



Essentials of Data Visualization with Tableau: A Guide for Novices

Essentials of Data
Visualization with Tableau: A
Guide for Novices

ANATH RAU KRISHNAN

PUSAT E-PEMBELAJARAN UNIVERSITI MALAYSIA SABAH
KOTA KINABALU



Essentials of Data Visualization with Tableau: A Guide for Novices Copyright © 2025 by Anath Rau Krishnan is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](https://creativecommons.org/licenses/by-nc-nd/4.0/), except where otherwise noted.

eISBN 978-629-99822-6-5

Pusat e-Pembelajaran makes no representation – express or implied, with regard to the accuracy of information contained in this book. Users of the information in this book need to verify it on their own before utilizing such information. Views expressed in this publication are those of the author(s) and do not necessarily reflect the opinion or policy of Universiti Malaysia Sabah. Some diagrams were beyond the control of the proofreaders and ebook editors to amend. Pusat e-Pembelajaran shall not be responsible or liable for any special consequential, or exemplary problems or damages resulting in whole or part, from the reader's use of, or reliance upon, the contents of this book.

Acknowledgments

This publication is made possible with the support of the Commonwealth of Learning, Canada and Pusat e-Pembelajaran Universiti Malaysia Sabah.

Published by

Pusat e-Pembelajaran,
Aras 5, Blok B, Bangunan Fakulti Komputeran Informatik,
Universiti Malaysia Sabah,
88400 Jalan UMS, Kota Kinabalu Sabah, Malaysia

Tel: 088-320 000 (207802)

Email: cel@ums.edu.my

This book was produced with Pressbooks (<https://pressbooks.com>) and rendered with Prince.

Contents

Dedication	vii
Preface	viii
Part I. <u>Main Body</u>	
1. CREATING YOUR FIRST VISUALIZATION	1
2. CUSTOMIZING VISUALIZATIONS	30
3. DATA FILTERING AND SORTING	54
4. GROUPS, SETS, AND COMBINED SETS	88
5. CALCULATIONS IN TABLEAU	100
6. OTHER CHARTS	114
7. MOTION VISUALIZATIONS	156
8. DASHBOARDS	174
9. CONCLUSION: ADVANCING YOUR TABLEAU SKILLS AND NEXT STEPS	188
Glossary	191
AUTHOR AND CONTRIBUTORS	193

Dedication

I dedicate this book to my parents, Mr Krishnan Simanjalam and Mrs Mariammah Seethiah; my wife, Mrs Phrabavathy Doraisamy; my children; my siblings; and all those who have supported and encouraged me.

Preface

In the context of business intelligence, data visualization assumes a pivotal role in converting extensive amounts of raw data into actionable insights. It entails transforming complex raw data into diverse visualizations, such as charts, graphs, geo maps, and dashboards, to uncover interesting stories within the data. Through visual representation, decision-makers can swiftly notice crucial information and trends, enabling informed decision-making that may not be doable with raw data alone. In essence, data visualization fosters a culture of data-driven decision-making within organizations and has become an indispensable skill for ensuring business sustainability.

As such, this book was written to guide and equip interested readers with basic data visualization skills. The book uses Tableau Public version 2024.2 as the main tool to demonstrate various visualization techniques. The tool does not demand extensive proficiency in computer programming languages; users can effortlessly create interactive visualizations by simply dragging and dropping selected data fields onto the worksheet. Additionally, advanced analysis can be performed without the need for intricate formulas.

The content of this book has been meticulously assembled and arranged to facilitate beginners in learning from the ground up. Chapter 1 primarily focuses on guiding readers through the process of connecting data source files to the Tableau Public environment and creating their initial visualization. Chapter 2 offers guidelines for customizing visualizations to include context or additional information, enhancing their appeal for presentations. Chapter 3 delves into various data filtering features within Tableau, enabling dynamic adjustments to the displayed details in visualizations. Chapter 4 illustrates the utilization of groups, sets, and combined sets in data visualization. Chapter 5 provides examples of

calculations that can be executed in Tableau Public. Chapter 6 walks readers through the creation of advanced charts or graphs using Tableau Public. Chapter 7 covers the process of constructing motion visualizations. Lastly, Chapter 8 outlines the steps for merging multiple visualizations to design a dashboard.

The book is tailored by adhering to the concept of learning by doing; proficiency can only be achieved through active practice. Mastering data visualization skills requires hands-on experience, and therefore, this book provides at least one exercise for every key concept discussed. In total, the book includes over 30 exercises, each accompanied by a detailed, step-by-step solution.


The book is anticipated to greatly benefit readers, depending on their current roles. University or college students can utilize it to acquire fundamental data visualization skills, highly valued by today's industries. These skills can enhance their employability prospects upon graduation and prepare them for Tableau professional certification exams.

Executives within business organizations can leverage the skills gained from this book to visually analyze their historical performance data. Insights derived from such analysis can inform evidence-based strategic or operational decisions, aiding in sustaining or enhancing business outcomes.

Researchers, meanwhile, can utilize Tableau skills to visually analyze their research data, aiding in achieving their research objectives. Finally, trainers may utilize this book as one of their main instructional resources in coaching their trainees from scratch.

All in all, the book offers a unique content structure, featuring numerous hands-on exercises and guided solutions, which can efficiently equip individuals with the desired data visualization skills in a minimal time frame.

I. CREATING YOUR FIRST VISUALIZATION



By the end of this chapter, readers will be able to:

- Download and install Tableau Public
- Connect a data source file to Tableau Public
- Identify some key interface components in a Tableau workbook
- Create their first visualization
- Save created visualizations to their Tableau Public profile
- Change aggregation types for data analysis
- Perform a simple drill-down analysis of the underlying data

Business Intelligence and Visual Analysis

Business intelligence (BI) refers to the use of various systematic procedures and technologies to gather, analyze and present data to gain meaningful business insights. It, therefore, promotes data-driven decision-making within a business organisation.

Data visualisation is one crucial component of BI. It involves the conversion of massive-sized raw data into graphical information using various traditional or advanced charts, graphs, geo maps, dashboards, etc. In the context of business, data visualisation helps in the detection of hidden correlations between various business performance metrics, business trends, outliers in the data etc., which enables the users to make better-informed decisions.

Data visualization also enables users to efficiently communicate data insights across different levels of an organization. Charts and

graphs can simplify complex information from the available raw data, making it easier for the audience to ingest and digest the presented information.

There is a wide range of powerful, modern data visualisation tools available in the current marketplace, including Tableau. These modern tools can help in producing traditional and advanced visualisations as per a user's needs. More importantly, these tools allow the users to interact further with the visualisations to seek the needed information. For instance, they can drill down into specific data points or filter the visualisations based on certain criteria.

The figure below summarises the connection between BI and data visualisation, and three popular modern data visualisation tools.

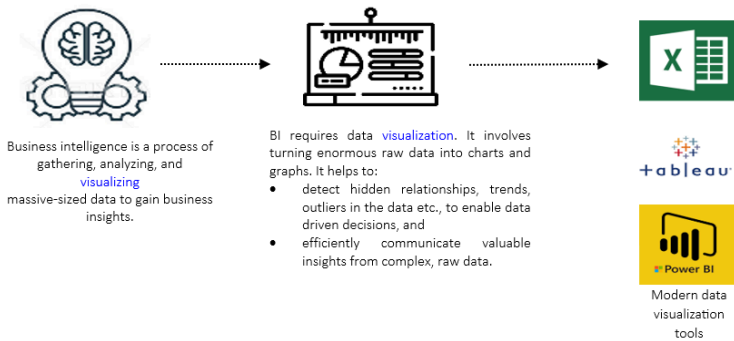


Tableau As a Visual Analysis Tool

Chris Stolte, Christian Chabot, and Pat Hanrahan founded Tableau Software in 2003 intending to enable users to visualize and comprehend their data effectively. Below are several advantages offered by Tableau:

- It enables users to **connect to a variety of data sources**,

including databases, spreadsheets, cloud services, and more. It allows users to combine multiple data sets for visual analyses. However, the focus of this training book is only narrowed to guide readers on connecting data from an EXCEL spreadsheet.

- Users can dynamically explore data thanks to the **interactive visualisations** that can be built with Tableau. Users can use filters, do drill-down investigations on specific data points, or customize the visualizations to gain a deeper understanding and answer ad-hoc questions.
- Users can create visuals merely through a few **drag-and-drop actions**.
- Users can construct a **dashboard** quickly by combining two or more visualizations.
- Users can develop a **storyboard** by merging more than one visualization/dashboard, which can be used to efficiently share data insights to different stakeholders.
- Tableau integrates **advanced analytical functions**. Within the tool itself, users can perform complex calculations, predictive modelling, and statistical analysis.

Tableau is well-suited for fast handling massive amounts of data, unlike Power BI which may become sluggish when managing such huge data. Tableau also has connectivity to a wider array of database sources and servers, such as Excel, Text Files, Google Sheets, and PDF Files, among others, in comparison to Power BI.

On the other hand, although Microsoft EXCEL appears as a very common tool used for data visualization purposes, it only handles data up to certain rows. In contrast, Tableau can handle unlimited rows of data.

Installing Tableau Public

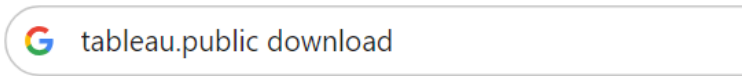
Ever since its establishment, many versions of Tableau products

have been launched in the market, such as Tableau Desktop, Tableau Public, Tableau Server, and Tableau Cloud.

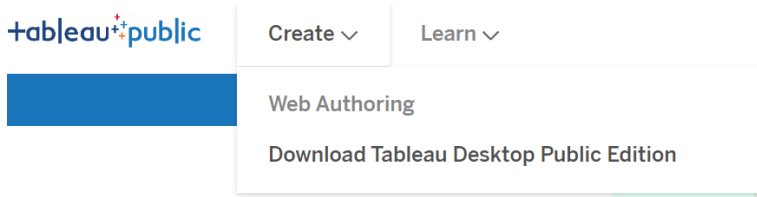
Tableau Desktop is the first product of Tableau, which offers a user-friendly drag-and-drop interface for creating visualizations from various data sources. Whereas Tableau Public is a free version of Tableau Desktop. It has all the essential features of Tableau Desktop, but the designed visualizations can only be saved and published to the Tableau Public website for public access and sharing; users cannot save the visualisations locally on their computers.

This book guides the readers to perform data visualization using Tableau Public since is not only free but also the ideal choice for beginners aiming to learn Tableau. The following are the steps to download and install Tableau Public.

Step 1: Type **public.tableau.com** in the browser address bar and press **ENTER**.



Step 2: Click the **Create** menu available on the top of the webpage and choose the **Download Tableau Desktop Public Edition** option.



Step 3: Fill out the registration form and click the download button.

Almost there!

It only takes 15 seconds to fill out. If you're already registered, [sign in](#).

By registering, you confirm that you agree to the processing of your personal data by Salesforce as described in the [Privacy Statement](#).

[DOWNLOAD THE APP](#)

Step 4: Install the downloaded software to your system.

Tableau Desktop

Public Edition

Welcome to Tableau

Before you install the product, you must read and accept the license agreement.

Tableau Public 2024.2.2 [license terms](#).

I have read and accept the terms of the license agreement.

To help improve our product, Tableau collects information about your feature usage. All usage data is handled according to our [Privacy Policy](#).

Select the check box to opt out. [Learn more](#)

Don't send product usage data.



Customize

Install

Note that Tableau Public is compatible with both Windows and Mac operating systems. To ensure optimal performance, all systems running Tableau Public must adhere to the specified minimum operating system requirements. Below is a screenshot from the official Tableau website detailing these requirements for both Windows and Mac platforms.

Windows

- Microsoft Windows 8/8.1, Windows 10 (x64), Windows 11
- 2 GB memory
- 1.5 GB minimum free disk space
- CPUs must support SSE4.2 and POPCNT instruction sets

Mac

- macOS Big Sur 11.4+, macOS Monterey 12.6+ (for Tableau 2022.3+), macOS Ventura (for Tableau 2022.3+), macOS Sonoma (for Tableau 2022.3+); Apple Silicon machines require the use of macOS Ventura (13+) or newer
- Intel processors - Core i3 (dual core) or newer
- Apple Silicon processors (using Rosetta - 2024.1 and below)
- Apple Silicon processors (version 24.2 or newer on MacOS Ventura or newer)
- 4 GB memory or larger
- 2 GB HDD free or larger

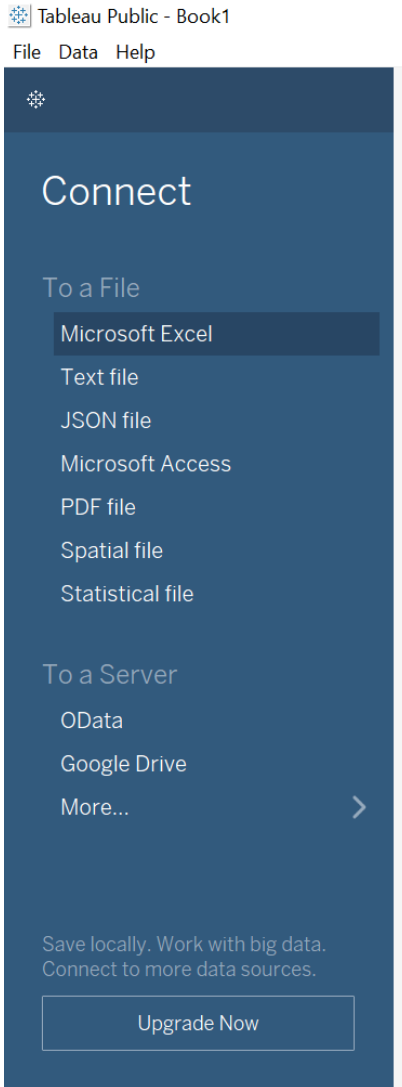
Connecting Data Source to Tableau Public

All demonstrations and hands-on exercises covered in this training book are based on the sample Superstore dataset. The superstore dataset is fictional sales data of a retail store offered by Tableau for practising purposes. The dataset is saved in a Microsoft EXCEL format, and it can be found in the **Data Sources** folder available in the **My Tableau Repository** folder, which is created in your computer storage once Tableau Public is installed.

As our first attempt, let us connect the **Orders** table from the **Sample Superstore** dataset. To establish this connection, follow the steps below.

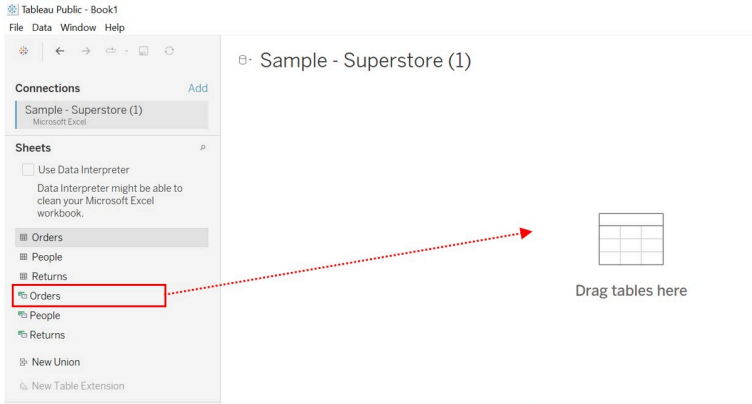
Step 1: Launch Tableau Public.

Step 2: Under **Connect**, choose **Microsoft Excel**.

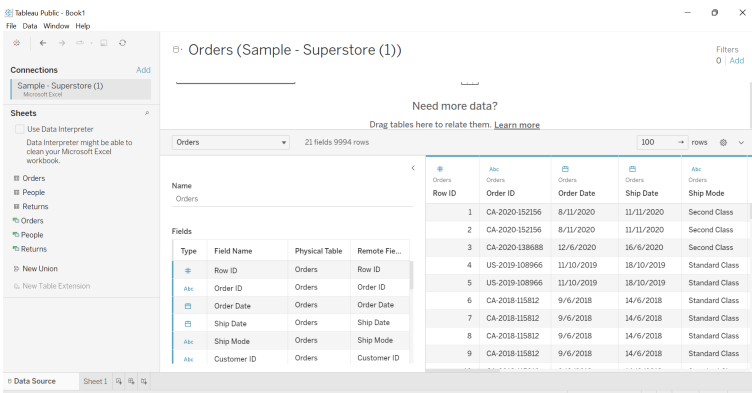


Step 3: Locate and open the **Sample Superstore** file.

Step 4: At the **Data Source** page, drag the **Orders** table from the left pane and drop it in the connection canvas.



Once the connection is established, the **Data Source** page will immediately display the **Data Grid** of the table. The **Data Grid** can be used to preview the fields available in the table and the first few rows of the dataset. It can also be used to make general alterations to the data. For example, users can hide fields that are out of scope, rename fields, perform data sorting, create calculated fields, generate aliases, and more.

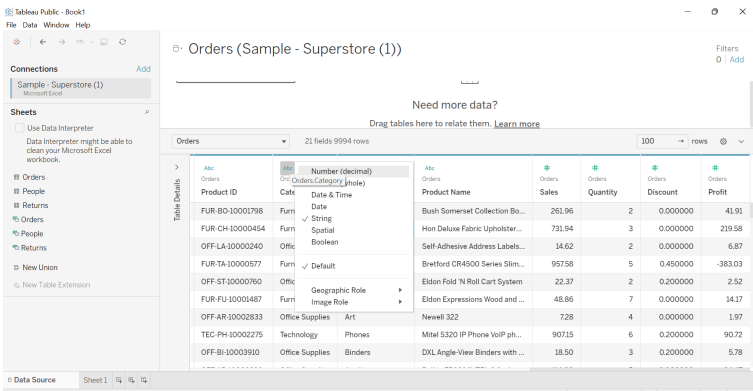


Users can also change the data type assigned by Tableau in the

Data Grid if needed. Note that when we connect a data source to Tableau, the software automatically determines the data type and role of each field in the dataset:

- **Data Type:** Tableau determines the data type of each field, indicating the nature of the data values within that field. Common data types include:
 - **String:** Represents textual or alphanumeric data, such as customer names or product descriptions.
 - **Numeric:** Indicates numerical values, including integers or decimals. Examples are sales amounts, quantities, or prices.
 - **Date/Time:** Denotes fields that contain date or time values, enabling time-based analysis and visualization.
 - **Boolean:** Represents true/false or binary values, which are often used for filtering or conditional calculations.
 - **Geographic:** Recognizes fields containing geographic information like latitude and longitude for mapping purposes.
- **Role:** Tableau assigns a role to each field based on the data type it carries. The two primary roles in Tableau are dimension and measure.
 - **Dimension:** Fields that contain categorical or qualitative data, including string, date, Boolean, and geographic data, are classified as dimensions. Examples include customer names, product categories, or regions. Dimensions are typically used for grouping, filtering, and creating visual encodings like labels, colours, or shapes. Dimension fields are typically indicated by their blue colour.
 - **Measure:** Fields that carry numeric or quantitative values are designated as measures. Examples include sales amounts, quantities, or profit margins. Measures are used for calculations, aggregations, and creating visual encodings like height, width, or size. Dimension fields are usually identified by their blue colour.

