarios, where the volume, variety, and velocity of the data can be overwhelming. Visualizations can help tease out subtle correlations, trends, and patterns that could be the key to unlocking significant business value.
- **Facilitating collaboration**: Data visualizations can also facilitate collaboration among stakeholders. It is easier for teams to discuss and understand data in visual form. Whether it is identifying performance issues, forecasting future trends, or strategizing business moves, visual data provides a common language that everyone can understand.
- **Instilling a data-driven culture**: In the era of digital transformation, organizations that leverage data to drive their decisions have a competitive advantage. Data visualization is a cornerstone of this transformation. It allows businesses to communicate insights in a universal manner, promoting a data-driven culture. This culture encourages curiosity, exploration, and objective decision-making, ensuring a more resilient and innovative organization.

Data visualization is an invaluable tool in the decision-making process. It simplifies data interpretation, uncovers hidden insights, promotes quick action, fosters collaboration, and instills a data-driven culture. By leveraging the power of data visualization, organizations can navigate the complexities of the modern business landscape with increased precision and confidence.

Timeline of data visualization

Data visualization has a colorful history that is full of creativity and innovation. It can be considered a visual language that has evolved over time, turning data into meaningful stories. Imagine a world where pictures speak the language of numbers and information. People created these pictures to tell stories hidden in data, making it easier and more interesting to understand. From simple drawings to colorful charts, every image has played a role in making information come alive.

Why were these visualizations created, and what secrets do they reveal? We will explore these questions by diving into key moments that have shaped the world of data visualization. We will uncover brilliant ideas and transformative milestones that have changed how we see and interpret information. In this chapter, we will explore and unveil the fascinating stories hidden in the visual language of data. To further illuminate our exploration of data visualization's rich heritage, the following timeline (*Figure 1.1*) showcases key milestones that have defined the evolution of this dynamic field.

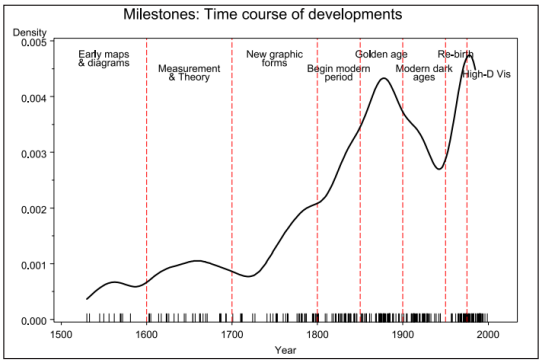

***Figure 1.1**: Timeline of Key Milestones in Data Visualization History*[1]

Origins of visual representation

A long time ago, before we had written history, people began using pictures to tell stories and share information. They would draw on cave walls or in the sand to express their ideas and experiences. For instance, the ancient cave paintings in Lascaux, around 40,000 years old, are believed to be early forms of guidebooks for hunting or even maps of the stars.

Early maps and diagrams: Pre-17th century

Our journey starts with simple geometric diagrams and maps, which were in use way before the 17th century. As far back as 200 BC, communities such as the ancient Egyptians used basic coordinates to plan towns and locate stars in the sky.

Claudius Ptolemy, between 85 and 165 AD, made significant contributions by creating earth map projections and setting standards that lasted until the 14th century.

Around 600 B.C., civilizations such as the Babylonians, Egyptians, Chinese, and Greeks began drawing maps on various materials like clay. These maps helped them navigate during travels and plan activities like farming.

In the 3rd century BC, Greek mathematician *Hipparchus* introduced one of the first coordinate systems to track stars, marking a significant advancement in data visualization. These early efforts laid the foundation for the rich field of data visualization that we see today. *Figure 1.2* elucidates the mechanics of this coordinate system.

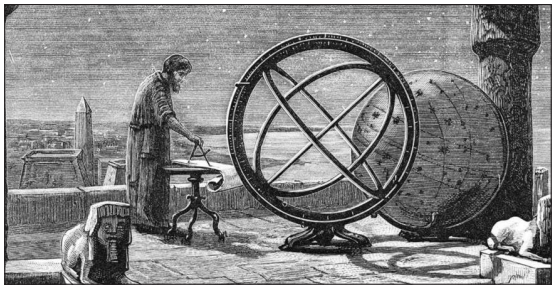

***Figure 1.2:** Hipparchus' innovative coordinate system*[2]

1. https://www.researchgate.net/figure/The-time-distribution-of-events-considered-milestones-in-the-history-of-data_fig1_45858111

2. https://www.brown.edu/academics/classics/news/2019/03/presenting-2019-david-pingree-prize-ancient-science

In the 10th century BC**,** Islamic scholars used shapes and pictures to explain ideas about astronomy and math. They created detailed graphs that showed the positions of important stars and planets over time, as shown in *Figure 1.3*. These graphs resembled early versions of the coordinate grids and graph papers that were developed much later, in the 1600s and 1700s. These visuals helped people understand complex concepts in a simpler way.