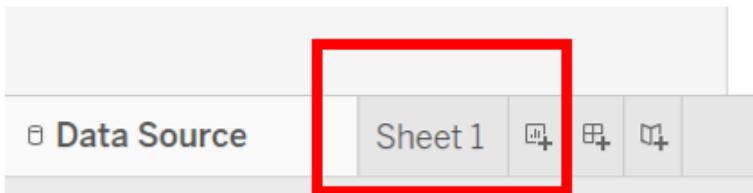
By automatically determining the role and data type of fields, Tableau can quickly start exploring and visualizing our data, making intelligent assumptions about how to handle and represent different field types in visualizations. Nonetheless, users have the flexibility to manually adjust the role or data type if such correction is needed to ensure precise analysis.



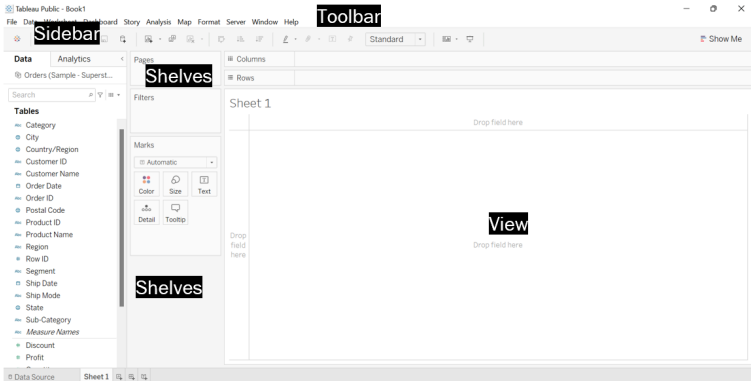
Creating the First Visualization

In this section, we learn to create our first visualisation based on the connected **Orders** data. The aim is to create a simple bar graph showing the **sum of sales per region**. Following are the steps to create the intended chart.

Step 1: Click **Sheet 1** on the data source page to shift to the worksheet page. Following are some of the important items that can be found in the worksheet user interface.

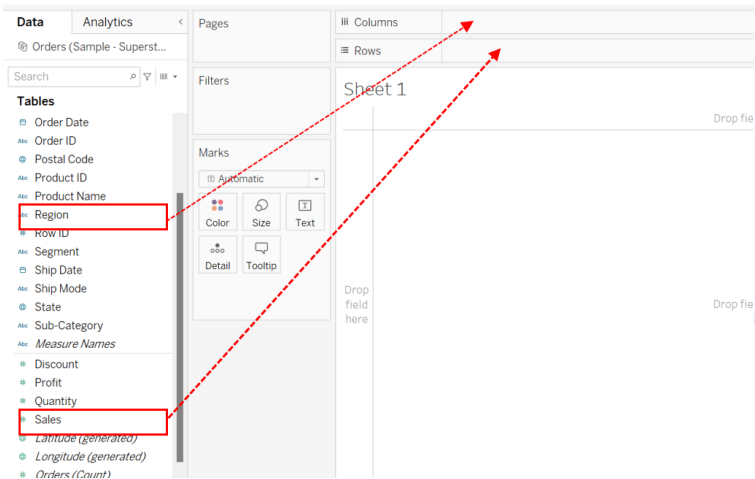


- **Sidebar:** The sidebar has two panes, which are the **Data Pane** and **Analytics Pane**. The **Data Pane** shows the list of fields that are available for the analysis. Tableau sets apart the dimension fields from the measure fields using different colour codes. As mentioned earlier, dimension and measure fields are represented by blue and green colours, respectively. On the other hand, the **Analytics Pane** offers us some additional tools to perform advanced analyses e.g. average line, trend line, forecast etc., that can be applied to the available visualisation.
- **Shelves:** The key shelves are the **Columns** and **Rows** shelves, where we can drop the fields to determine the structure of the visualization. Other shelves include the **Marks** shelf (can be used to customize and add context to a visualisation), **Filters** shelf (can be used to control the level of details offered by a visualisation) and **Pages** shelf (can be used to help animate the transition of data points over a specific domain).
- **View:** View is the area where the visualization is displayed, and the users can interact.
- **Toolbar:** The toolbar is located at the top of the interface and contains various key items such as **Data**, **Worksheet**, **Dashboard**, **Story**, **Analysis**, and **Format**, meant for data visualization or presentations. The items in the toolbar permit the users to edit/refresh data sources, modify/enhance the appearance of the visualizations, add interactivity features, and apply calculations to the visualizations.

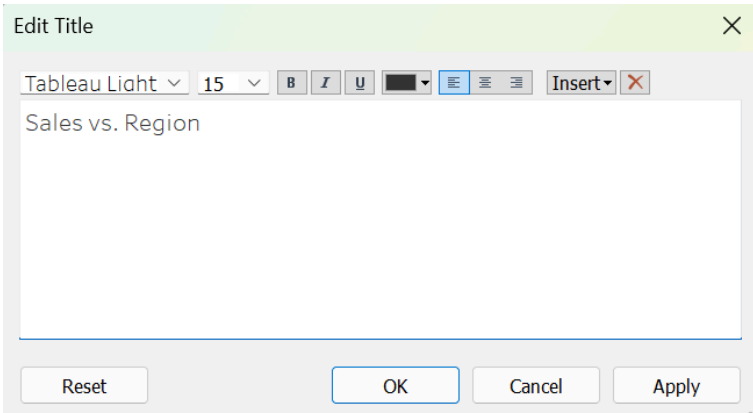


Step 2: Drag and drop the **Region** field in the **Columns** shelf.

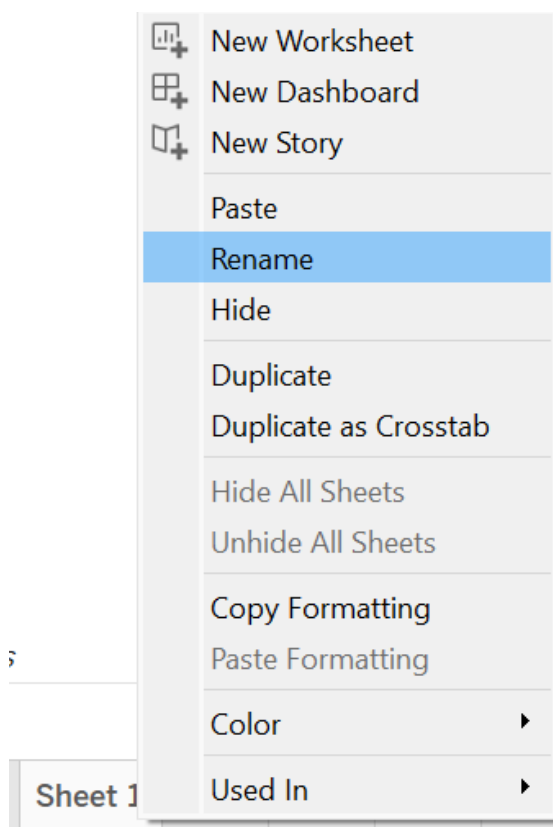
Step 3: Drag and drop the **Sales** field in the **Rows** shelf.



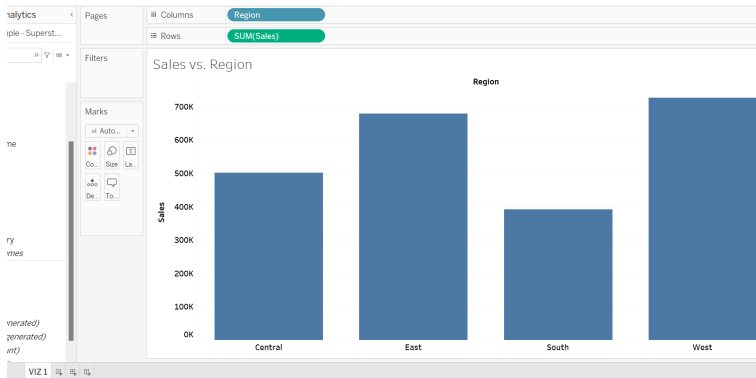
Step 4: Right-click the existing title and choose **Edit Title** to add the following title, **Sales vs. Region**.



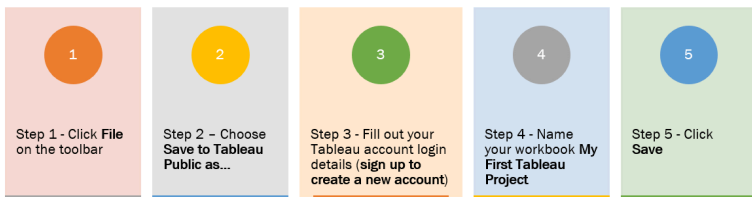
Step 5: Rename the worksheet to **VIZ 1** (Hint: Right-click the **Sheet 1** tab and choose **Rename**).



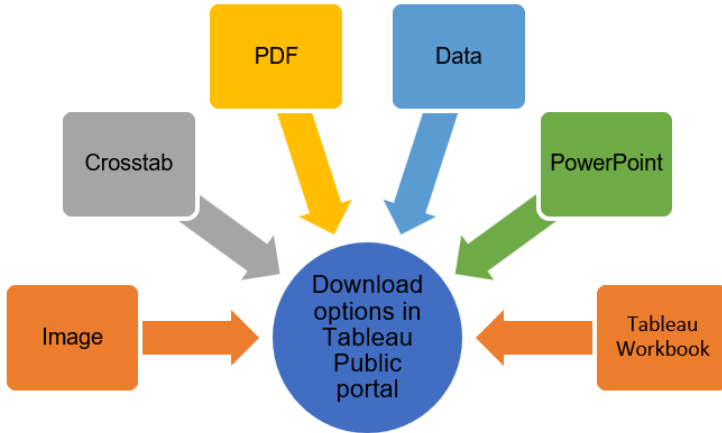
Once a visualisation is created, it can be saved and published on the Tableau Public portal.



The figure below shows the steps to save the visualization.



It is interesting to notice that the visualisation published in Tableau Public can also be downloaded into various formats, e.g., PDF, PowerPoint, Image etc., for reporting purposes (refer to the figure below). We can also customize the appearance of sheets and accessibility to the visualizations at our Tableau Public profile.



An interactive H5P element has been excluded from this version of the text.

You can view it online here:

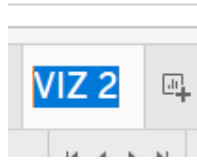
<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=56#h5p-2>

Exercise 1

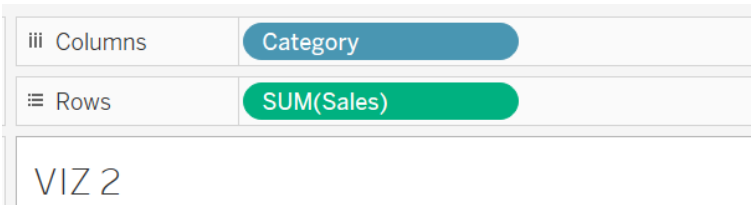
Build a visualization that displays the sum of sales for each product category and modify the title accordingly before saving it in the same **My First Tableau Project** workbook.

Solution- Exercise 1

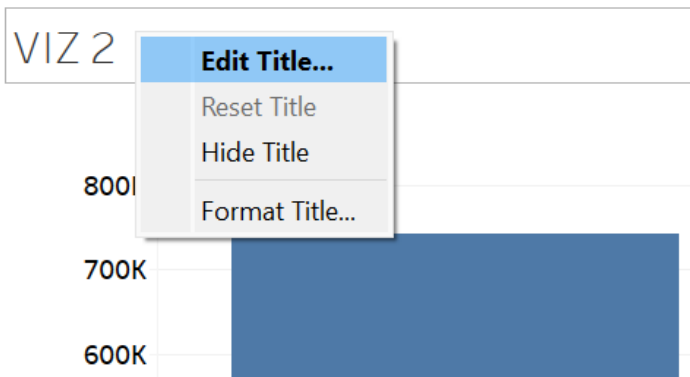
Step 1: Open a new worksheet and rename it to **VIZ 2**.



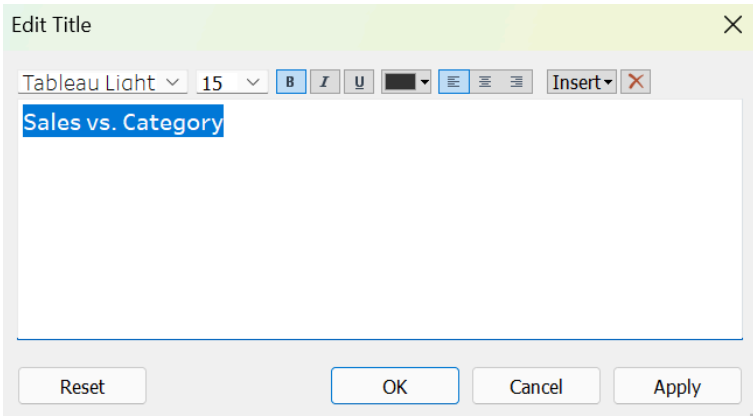
Step 2: Drop the **Category** field onto the **Columns** shelf and the **Sales** field onto the **Rows** shelf.



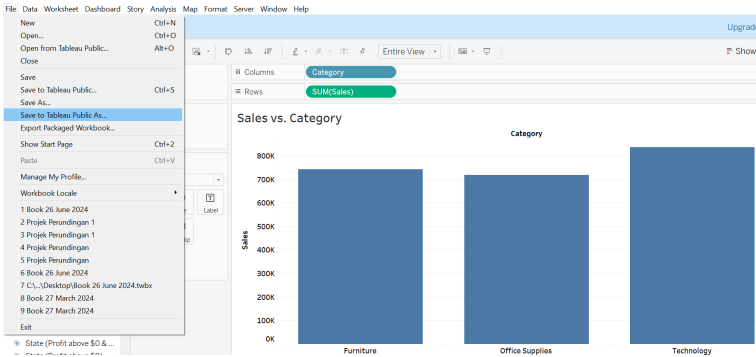
Step 3: Right-click on the existing title and choose **Edit Title**.



Step 4: Revise the title accordingly and click the **OK** button.



Step 5: Click **File** on the toolbar and choose **Save to Tableau Public As** to save it in the same **My First Tableau Project** workbook.



Aggregation in Tableau

Aggregation aids in summarizing the level of data points presented in a visualization, which is useful for making quick decisions. Tableau automatically aggregates the data of a measure field when it is added to a visualization. The default aggregation performed

in Tableau is **Sum**. The type of aggregation can also be switched to **Average, Count, Minimum, Maximum, Standard deviation** etc., subject to the goal of the analysis.

To have disaggregated (detailed) data points in the visualization, users may click the **Analysis** menu available in the toolbar and uncheck the **Aggregate Measure** sub-menu.

Exercise 2

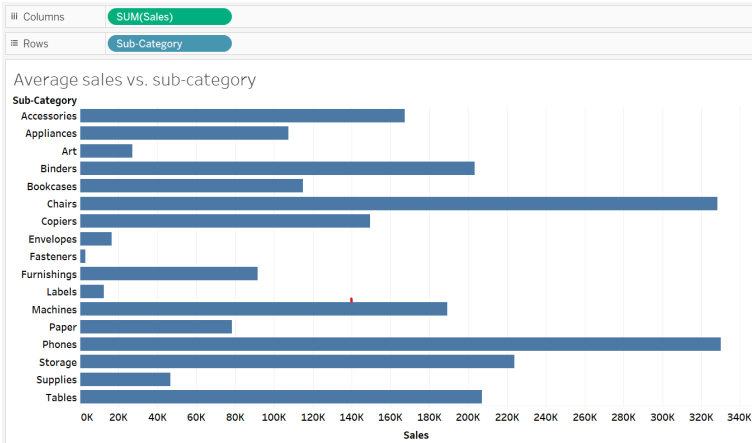
Open a new worksheet. Rename it to **VIZ 3**. Create a chart showing average sales per sub-category product. Change the chart's title accordingly. Which sub-category product recorded the highest and lowest average sales, respectively?

Solution – Exercise 2

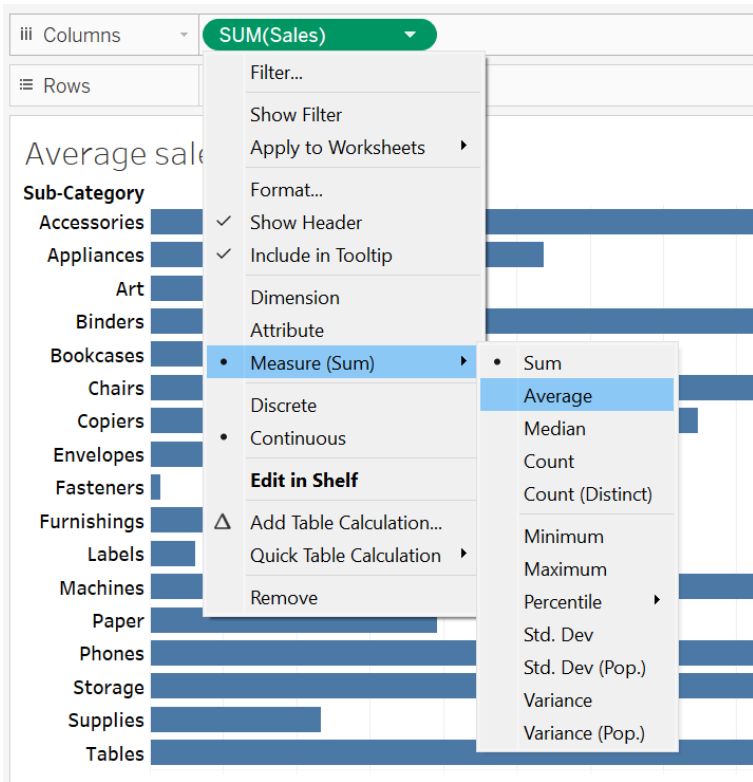
Step 1: Open a new worksheet. Rename it to **VIZ 3**. Drag and drop the **Sales** field onto the **Columns** shelf, whereas the **Sub-Category** field onto the **Rows** shelf.

iii Columns	SUM(Sales)
☰ Rows	Sub-Category

Step 2: Right-click on the existing title and choose **Edit Title** to revise the title accordingly.

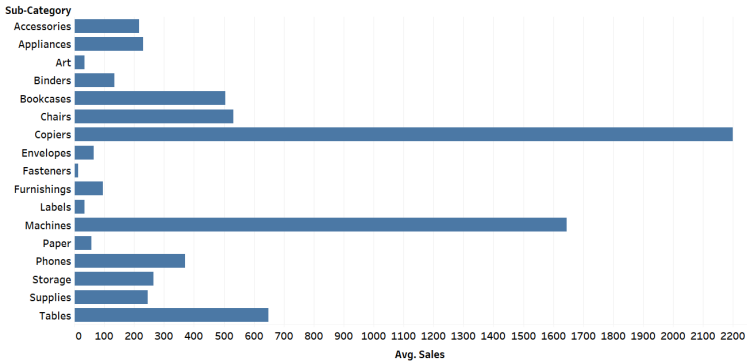


Step 3: Click the down arrow next to the **Sales** field available on the **Rows** shelf. Choose **Measure** to switch the aggregation type from **Sum** to **Average**.



Step 4: Based on the chart, it is obvious that copiers earned the highest average sales. On the contrary, fasteners recorded the lowest average sales.

Average sales vs. sub-category



An interactive H5P element has been excluded from this version of the text.

You can view it online here:

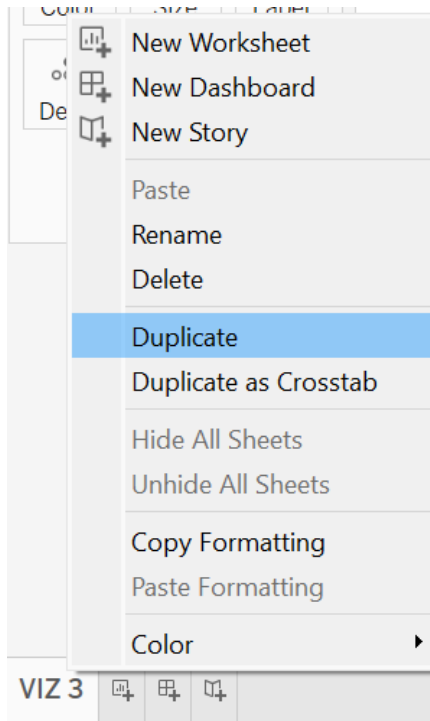
<https://openbook.ums.edu.my/essentialsodatavisualizationwithtableau/?p=56#h5p-3>

Exercise 3

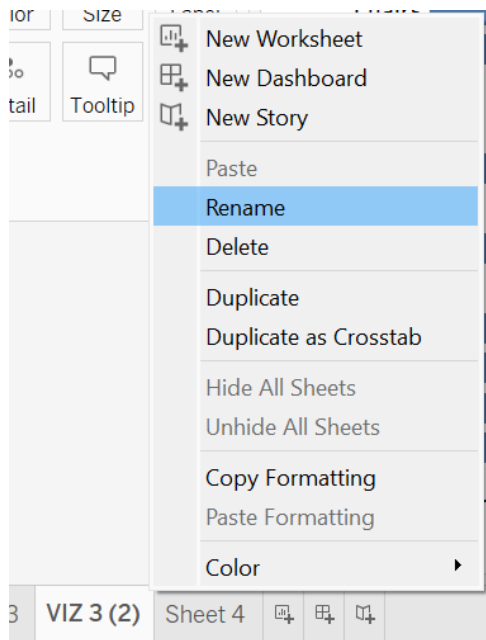
Duplicate **VIZ 3** to another worksheet. Rename the worksheet to **VIZ 4**. Disaggregate the data displayed in **VIZ 4**. What was the highest order sales ever recorded for the accessories?

Solution – Exercise 3

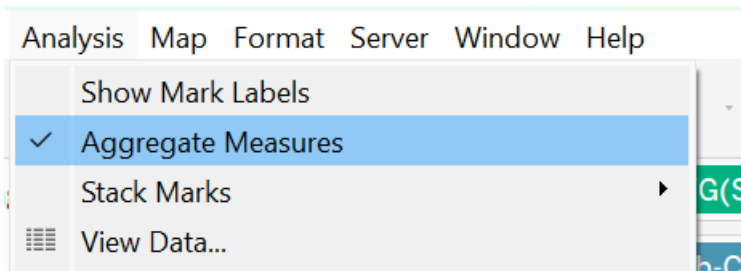
Step 1: Right-click on worksheet **VIZ 3** and choose **Duplicate**.



Step 2: Rename the duplicated worksheet to **VIZ 4**.

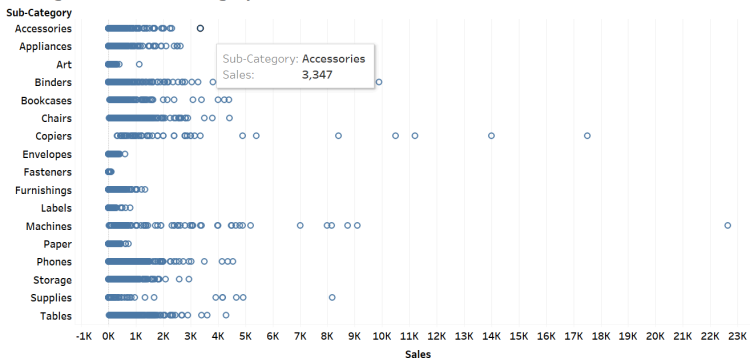


Step 3: Access the **Analysis** menu on the toolbar and deselect the **Aggregate Measure** sub-menu.



Step 4: Based on the chart, it can be concluded that the highest-ever order sales recorded for accessories was \$3,347.

Average sales vs. sub-category



View Underlying Data

The **View Data** feature in Tableau enables users to inspect the underlying data of a visualization. It allows users to drill down particular marks or data points within a visualization to enhance insights through comparisons with other fields. It is particularly useful if the users wish to investigate outliers.

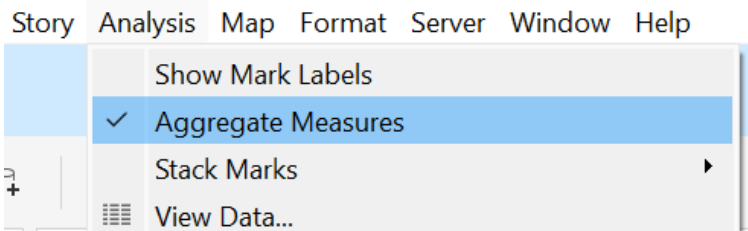
To explore the underlying data of a mark, simply right-click on the mark and select **View Data**. Users can also inspect the underlying data of multiple marks simultaneously by selecting them together using the **Ctrl** button.

Exercise 4

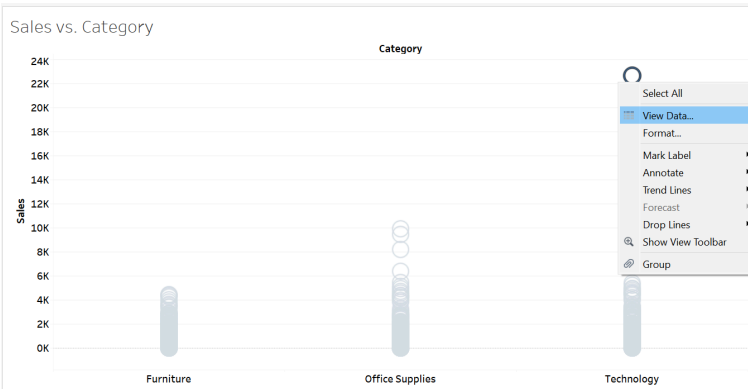
Disaggregate the data in **VIZ 2**. What was the highest sales recorded for the technology category? What profit was achieved through this top sale? Which specific product contributed to this highest sale, and what discount was offered by the store for this purchase? Based on these comparisons, what conclusion can you draw?

Solution – Exercise 4

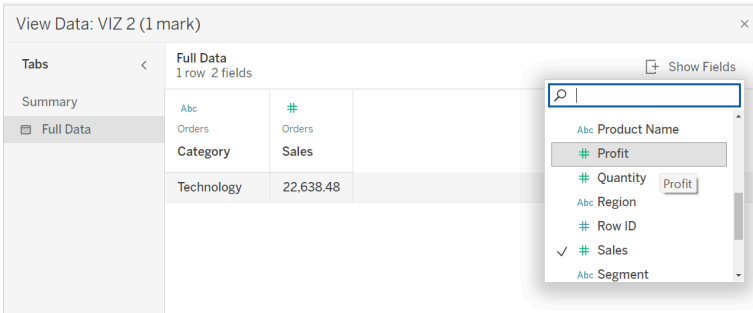
Step 1: Click on the **Analysis** in the toolbar and uncheck the **Aggregate Measure** option.



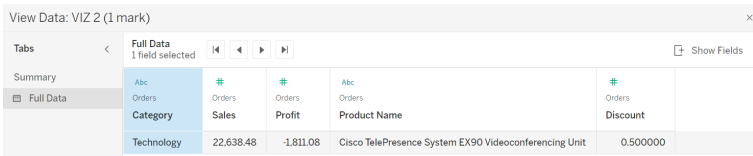
Step 2: Right-click the highest sale point for the technology category and choose **View Data**.



Step 3: Click **Full Data**, followed by the **Show Fields** button. Choose the **profit**, **product name**, and **discount fields**.



Step 4: With the help of the **View Data** feature, it is shocking to find out that the purchase which generated the highest sales actually resulted in a loss. Although the sale amounted to \$22,638.48, it incurred a loss of \$1,811.08. The specific product accountable for this loss was the Cisco TelePresence System EX90 Video Conferencing Unit. Furthermore, it was observed that the store offered a 50% discount for this product. This situation suggests that the store management should immediately re-examine and adjust the selling price or discount provided for the product to prevent such undesirable losses in the future.



An interactive H5P element has been excluded from this version of the text. You can view it online here:

[https://openbook.ums.edu.my/
essentialsofdatavisualizationwithtableau/?p=56#h5p-4](https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=56#h5p-4)

2. CUSTOMIZING VISUALIZATIONS



By the end of this chapter, readers will be able to:

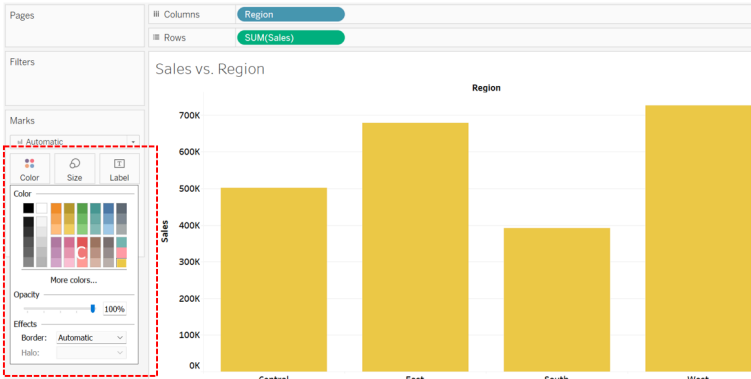
- Customize the colours of marks in a visualization
- Adjust the size of marks in a visualization
- Modify labels in a visualization
- Add extra details to the marks
- Edit the tooltips
- Create and use hierarchy fields

Colour Card

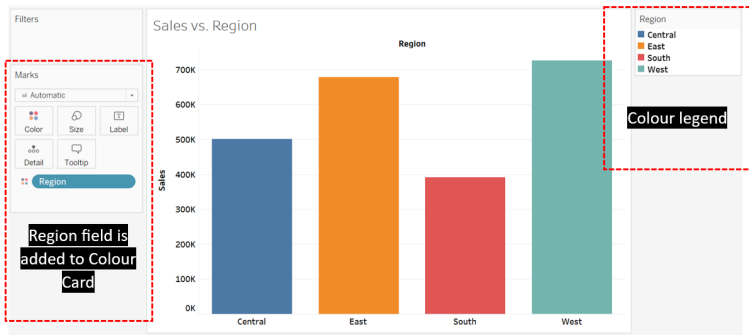
Colours play a crucial role in data visualization. They are not only used to enhance the appearance of a visualisation but more importantly to differentiate the marks according to dimension members or to indicate the value of a dimension member.

In Tableau, the colour of marks can be customized by dragging a field to the **Colour Card** located on the **Marks** shelf. Following are some interesting facts about the **Colour Card**:

- Users have the option to modify the default colour of all marks within a visualization at once. For example, click the **Colour Card** in **VIZ 1** to switch the colour of the marks from blue to yellow.

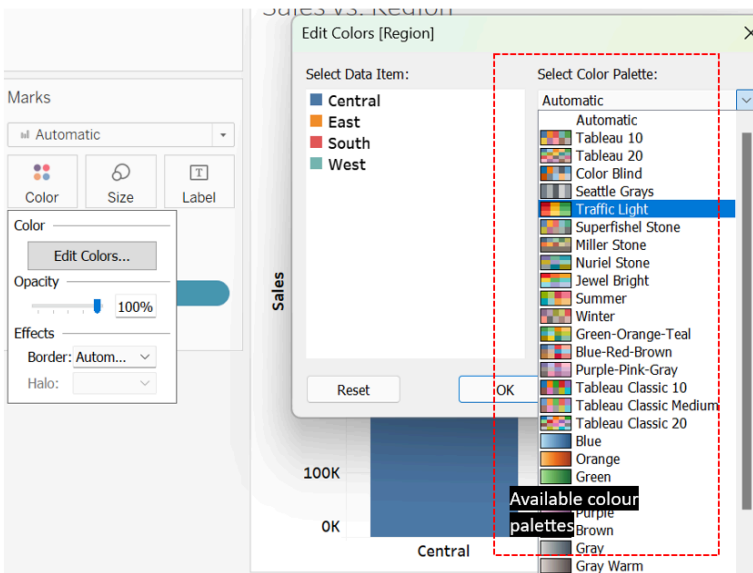


- Different colour codes can be assigned to items within a dimension field by dragging the field to the **Colour** card. Tableau utilizes an appropriate colour palette to distinguish between the dimension items. For example, dragging the region field to the **Colour** card in **VIZ 1** will assign a different colour to each region. When a dimension field like the region is added to the **Colour** card, a colour legend is automatically included in the **View**.



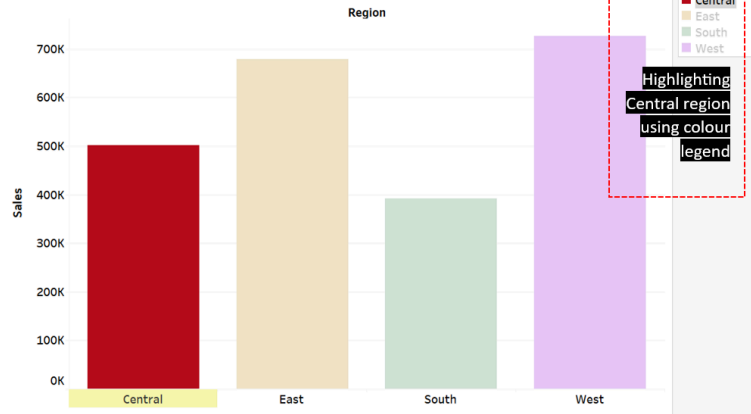
- Users have the option to replace the automatically assigned

colour palette with another by using the **Edit Colours** feature, which appears upon clicking the **Colour** card. Tableau provides a range of colour palettes to choose from. Simply select the preferred colour palette to replace the existing one, and click **Assign Palette**, followed by **Apply**. The following figure is the screenshot capturing the process of changing the existing colour palette in **VIZ 1** to the **Traffic Light** option. Note that users can also change specific colours of a palette once it is applied to a visualization.

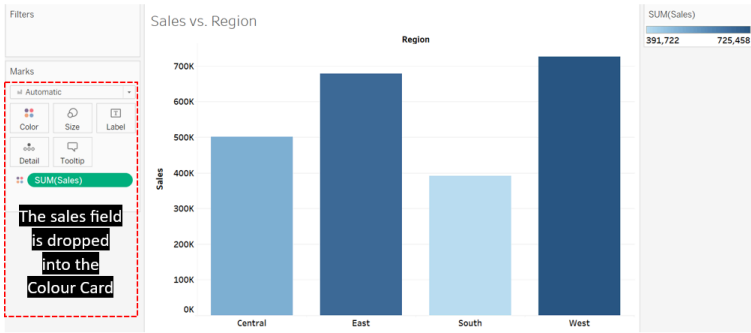


- The colour legend can serve as an alternative highlighter, directing the audience's focus to specific selected marks within a visualization. For instance, clicking **Central** on the colour legend in **VIZ 1** causes the other marks in the visualization to appear faded in comparison to the highlighted **Central**.

Sales vs. Region



- Instead of using a colour palette, Tableau automatically assigns sequential or diverging colours to dimension items when a measure field is added to the **Colour** card. The sequential colour uses a specific colour as a base and the darkness of the colour changes based on the data value of each item. Typically, darker colours indicate higher values, but this can also be reversed using the **Edit Colour** option that appears when the **Colour** card is clicked. Diverging colours serve a similar purpose, but they have two base colours. They are suitable for a field that has both negative and positive values, with one colour representing negative values and the other representing positive values. Below is **VIZ 1**, where sequential colours are applied, representing the sales value of each region. The darkest blue is attributed to the West region, which has the highest sales, while the lightest blue corresponds to the South region, reflecting its lowest sales.