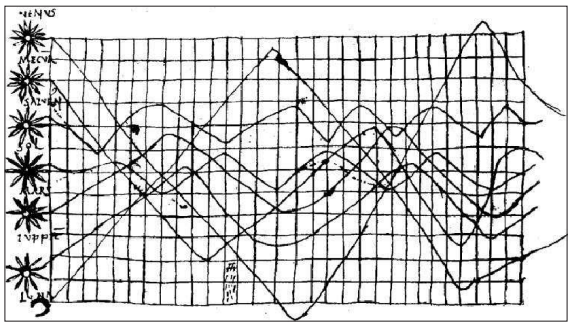

Figure 1.3: *Celestial rhythms: A 10th-century visualization of planetary movements over time*[3]

14th century: Innovative visual concepts

In the 14th century, a brilliant thinker named *Nicole Oresme* (1323-1382) brought forward some revolutionary ideas. He started drawing theoretical functions, that is, he began using pictures to show and explain mathematical ideas and relationships. His drawings were like the bar graphs we see today, helping people to see and understand the connections between different values more clearly.

16th century: Progress in observation and measurement

Moving on to the 16th century, there was a wave of advancements in the ways people observed and measured things. One of the key figures of this time was *Tycho Brahe* (1546-1601), who made significant contributions by building massive instruments, like the *wall quadrant*, to study the sky more accurately.

During this time, new and important methods were also developed to improve mapping. A technique called **triangulation** was introduced by experts like *Frisius* in 1533 and *Tartaglia* in 1556. This technique made it possible to create more accurate maps by allowing precise locations to be determined and plotted.

A leap in geographic visualization

In the 16th century, maps evolved to include lines of latitude and longitude, enhancing geographic accuracy. To provide a visual context to the discussion on geographic accuracy and innovation in map-making, *Figure 1.4* illustrates how 16th-century cartographers enhanced maps with latitudes and longitudes, paving the way for more precise navigational charts.

Figure 1.4: *Enhancing Maps with Latitudes and Longitudes in the 16th Century*[4]

3. https://www.semanticscholar.org/paper/Data-driven-Biased-Decision-making-Exploring-the-Bergram-Ochan/ec06dbae0efb397cd505862860dfe8517f2c681e

4. https://guides.loc.gov/maps-illustrated-guide/european-atlases

Key innovations of this era include:

- **Camera Obscura (1545):** Invented by *Reginer Gemma-Frisius*, this tool improved object observation, marking a significant advancement in visualization.
- **Trigonometric tables (1550):** Created by *Georg Rheticus*, these tables refined mathematical calculations, improving data accuracy and representation.
- **First modern atlas (1570):** Abraham Ortelius introduced a comprehensive atlas, revolutionizing map compilation and presentation, setting a solid foundation for future developments in data visualization.

17th century: The dawn of scientific visualization

In this century, a harmonious blend of measurement and theoretical analysis paved the way for enriched scientific insights. Pioneers of this era meticulously intertwined empirical observations with theoretical frameworks, fostering a holistic approach to exploring and understanding various phenomena.

The 17th century was a vibrant era of discovery and innovation in science and mathematics. Pioneers of this age focused on precise measurements like time and distance, essential for astronomy and navigation.

Key milestones:

- **1613: First bar graph**: *Michael Florent van Langren* created the first known bar graph, marking a pivotal moment in the annals of data representation. Refer to *Figure 1.5*:

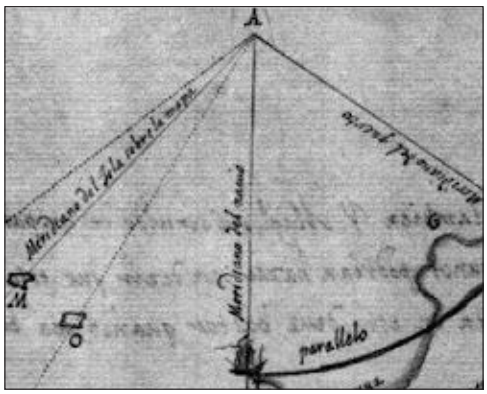

Figure 1.5: *Michael Florent van Langren Bar Graph*[5]

  - **1626-1630: Tracking sunspots**: C*hristopher Scheiner* used *small multiples* to detail the changing positions of sunspots, enhancing the clarity of visual data. Refer to *Figure 1.6*:

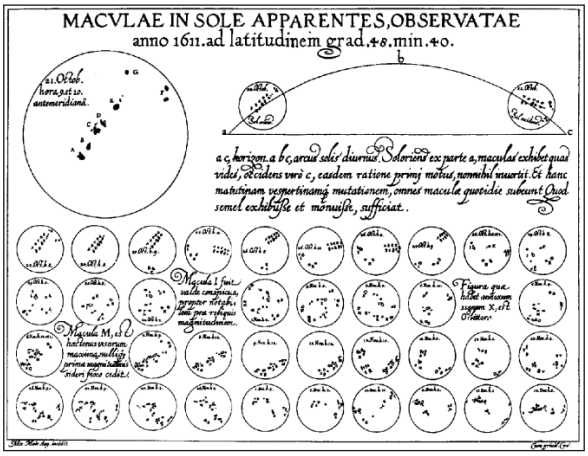

Figure 1.6*: Scheiner's 1626 Illustration: Tracking the transformation of sunspots over time*[6]

5. **https://www.researchgate.net/figure/fig3_227369016**
6. **Source: Scheiner, 1626-1630**