An interactive H5P element has been excluded from this version of the text. You can view it online here:

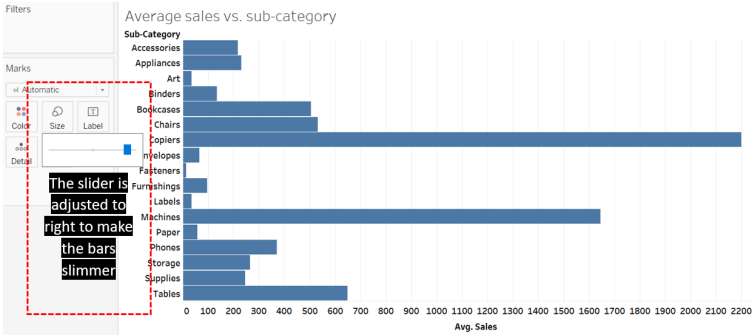
<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=91#h5p-5>

Size Card

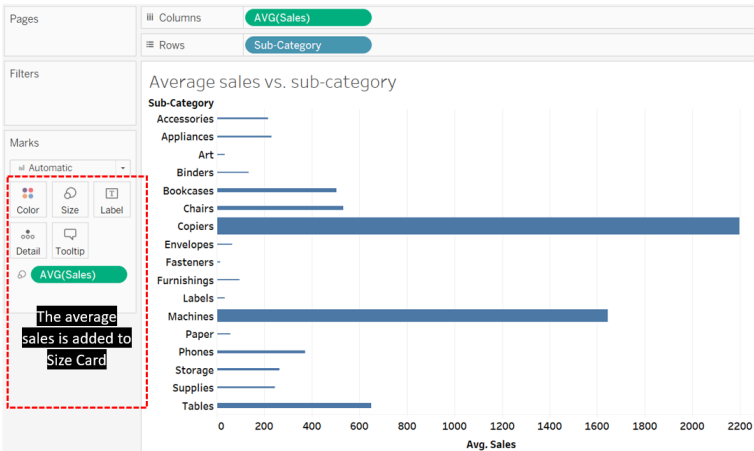
In Tableau, users can adjust the size of marks according to the needs of the analysis. Sizing enables easy comparison between dimension items and sometimes may help reveal intriguing relationships within the data. Mark size adjustments can be made using the **Size Card** located on the **Marks** shelf. Here are some interesting details about the **Size Card**:

- Users can enlarge or shrink marks within the visualization using the slider that pops up once the **Size Card** is clicked. For

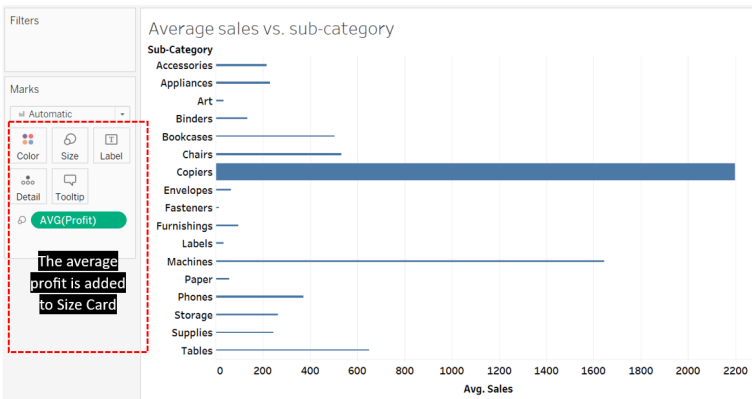
example, use the size slider to make the bars in **VIZ 3** broader.



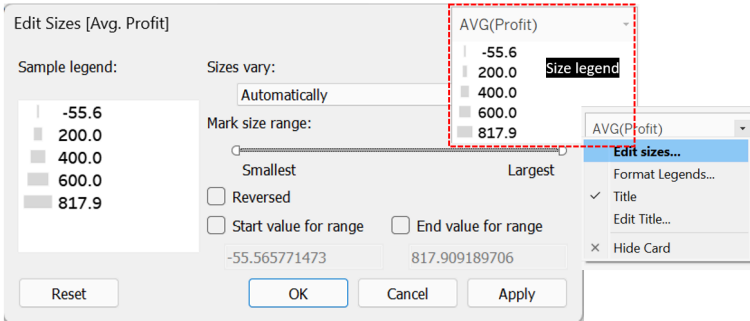
- Users have the option to customize the size of marks based on the values of a field. For instance, in **VIZ 3**, the height of the bars signifies the sales value of each region, while the width of the bars remains consistent. However, by including the average sales in the **Size Card**, akin to the adjustment made for the bar height, the width can also be aligned with sales values.



- Users have the flexibility to customize marks based on the values of two fields, potentially revealing hidden relationships between both fields. For instance, in **VIZ 3**, users can leave the height of the bars to reflect average sales, while adjusting the width based on **average profit**. Based on the chart, it is interesting to note that the average profit is not actually proportional to average sales. Despite machines and tables ranking second and third in sales, respectively, their average profits appear relatively low, as reflected by their bar width.



- Users can edit further the mark size scale using the **Edit Size** option. **Edit Size** appears when the users click the down arrow located in the size legend.

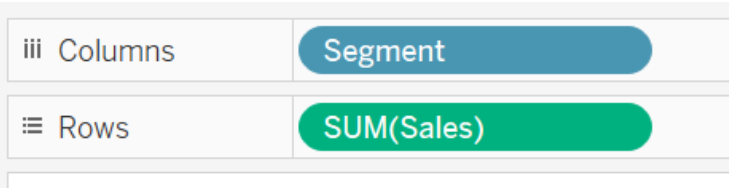


Exercise 5

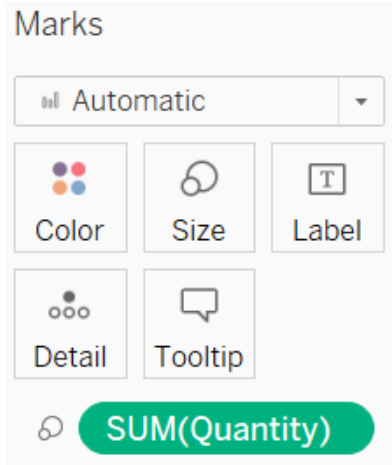
Open a new worksheet and rename it to **VIZ 5**. Generate a bar graph displaying the sum of sales per customer segment. Adjust the width of the bars according to the sum of quantity. What inference can you draw regarding the relationship between the sum of profit and the sum of quantity?

Solution – Exercise 5

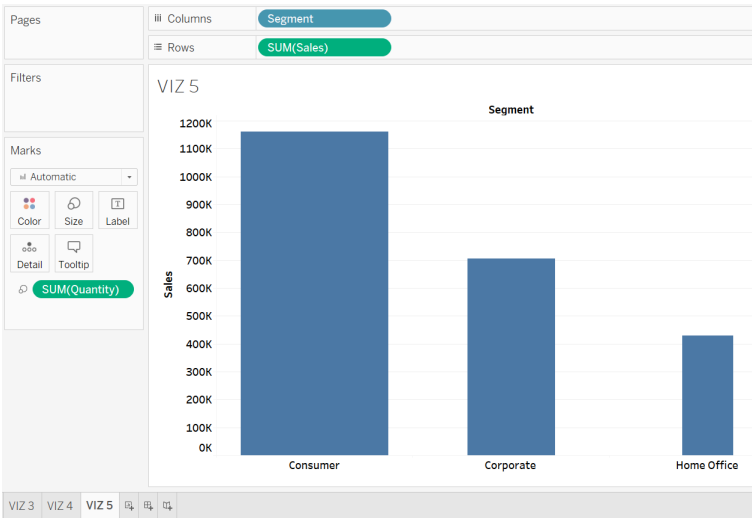
Step 1: Drag and drop the **Customer Segment** field onto the **Columns** shelf and the **Sales** field onto the **Rows** shelf.



Step 2: Drag and drop the **Quantity** field onto the **Size Card**.



Step 3: From the chart, it is evident that the total sales per customer segment increases with the quantity of orders.

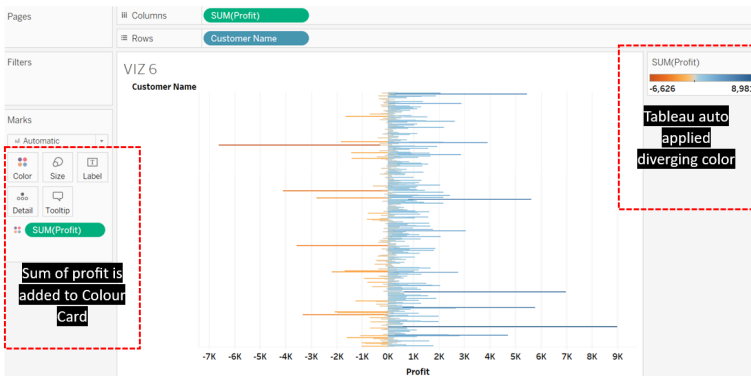


Exercise 6

Open a new worksheet. Rename it to **VIZ 6**. Create a bar chart showing the total profit against each customer's name. Add the **Profit** field to the **Colour Card**. What type of colour was applied to **VIZ 6**?

Solution – Exercise 6

Tableau automatically assigns diverging colours to **VIZ 6** since the total profit values span both negative and positive ranges.



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=91#h5p-6>

Label Card

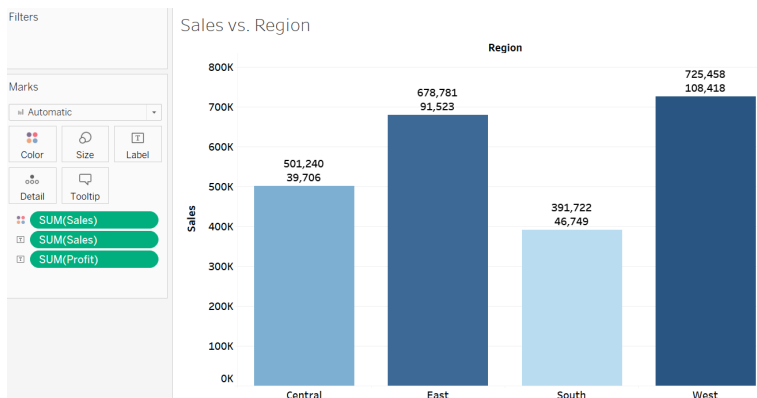
Tableau offers the option to include labels on marks, which can display values pertinent to those marks. These labels can be based on one or more fields, added by dragging and dropping fields onto the **Label Card** found in the **Marks** shelf. Additionally, users have the flexibility to format various aspects of the labels, such as colour, alignment, font type, font size, and text direction according to their preferences. Users can easily access label formatting by clicking on the **Label Card**. Furthermore, users can specify whether to display labels for all marks, selected marks, highlighted marks, or marks with maximum and minimum values.

Exercise 7

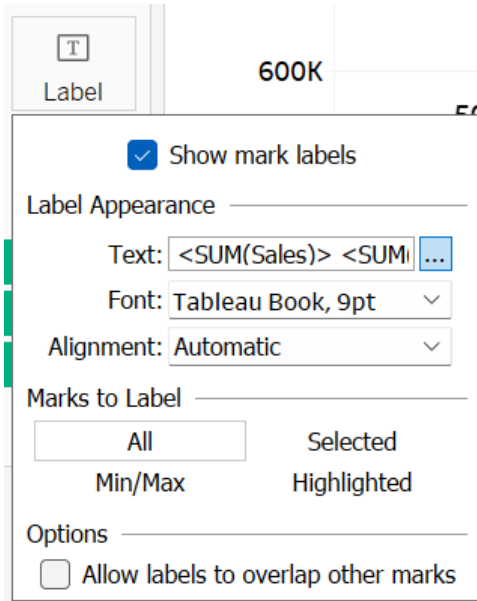
Add the sum of sales and profit information to each region in **VIZ 1** and include tags within these labels to differentiate between sales and profit.

Solution – Exercise 7

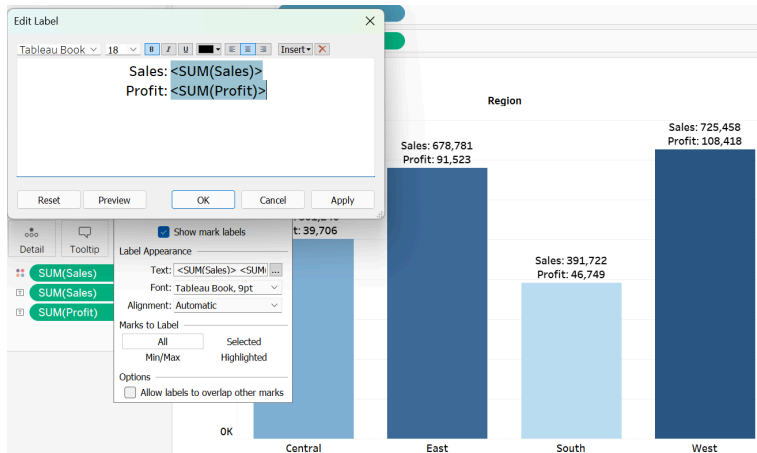
Step 1: Add the **Sales** and **Profit** fields to the **Label Card**.



Step 2: Click the **Label Card**, followed by clicking the three dots provided in the label formatting pop-up.



Step 3: Revise the labels by including the terms “Sales” and “Profit”, then click **OK**.




Exercise 8

Open a new worksheet and rename it to **VIZ 7**. Create a bar graph showing the average sales per region per order date (by year). Convert the colour of the marks to red. Include labels on the years highlighting the minimum and maximum average profit within each region. In which years, the maximum and minimum profits were recorded for the South region? Also, compare the average sales corresponding to these maximum and minimum profit values, and comment.

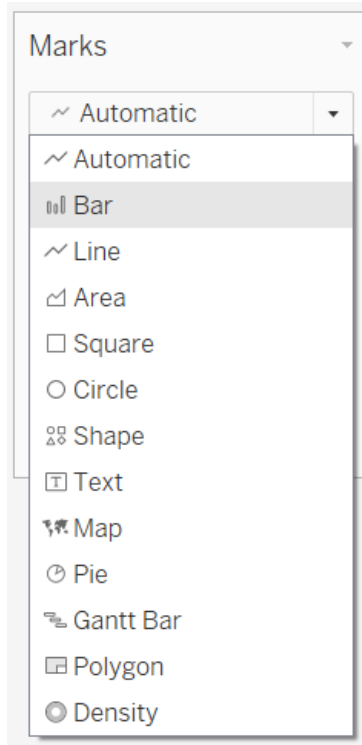
Solution – Exercise 8

Step 1: Place the region and order date in the **Rows** shelf, and the sales in the **Columns** shelf. Make sure to aggregate sales using the average measure.

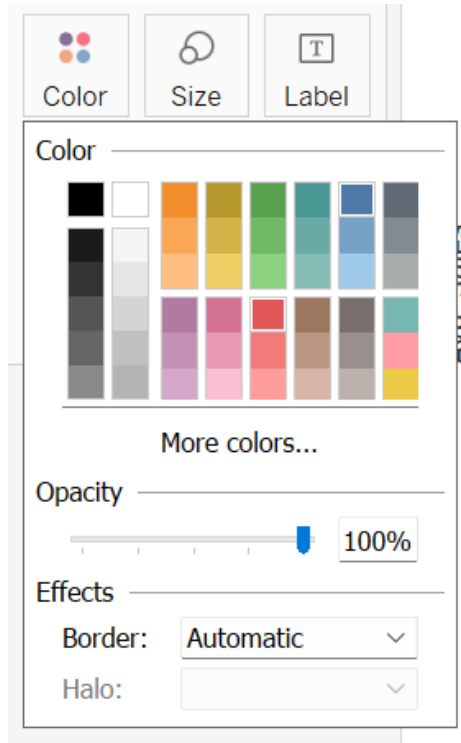


iii Columns	Region	YEAR(Order Date)
☰ Rows	AVG(Sales)	

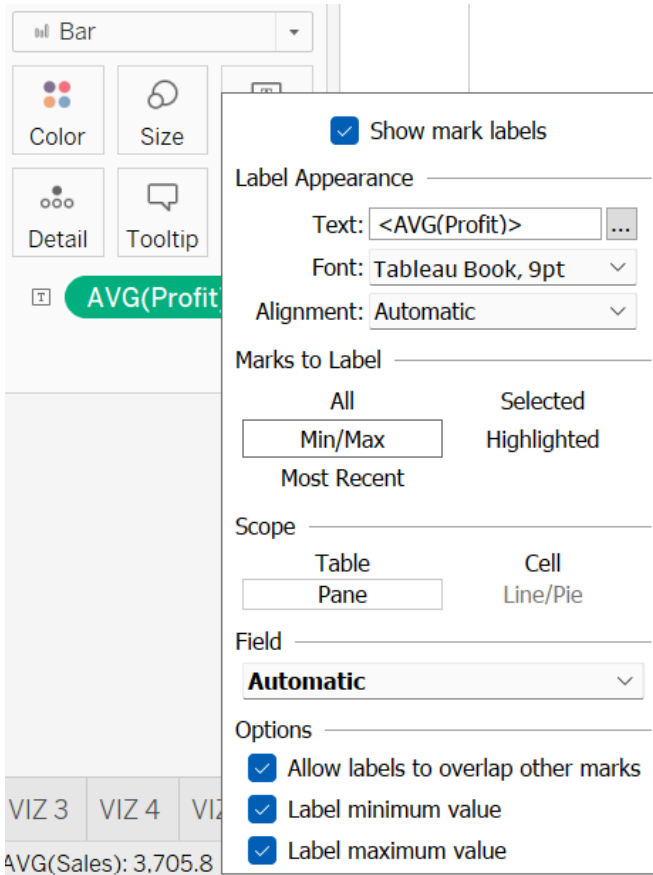
Step 2: Normally, Tableau automatically creates a line graph if a date field is involved. As such, to convert the chart into the intended bar graph, switch the type of marks to **Bar** by clicking the drop-down located on the **Marks** shelf.



Step 3: Click the **Colour Card** to switch the default blue colour of the marks to red.

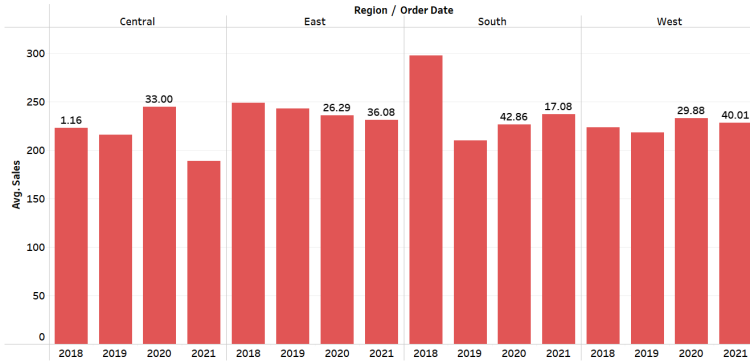


Step 4: Add average profit to the **Label Card**. Then, access the **Label Card** to further format the data labels. Within the label formatting pop-up, select **Min/Max** under **Marks to Label**, and **Pane** under **Scope**. This configuration ensures that labels are only shown on the years with the maximum and minimum profit within each region.



Step 5: According to the chart, it is evident that the South region attained its highest average profit in 2020, whereas the lowest average profit was registered in 2021. Specifically, there was an average profit of \$42.86 in 2020 compared to \$17.08 in 2021. Interestingly, these average profits contradict the average sales recorded for both years, with 2021 showing higher average sales compared to 2020.

VIZ 7

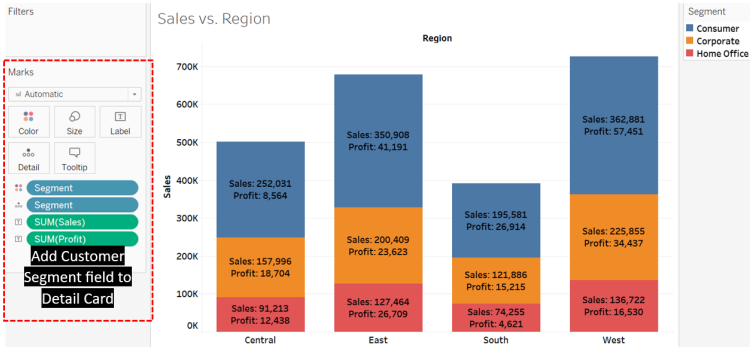


An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=91#h5p-7>

Detail Card

Marks within a visualization are divided by dimension members when users add a dimension field to the **Detail Card**. For instance, in **VIZ 1**, each region mark is separated based on three customer segments, distinguished by distinct colour codes when the **Customer Segment** field is added to both the **Detail** and **Colour Cards**. The labels for each region are also displayed according to each separated customer segment.



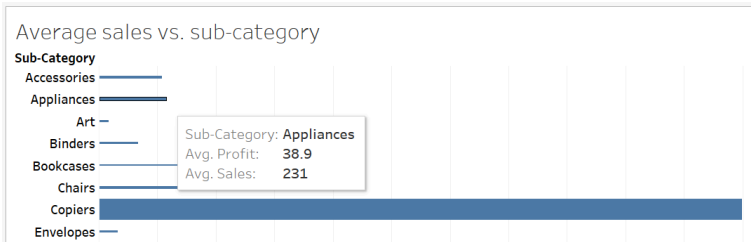
An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=91#h5p-9>

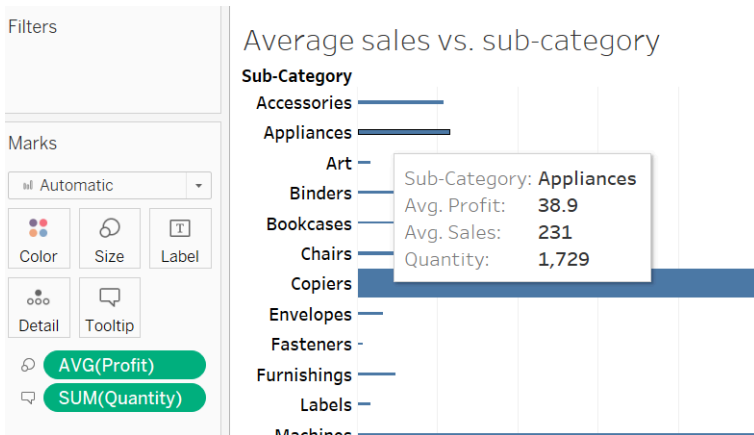
Tooltip Card

Tableau tooltip helps to display additional relevant information in the form of a text box when the users hover the mouse cursor or click the marks of a visualization. Usually, the data of all fields placed in **Columns**, **Rows**, **Marks**, **Filters**, or **Pages** shelves, are automatically displayed in the tooltip. The tooltip helps provide extra information to the viewers without muddling the visualization with too many labels or annotations.

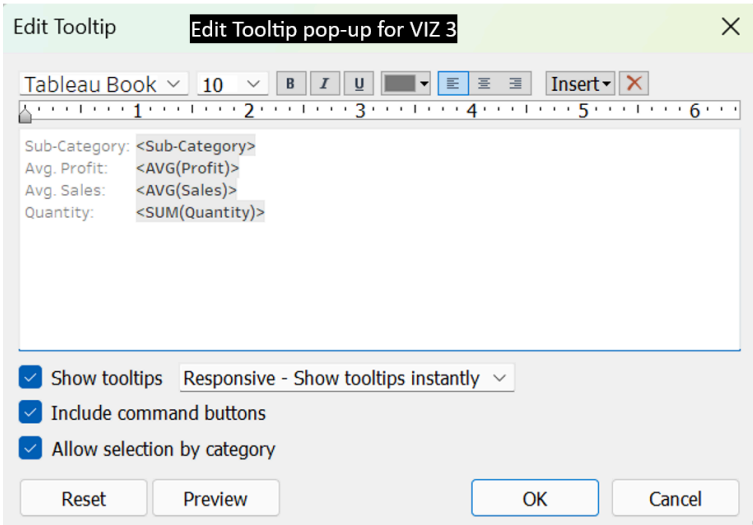
For example, in **VIZ 3**, the tooltip only shows the type of sub-category item, the average sales and the average profit when the cursor is moved over the marks.



Nevertheless, if users wish to add the sum of the quantity ordered in the tooltip, they can simply drag and drop the **Quantity** field onto the **Tooltip Card**.



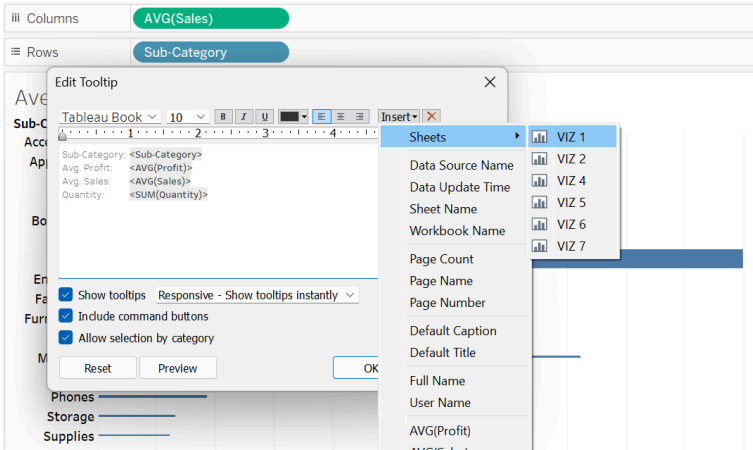
The colour, alignment, font type, and font size of the information in the tooltip can also be formatted as per the users' preferences. Users can perform such formatting on the **Edit Tooltip** that pops out once the **Tooltip Card** is clicked.



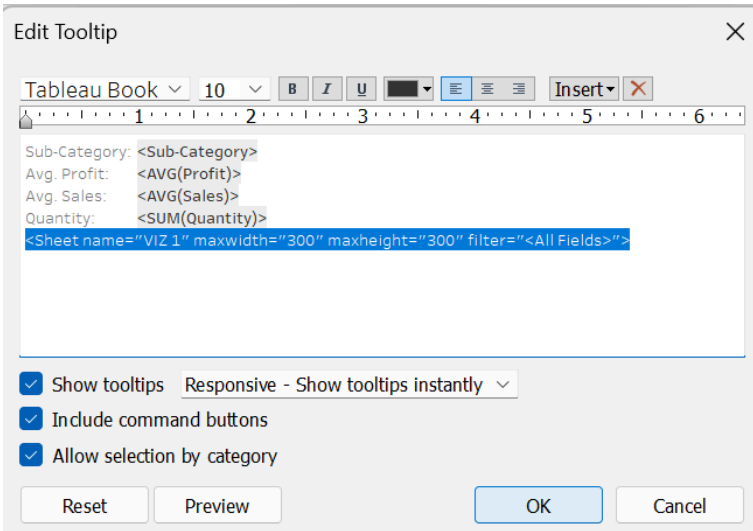
Users can also link the tooltip with a chart available in the other worksheet. For example, assume that we want to further compare the sales of sub-category items in **VIZ 3** according to region and customer segment. As such, we can add **VIZ 1**, which shows sales per customer segment per region, to the tooltip in **VIZ 3**. The steps of adding the **VIZ 1** in the **VIZ 3**'s tooltip can be summarized as follows:

Step 1: Click the **Tooltip Card**.

Step 2: Choose **Insert** in the **Edit Tooltip** and choose the sheet where the targeted chart is located.

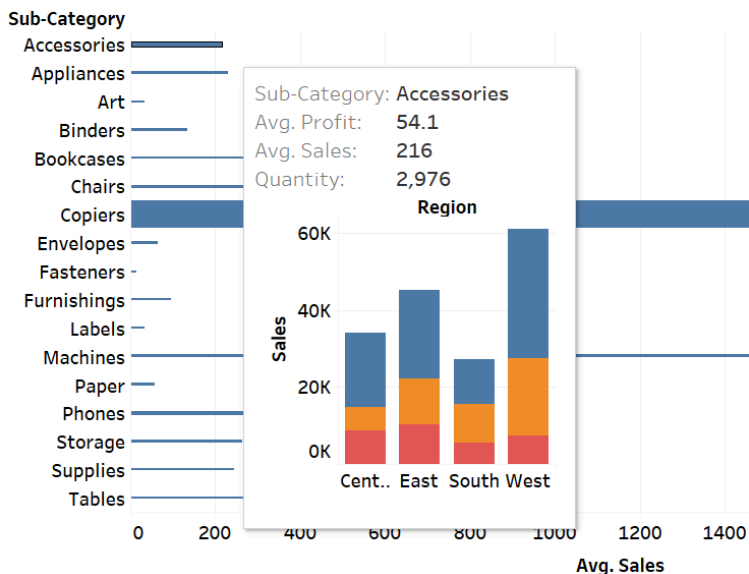


Step 3: Click **OK** to apply the changes.



It can also be noticed that data of **VIZ 1** available in the tooltip gets adjusted based on the selected sub-category item in **VIZ 3**.

Average sales vs. sub-category

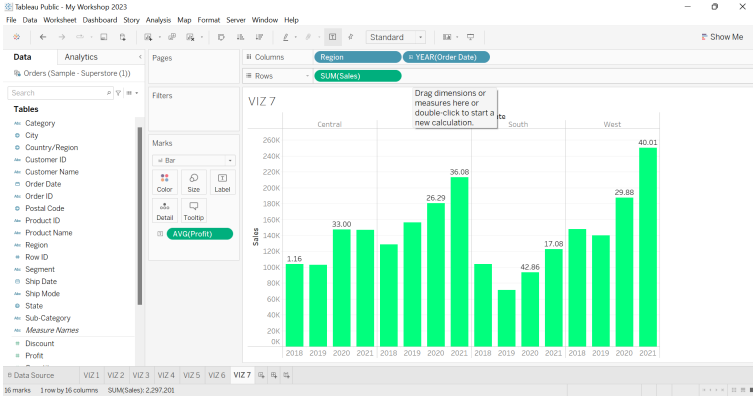


An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=91#h5p-8>

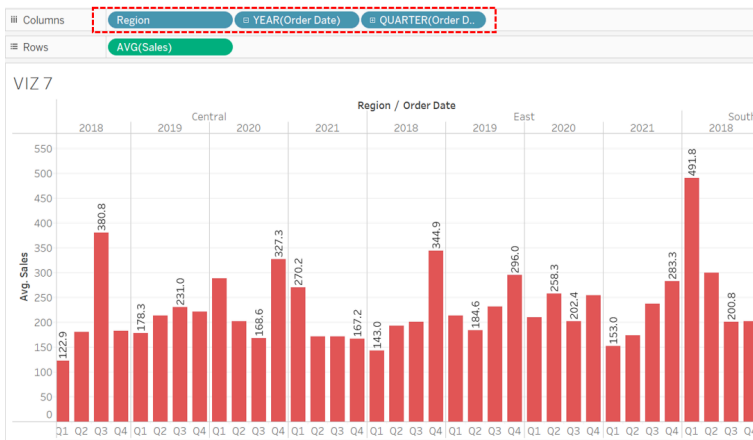
Hierarchical Fields

A hierarchical field refers to a structured arrangement of related fields into logical parent-child levels that allows for drill-down (viewing more detailed data) and roll-up (aggregating data at a higher level).







A hierarchical field is denoted by a plus (+) sign. Clicking the plus sign expands the visualization's marks to reveal additional layers of information, providing users with more detailed insights at each sub-level.

An example of a hierarchical field is the **Order Date** field. Users can expand the data in **VIZ 7** from year to quarter, month, week, or day levels only by clicking the (+) sign found in the order date field. Conversely, the (-) sign can be used to condense (roll-up) the levels of data in the visualization.



Users also have the option to create their own (logical) hierarchy field. This is achieved by dragging the sub-level field from the **Data Pane** and laying it directly over the main level field. For example, users could establish a hierarchy field featuring country (main level), state (sub-level), and city (sub-sub-level).

Tables

- Abc Category
- ▼  Country/Region, State
 -  Country/Region
 -  State
 -  City
- Abc Customer ID

3. DATA FILTERING AND SORTING



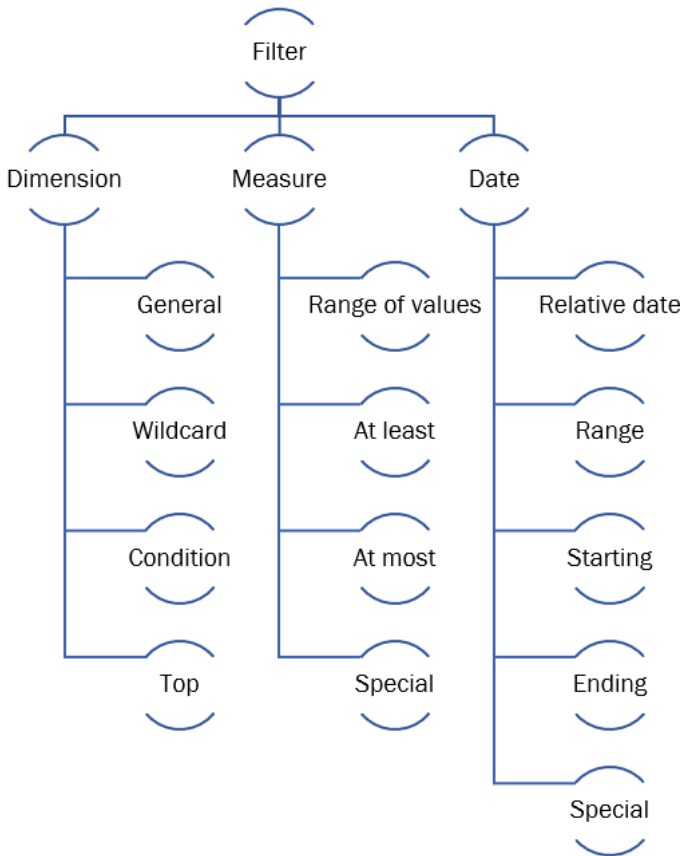
By the end of this chapter, readers will be able to:

- Filter data based on the dimension, measure, or date fields
- Use the parameter feature to dynamically filter data
- Sort data effectively

Filters

Filters can be used to control the degree of information depicted in a visualisation. In other words, users can include and exclude the type or level of information displayed in a visualisation, allowing a focused investigation. Filters also allow users to make certain comparisons for decision-making purposes, e.g., comparison between a selected range of dimension members, comparison across a selected range of periods etc.

A filter dialogue box appeared immediately once the users dropped a field to the **Filters** shelf. This dialogue box permits the users to set the characteristics of the filter. The available characteristics in each dialog box vary according to the type of field dropped to the filter shelf i.e. dimension, measure, or date field. The figure shows the summary of filter characteristics according to each field type.



Filtering Based on a Dimension Field

When a dimension field, is dropped to the filter shelf, a dialogue box pops out, with each tab in the dialogue box representing a characteristic that the user can set to the filter:

- **General Tab:** Users can use the **General** tab to choose the dimension members that they wish to include or exclude. You can control the exclusion or inclusion of the data points later

with the help of a filter control card. Filter control card will appear together with the visualization once the users click the **Show Filter** option.

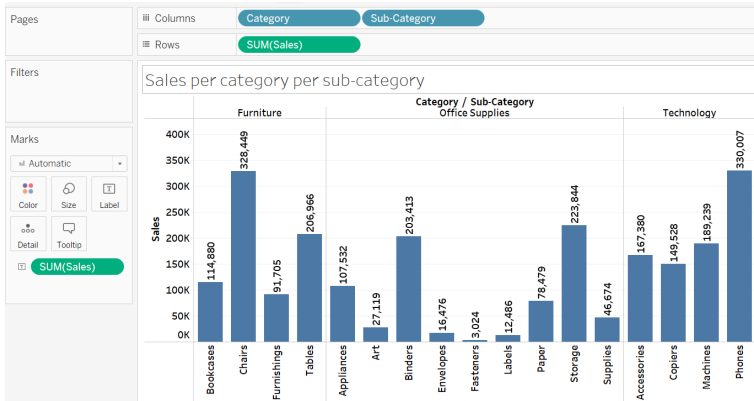
- **Wildcard:** Users can use the **Wildcard** tab to filter the dimension members that follow a specific pattern. For example, when filtering on email addresses you might want to only include emails from a specific domain. You can define a wildcard filter that ends with “@ums.edu.my” to only include Universiti Malaysia Sabah email addresses.
- **Condition:** The **Condition** tab can be used to only depict dimension members that satisfy certain rules. For example, in a visualization that shows the sub-category products vs. the sum of sales, users can opt to only depict sub-category products that made at least \$140,000 in sales by defining the condition tab.
- **Top:** The **Top** tab can be used to show the top or bottom N dimension members in the visualization based on a measure field. For example, users can customize the **Top** tab to only show the top 5 sub-category products in terms of total sales.

Exercise 9

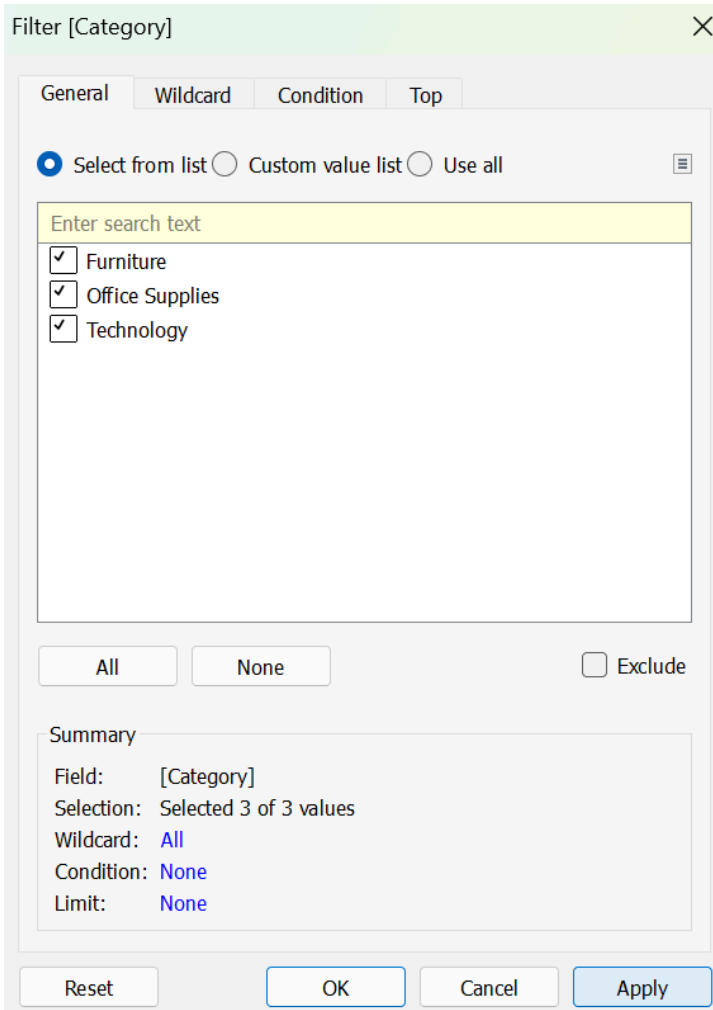
With the help of the filter tool, create a bar graph that compares only the total sales between furniture and technology sub-category items.

Solution – Exercise 9

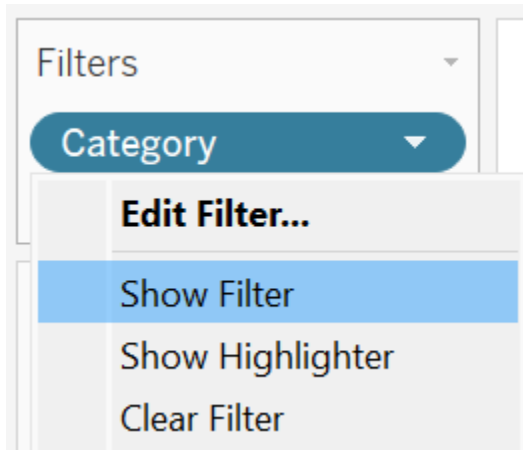
Step 1: Drop the **Category** and **Sub-Category** fields to the **Columns** shelf and the **Sales** field to the **Rows** shelf to create the intended graph. Name the sheet **VIZ 8**. Also, drop the **Sales** field onto the **Label Card** to add the sales information in the **VIZ 8**.



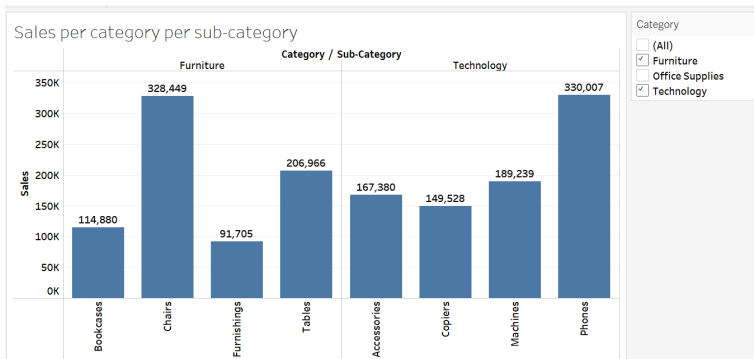
Step 2: Drag and drop the **Category** field onto the **Filters** shelf. In the dialog box that appears, under the **General** tab, include all the categories and click **Apply**, followed by **OK**.



Step 3: Click the down arrow next to the **Category** field located in the **Filters** shelf and choose **Show Filter** to display the filter control.



Step 4: Check the **Furniture** and **Technology** categories in the filter control to compare the sales of sub-category items that belong to both Furniture and Technology categories.

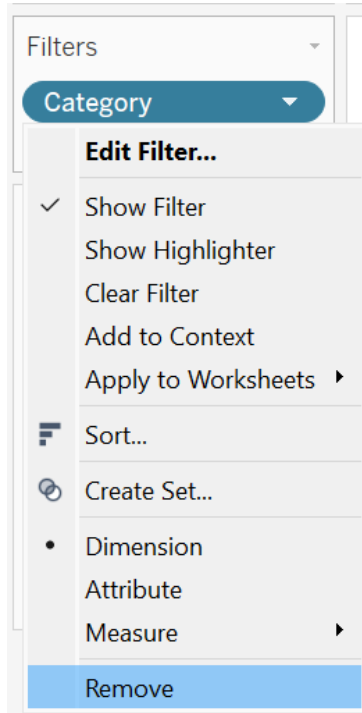


Exercise 10

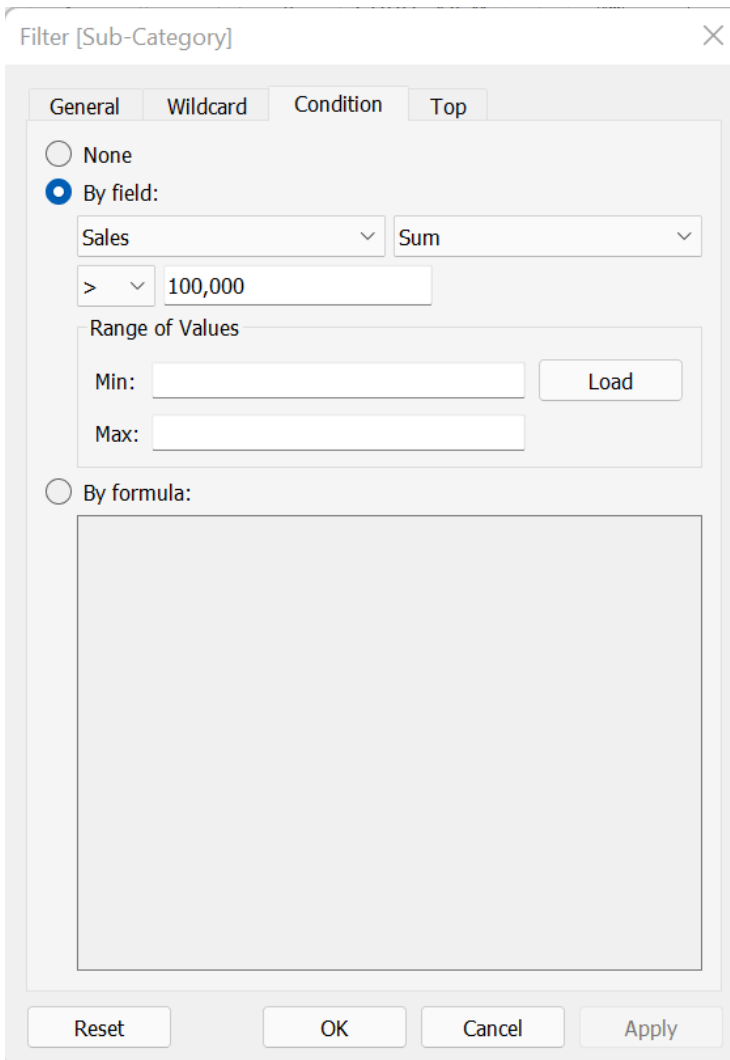
Apply the condition filter on **VIZ 8** to identify sub-category items with total sales exceeding \$100,000.

Solution- Exercise 10

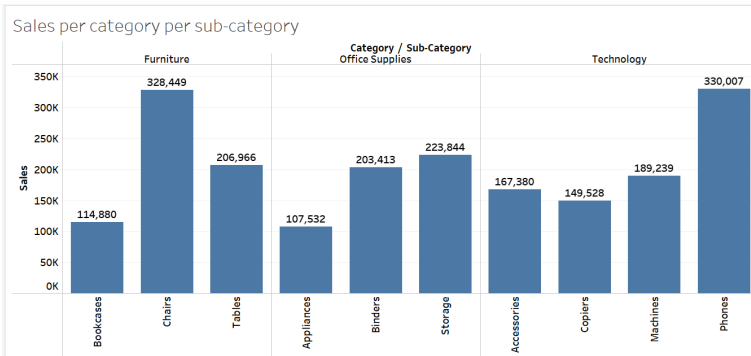
Step 1: Remove the existing filter in **VIZ 8** by clicking the down arrow next to the field available on the **Filters** shelf.



Step 2: Drag and drop the **Sub-Category** field to the filter shelf. Choose the **Condition** tab in the dialogue box that appears. Under the **Condition** tab, select **By Field** and set the values accordingly to meet our specifications.



Step 3: Click **Apply** and **OK** to only display sub-category items exceeding a total sale of \$100,000. The analysis points out bookcases, chairs, tables, appliances, binders, storage, accessories, copiers, machines, and phones as items meeting the condition set.

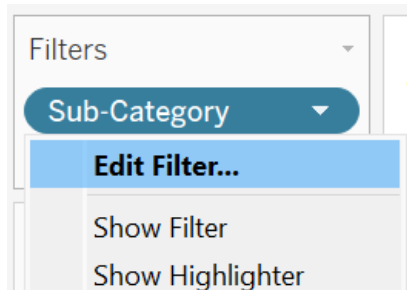


Exercise 11

Apply the top filter on **VIZ 8** to identify the top three sub-category items with the highest total sales.

Solution – Exercise 11

Step 1: Click the down arrow next to the **Sub-Category** field available in the **Filters** shelf, and choose **Edit Filter**.



Step 2: Under the **Condition** tab, select **None** to reset (remove) the condition setting.

Filter [Sub-Category] ✕

General Wildcard Condition **Top**

None
 By field:

Sales

=

Range of Values

Min:

Max:

Step 3: Switch to the **Top** tab, choose **By field**, and set the values according to the needs of the analysis.

General Wildcard Condition Top

None

By field:

Top 3 by

Sales Sum

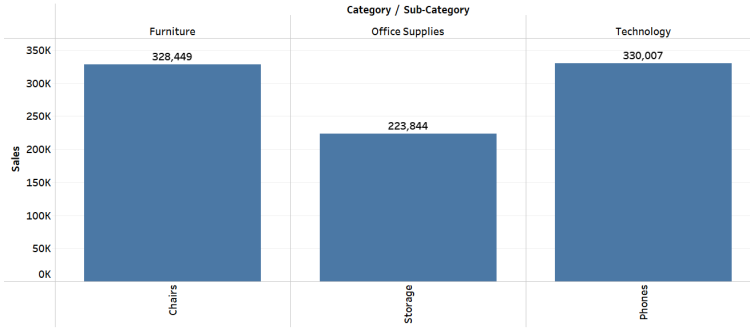
By formula:

Top 10 by

Reset OK Cancel Apply

The filtered chart identifies phones, chairs, and storage as the top-selling sub-category items, achieving total sales of \$330,007, \$328,449, and \$223,844 respectively.

Sales per category per sub-category



Using Parameter with Top N Filter

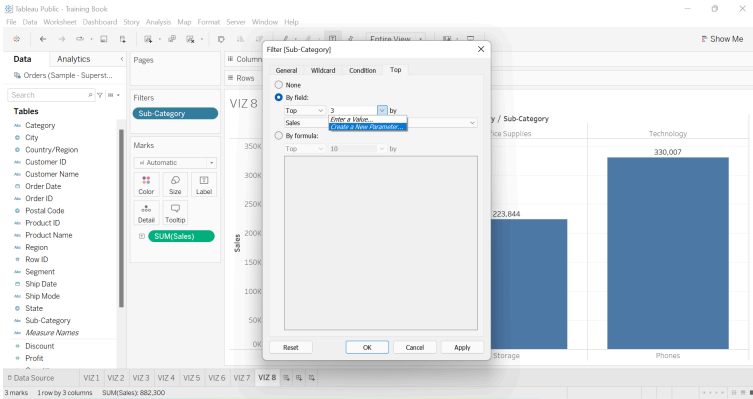
A parameter can be combined with a Top N filter to dynamically adjust the “N” value without requiring users to repeatedly modify the “N” value in the filter settings. In Tableau, a parameter serves as a control mechanism that enables users to dynamically adjust an input value, resulting in corresponding adjustments to the visualization based on the selected parameter value. Parameters are highly beneficial for conducting what-if analyses, allowing users to observe visualization changes as input values are modified.

Exercise 12

Based on **VIZ 8**, create a parameter to allow the user to switch the top N sub-category items, with N ranging from 1 to 10.

Solution – Exercise 12

Step 1: Edit the **Top N** filter for sub-category by the choosing **Create a New Parameter** instead of entering a value like Top 1, 2, 3 etc.



Step 2: The **Create Parameter** box pops out, in which we can customize the name and other features of the parameter. Name the parameter **Top N Sub-Category**, and set the range of values with 1 as the minimum and 10 as the maximum.

×

Create Parameter

Name
Top N Sub-Category

Properties

Data type Integer	Display format 3
-----------------------------	----------------------------

Current value 3	Value when workbook opens Current value
---------------------------	---

Allowable values
 All List Range

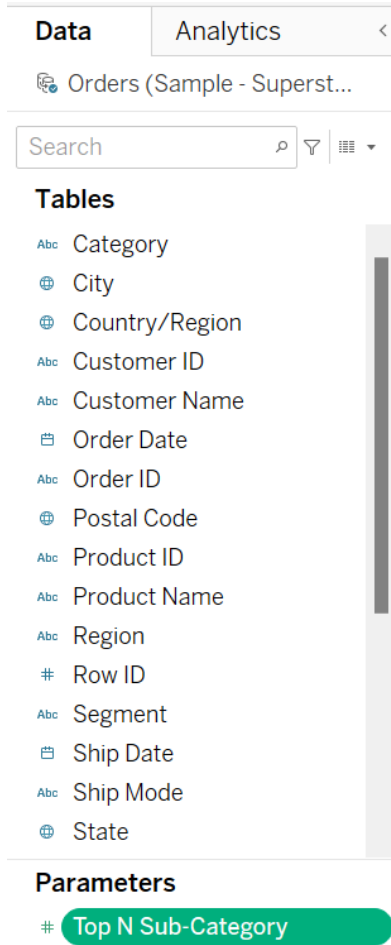
Range of values

<input checked="" type="checkbox"/> Minimum	<input type="text" value="1"/>	<input checked="" type="radio"/> Fixed
<input checked="" type="checkbox"/> Maximum	<input type="text" value="10"/>	<input type="radio"/> When workbook opens
<input type="checkbox"/> Step size	<input type="text" value="1"/>	<div style="border: 1px solid #ccc; padding: 2px; display: inline-block;">Add values from ▼</div>

Cancel

OK

Step 3: The parameter is created and appears in the **Data Pane** once the **OK** button is clicked.



Step 4: Click the down arrow on the parameter and choose **Show Parameter** to display the parameter control.

- 🌐 Country/Region
- Abc Customer ID
- Abc Customer Name
- 📅 Order Date
- Abc Order ID
- 🌐 Postal Code
- Abc Product ID
- Abc Product Name
- Abc Region
- # Row ID
- Abc Segment
- 📅 Ship Date
- Abc Ship Mode
- 🌐 State

Parameters

- # Top N Sub-Category

Add to Sheet

Show Parameter

Cut

Copy

Edit...

Duplicate

Rename

Hide

Delete

Create ▶

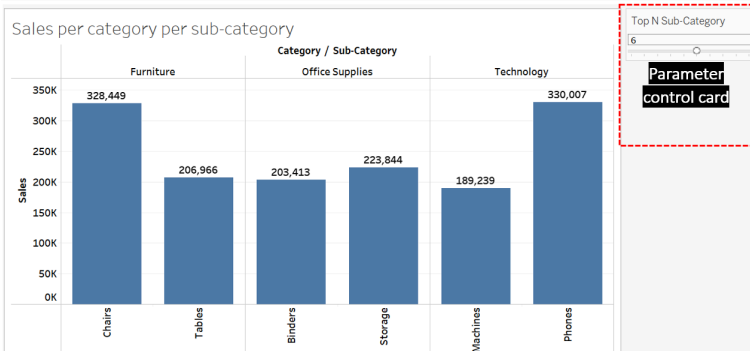
Default Properties ▶

Folders ▶

Replace References...

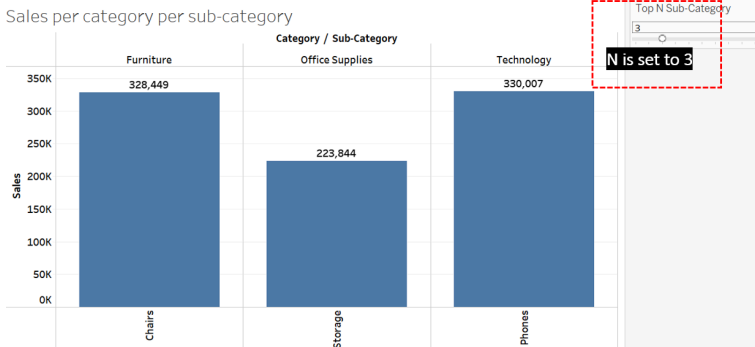
Describe...

Step 5 – The parameter control allows us to switch the input value, N, from 1 to 10 to display the top N category items. The visualization updates based on the selected value in the control.

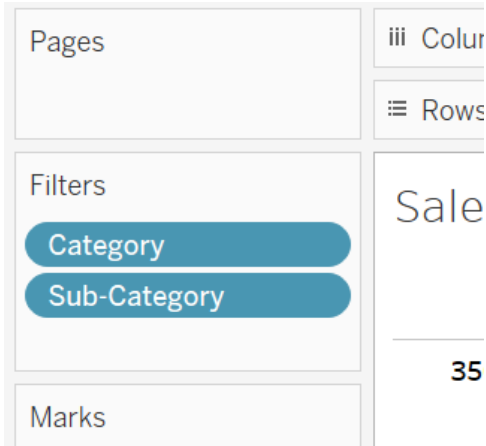


Context Filter

Set the **Top N Sub-Category** parameter value in **VIZ 8** to 3. **VIZ 8** now shows the top 3 sub-category items with the highest sales. **VIZ 8** detects Phones from the Technology category, Storage from the Office Supplies category, and Chairs from the Furniture category as the top 3 sub-category items, regardless of the main Category that these items belong to.

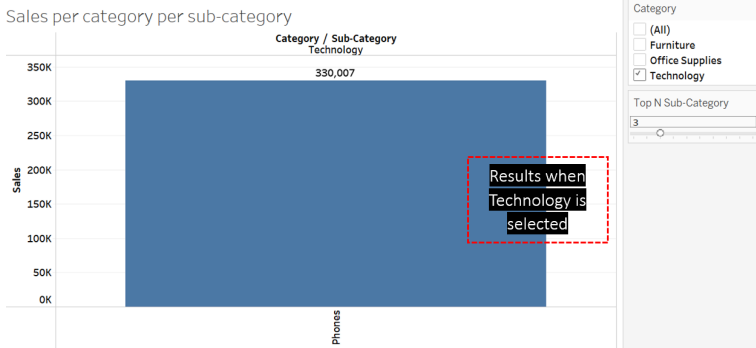
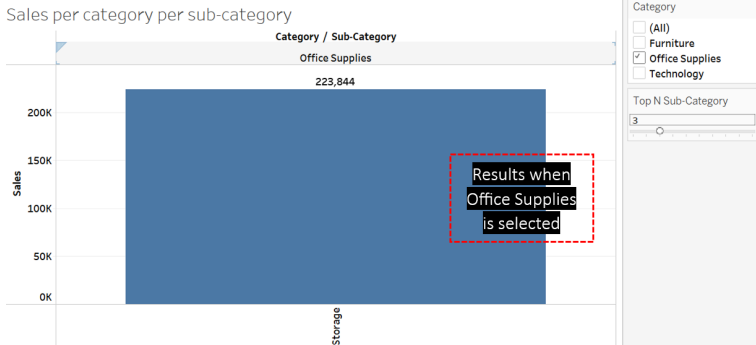
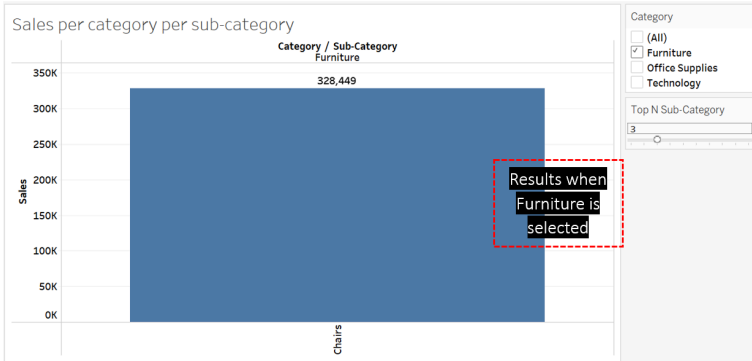


However, assume that you now wish to find the top 3 sub-category items for each main category. As such, drop the **Category** field to the **Filters** shelf and locate it above the **Sub-Category** filter.



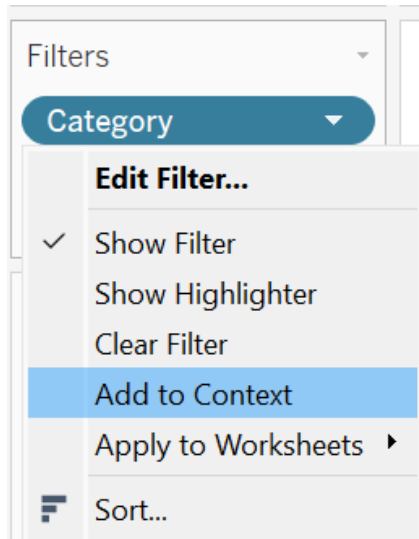
Click **Show Filter** to display the filter control for **Category** items and choose **Furniture**. Repeat the process by only choosing the **Office Supplies** and **Technology** categories. What did you notice? Is the visual showing the intended results?

We anticipate that the visualization will exhibit the top three sub-categories when each category is selected, but it behaves differently. For instance, when **Furniture** is chosen, only one sub-category is displayed. This occurs because Tableau initially applies the Top N Sub-category filter, scanning through the entirety of the data to identify the top three sub-category items before executing the second filter, which is the **Category** filter. Consequently, the second filter operates based on the results of the first filter.

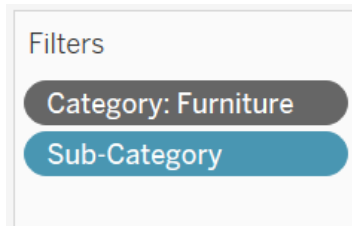


To avoid this, we can use **Context Filter**. A context filter is a filter which is executed first before any other filters. When a filter is designated as a context filter, Tableau first applies that filter to the data and then uses the filtered data as the context for subsequent filters.

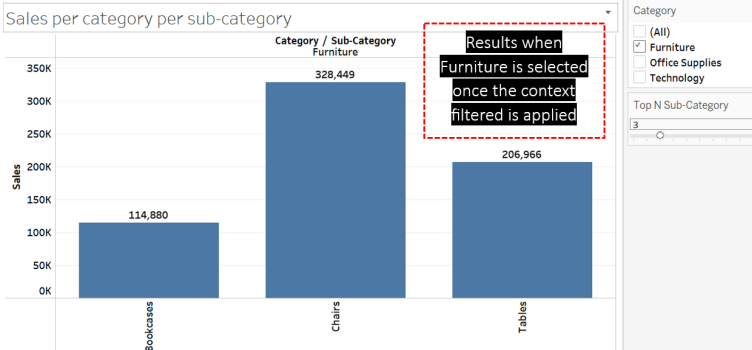
In this scenario, we should designate the **Category** as the context filter. To do this, click the down arrow next to the **Category** field available in the **Filters** shelf, and select **Add to Context**.



The **Category** field will then turn grey, indicating it is now a context filter.



Now, choose the **Furniture** option in the filter card. We can notice that the visualization now displays the intended results, showing the top three sub-category items for each category. What happens? When a category such as **Furniture** is chosen, Tableau filters the relevant data, and then performs the second filtering; it identifies the top three sub-categories solely based on the **Furniture** data filtered earlier.

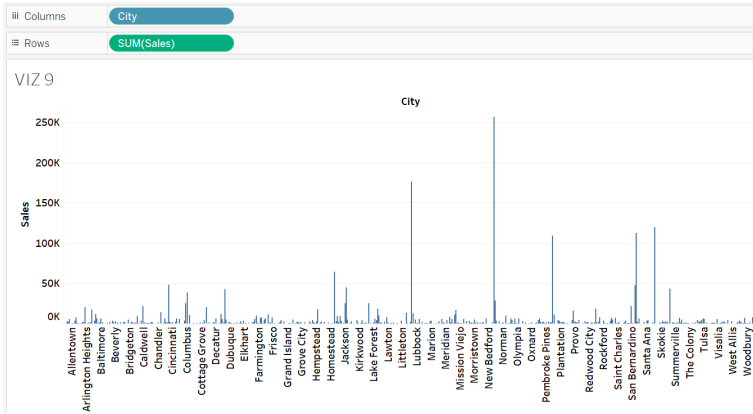


Exercise 13

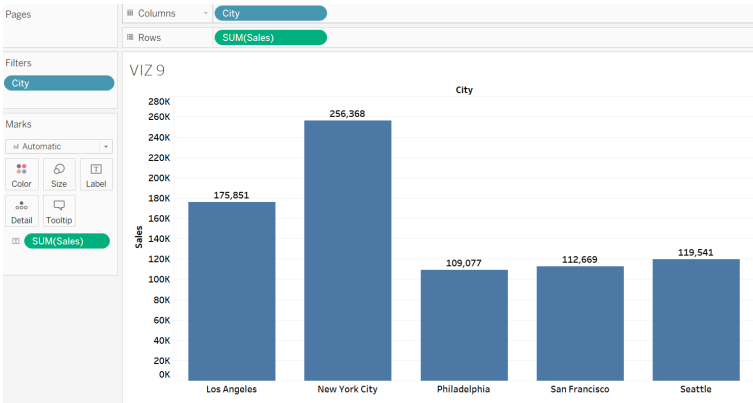
Open a new worksheet and rename it to **VIZ 9**. Create a bar graph showing the sum of sales vs. cities. Apply a filter to identify the top 5 cities based on sales. Additionally, use a context filter to determine the top 5 cities specifically within the Arizona state.

Solutions – Exercise 13

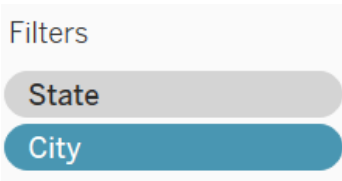
Step 1: To create the desired graph, drop the **City** field to the **Rows** shelf and the **Sales** field to the **Columns** shelf. Rename the sheet to **VIZ 9**.



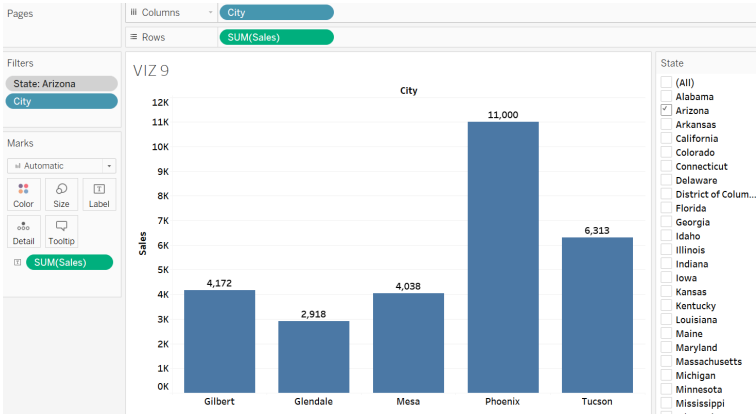
Step 2: Include the **City** field in the filter, then select **Edit Filter** to apply a Top N filter to identify cities with top five sales. The results indicate that, overall, New York City leads in total sales, followed by Los Angeles, Seattle, San Francisco, and Philadelphia.



Step 3: Drop the **State** field to the **Filters** shelf and locate it above the **City** filter. Click the down arrow next to the **State** field available in the **Filters** shelf and select **Add to Context**.



Step 4: Click **Show Filter** for **State**, and check **Arizona** in the filter card. The results indicate that Phoenix is the city with the highest sales in Arizona state, followed by Tucson, Gilbert, Mesa, and Glendale.



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=135#h5p-10>

Filtering Based on a Measure Field

When a measure field is added to the filter shelf, a dialogue box appears, providing users with the ability to display only dimension members that fall within a specified range of values. There are four filter options that can be applied to a measure field:

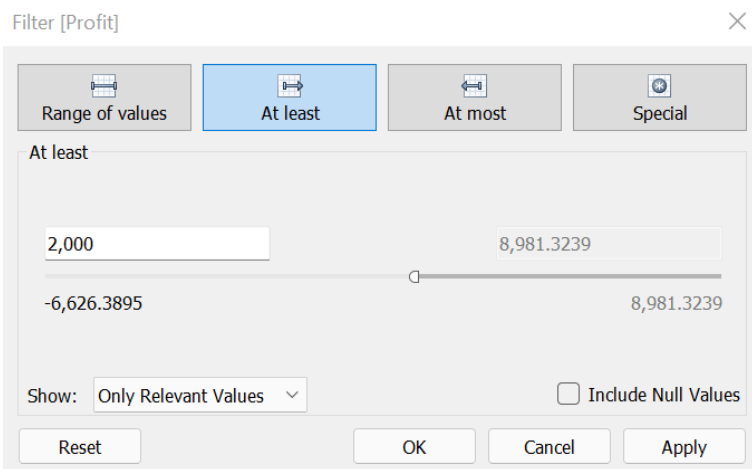
- **Range of Values:** This option enables users to exhibit only the dimension members that lie within a chosen minimum and maximum value range. For example, users can choose to display only the sub-category items that achieved total sales between \$100,000 and \$200,000.
- **At Least:** This option enables users to filter data to show only the dimension members that meet or exceed a specific threshold value. For example, users can choose to display only the sub-category items with total sales of at least \$200,000.
- **At Most:** This option enables users to display only the dimension members that have a value equal to or less than a specified threshold. For example, users can choose to show only the sub-category items with total sales of at most \$200,000.
- **Specific:** Utilize this option to determine whether to include only null values, non-null values, or all values in your analysis.

Exercise 14

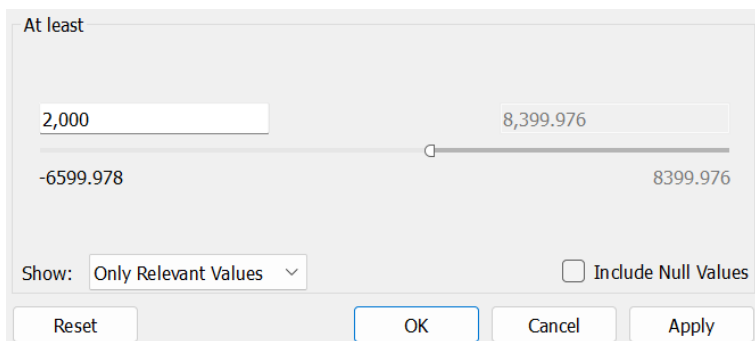
Using a filter in **VIZ 6**, identify the customer who contributed a minimum total profit of \$2000 or more.

Solution – Exercise 14

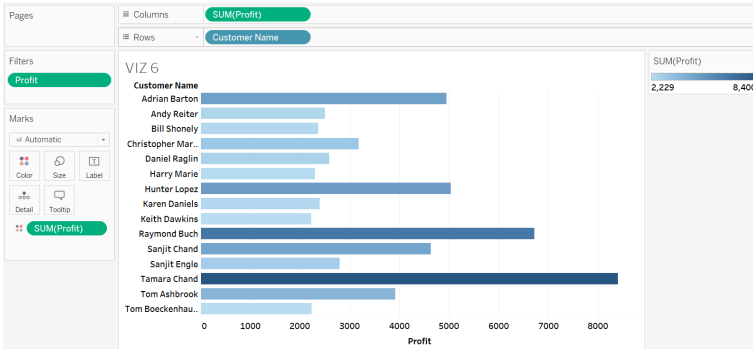
Step 1: Drop the **Profit** field to the **Filters** shelf and choose the **At least** option.



Step 2: Set the threshold value as \$2,000.



Step 3: Click **OK** once setting the targeted value to get the list of customers who contributed a minimum total profit of \$2000 or more.



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=135#h5p-11>

Filtering Based on a Date Field

The level of data in a visualization can also be filtered based on a date field. When a date field is added to the filter shelf in Tableau, users are provided with five options to customize the date filter:

- **Relative Date:** This option allows users to incorporate data from a number of days, weeks, months, or years preceding or following a particular date.
- **Range of Dates:** This option includes data within a selected range of two dates.
- **Starting Date:** This option includes data from a specific date onwards.

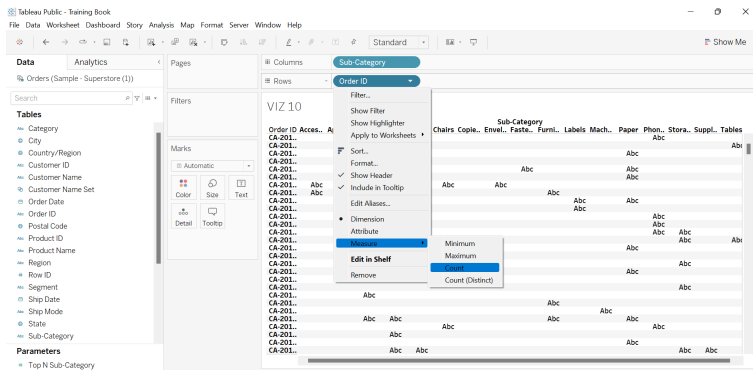
- **Ending Date:** This option includes data up to a particular date.
- **Specific:** This option determines whether to include only null dates, non-null dates, or all values in the analysis.

Exercise 15

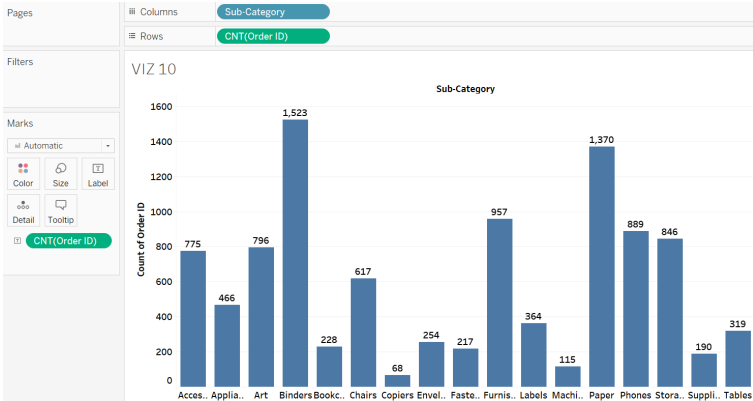
Create a bar graph showing no. of orders per sub category item. Rename the sheet to **VIZ 10**. What is the total number of orders received for papers? Next, using the **Order Date** as a filter, determine the number of orders received for papers in 2019 alone.

Solution – Exercise 15

Step 1: Drop the **Sub-Category** field to the **Columns** shelf and the **Order ID** to the **Rows** shelf. Set the aggregation measure of **Order ID** to **Count**. This allows Tableau to compute and display the number of orders received for each sub-category item.



Step 2: The resulting chart based on the entire data shows that the total number of orders received for papers was 1370.



Step 3: Drop **Order Date** to the **Filters** shelf and choose **Range of Dates**.

Filter [Order Date] ✕

Relative dates
Range of dates
Starting date
Ending date
Special

Range of dates

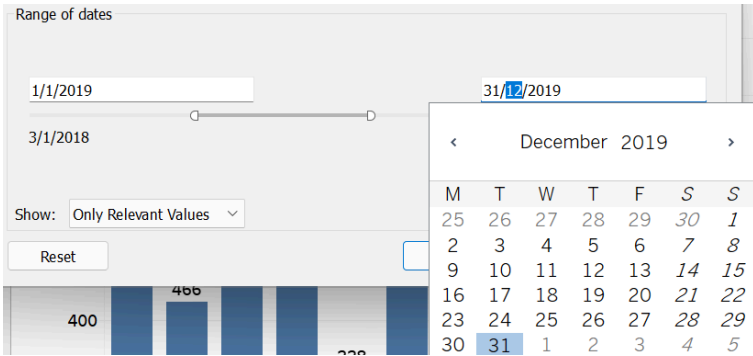
|

|

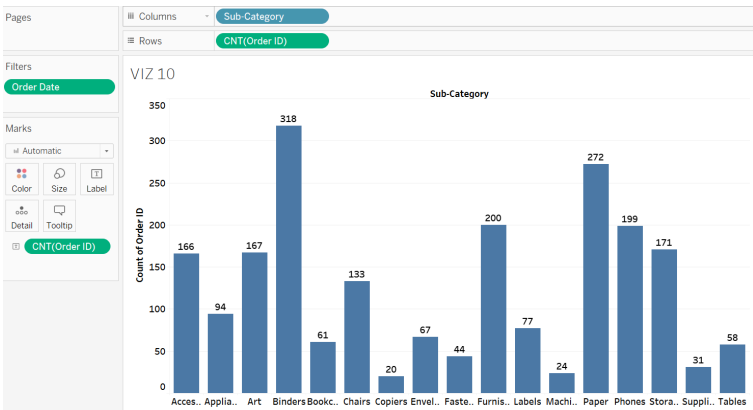
Show: Only Relevant Values
 Include Null Values

Reset
OK
Cancel
Apply

Step 4: Set the date interval from 1/1/2019 to 31/12/2019.



Step 5: The number of orders received for papers within 2019 was 272.

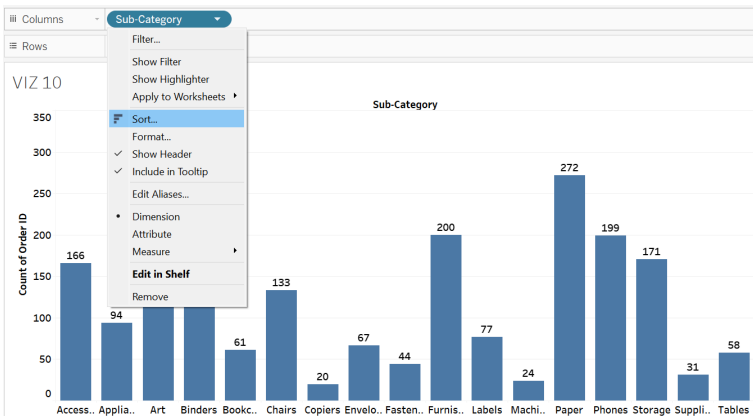


Sorting Data

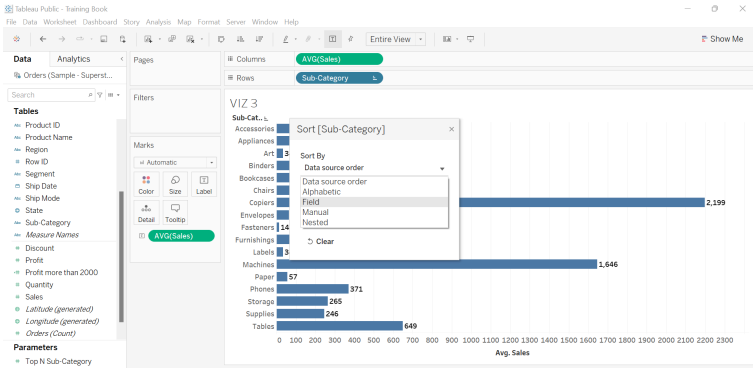
Tableau enables us to sort dimension members within a visualization. This sorting feature aids in organizing dimension members according to our preferences. Tableau provides five sorting methods, including the commonly used alphabetical and

field-based methods. The field-based method, specifically, involves arranging dimension members in either ascending or descending order according to a field's value. This sorting allows us to quickly identify the most and least significant dimension members, particularly when their mark sizes in the visualization are not easily comparable. Additionally, it provides insights into how the values vary across different dimension members.

Suppose we aim to arrange the Sub-Category items in **VIZ 10** in descending sequence based on their no. of orders. To achieve this, firstly, click the down arrow next to the **Sub-Category** field available in the **Columns** shelf and choose **Sort**.



Next, click the drop-down that popped out to select **Field**.



Lastly, select **Descending** and pick the correct **Field Name** and **Type of Aggregation** to ensure the visualization is sorted accordingly.

Sort [Sub-Category]
✕

Sort By

Field ▼

Sort Order

Ascending

Descending

Field Name

Order ID ▼

Aggregation

Count ▼

↻ Clear

The chart below displays **VIZ 3**, listing sub-category items sorted in descending order based on average sales.



Interestingly, in Tableau, dimension members can be sorted according to a field that is not directly visualized on the chart. For example, suppose we want to arrange the sub-category items in **VIZ 10** based on the average profit contributed by each, rather than their number of orders. In this case, we then can merely edit the sorting setting by switching the field selection to **Profit**, and setting the aggregation type to **Average**.

Sort [Sub-Category] ×

Sort By
Field ▼

Sort Order

Ascending

Descending

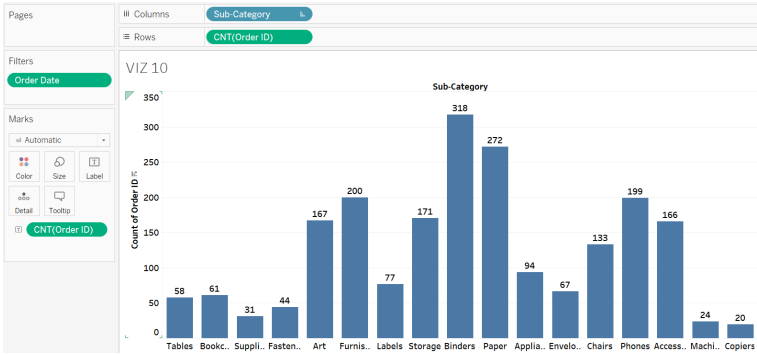
Field Name
Profit ▼

Aggregation
Average ▼

↶ Clear

The sorting function in Tableau could lead users to interesting findings. For example, in the current **VIZ 10** where sub-category items are sorted by average profit, the analysis concludes the following:


- The no. of orders of the sub-category items is not proportional to their average profit; items with a decent no. of orders may not yield a promising average profit.
- Despite chairs, phones, and accessories generating substantial order volumes, they do not rank among the top profit-making items. This situation suggests the need for management to consider adjusting pricing or enhancing marketing and promotional strategies for these products.



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=135#h5p-12>

4. GROUPS, SETS, AND COMBINED SETS

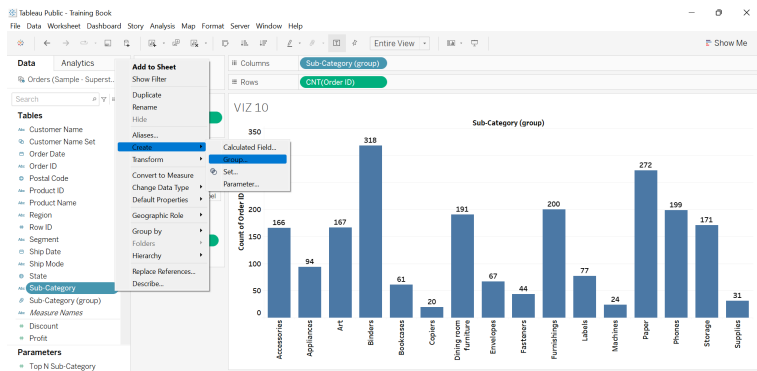


By the end of this chapter, readers will be able to:

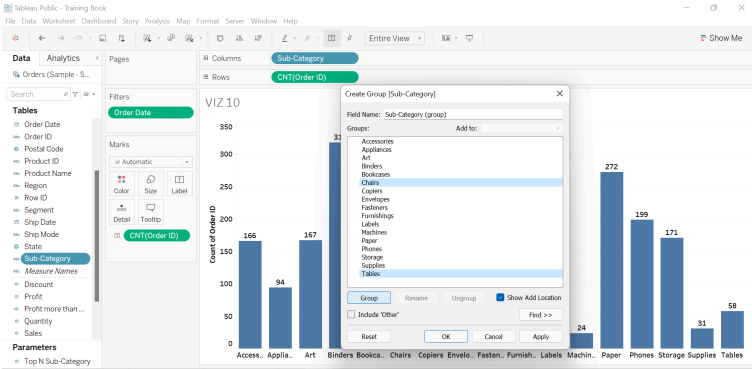
- Group dimension members
- Create data sets
- Create combined data sets

Grouping Dimension Members

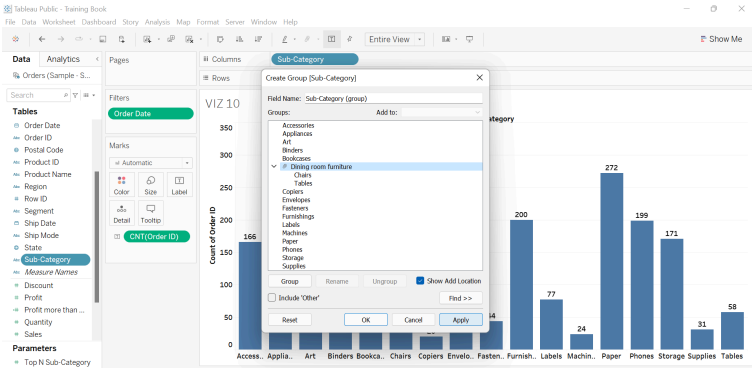
The group feature in Tableau can be used to merge related dimension members in a visualization. For instance, assume that we want **VIZ 10** to show the combined number of orders for dining room furniture, which includes chairs and tables. As such, firstly, click the **Sub-Category** field in the **Data Pane**, then choose **Create**, followed by **Group** (Note: Clear the sorting in **VIZ 10** before proceeding with this step).



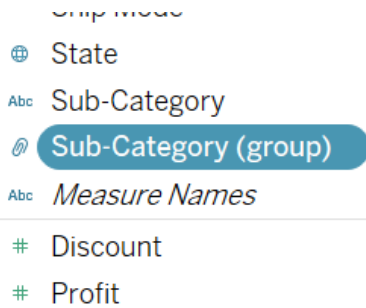
In the **Group** setting, choose both the **Chairs** and **Tables** using the **Ctrl** button, and click **OK**.



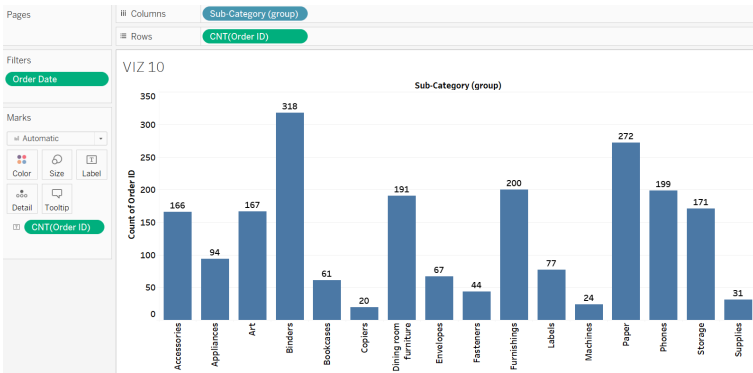
Rename the group to **Dining Room Furniture** and click **OK**.



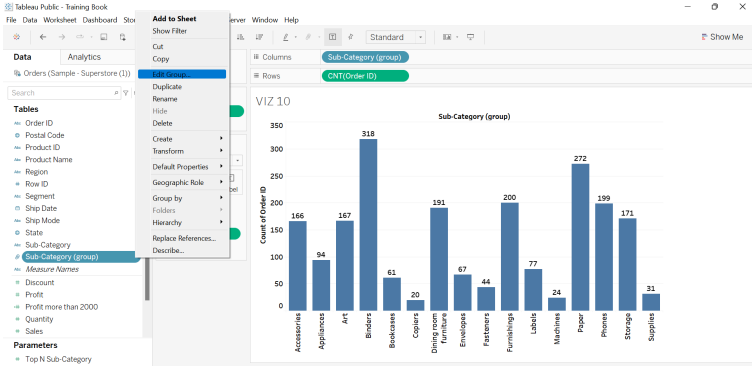
The group field for **Sub-Category** items is typically created in the **Data Pane**, identified by the accompanying paperclip icon.



Drag the **Sub-Category** field from the **Data Pane** and replace it with the **Sub-Category (group)** to depict the combined total number of orders for both Chairs and Tables in **VIZ 10**.



Users may utilize the **Edit Group** function by clicking the field in the **Data Pane** if they wish to form more groups within a dimension field.



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=154#h5p-15>

Sets in Tableau

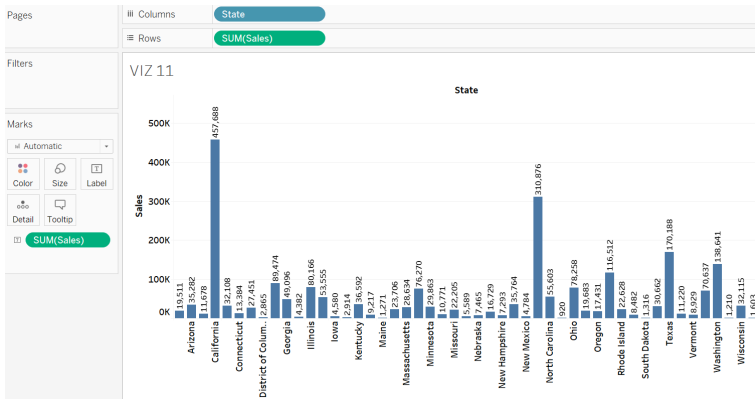
Set offers a more dynamic way for the users to group the dimension members. It helps users to identify and group dimension members that meet a specific condition. In Tableau, dimension members that meet the condition as grouped as **IN** items. Otherwise, they are considered **OUT** items. The **IN** items can be coloured differently to grab the audience’s attention during the data presentation.

Exercise 16

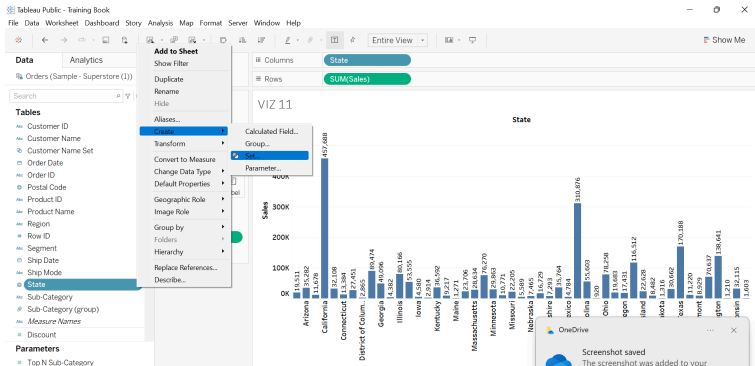
Create a visualization to show total sales per state. Name the visualization **VIZ 11**. Using a set, identify the states with total sales above \$100,000. Colour the states meeting this condition differently.

Solution – Exercise 16

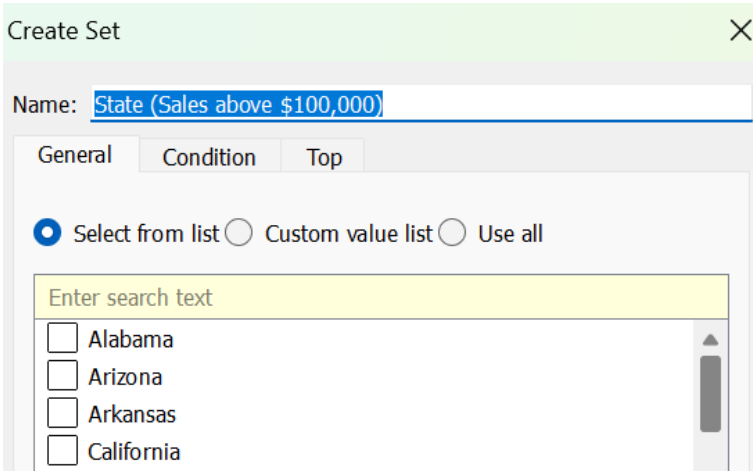
Step 1: Drop the **State** field to the **Columns** shelf and the **Sales** field to the **Rows** shelf to create **VIZ 11**.



Step 2: To create the set field, click **State** in the **Data Pane** and choose **Create**, followed by **Set**.

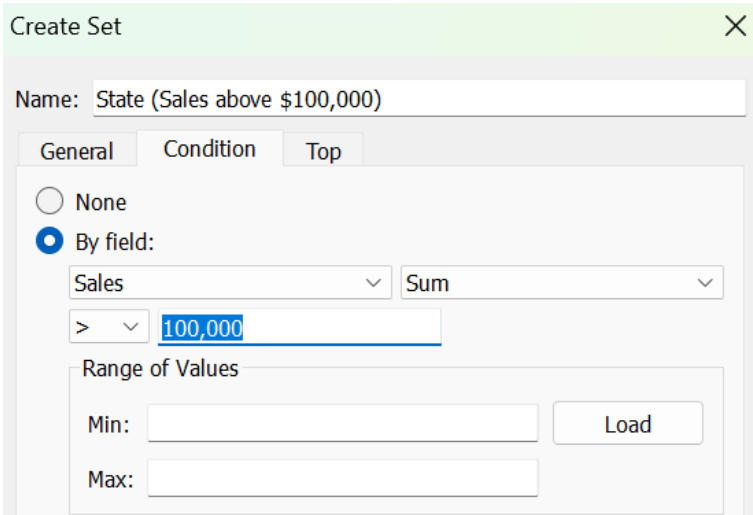


Step 3: Name the set **State (Sales above \$100,000)**, reflecting its characteristics.



The screenshot shows the 'Create Set' dialog box with the 'General' tab selected. The 'Name' field contains 'State (Sales above \$100,000)'. Below the name field are three tabs: 'General', 'Condition', and 'Top'. Under the 'General' tab, there are three radio buttons: 'Select from list' (which is selected), 'Custom value list', and 'Use all'. Below these is a search bar with the placeholder text 'Enter search text'. A list of states is shown with checkboxes: Alabama, Arizona, Arkansas, and California.

Switch to the **Condition** tab. Set the prefixed condition, i.e., **Sum of Sales > \$100,000**, in the **By Field** section.

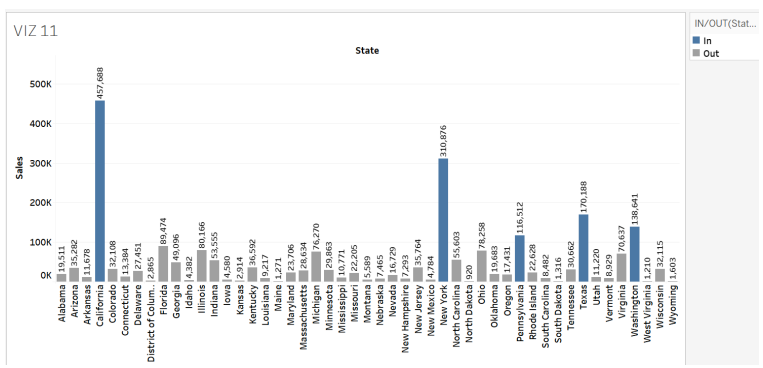



The screenshot shows the 'Create Set' dialog box with the 'Condition' tab selected. The 'Name' field still contains 'State (Sales above \$100,000)'. The 'Condition' tab is active, showing three radio buttons: 'None', 'By field:' (which is selected), and 'By value:'. Under 'By field:', there are two dropdown menus: the first is set to 'Sales' and the second is set to 'Sum'. Below these is a comparison operator dropdown set to '>' and a text input field containing '100,000'. At the bottom, there is a 'Range of Values' section with 'Min:' and 'Max:' input fields and a 'Load' button.

The newly created set field, i.e., **State (Sales above \$100,000)**, will be available at the **Data Pane** once the OK button is clicked. In Tableau, the set field is usually denoted by a Venn diagram icon.



Drag and drop the set field in the **Colour Card**. We can now notice that all the states with total sales above \$100,000 are coloured oddly. In this case, they are coloured in blue. The visual below shows that there are five states which satisfy the condition of the set field, which are California, New York, Pennsylvania, Texas, and Washington.



 An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=154#h5p-13>

Combined Sets

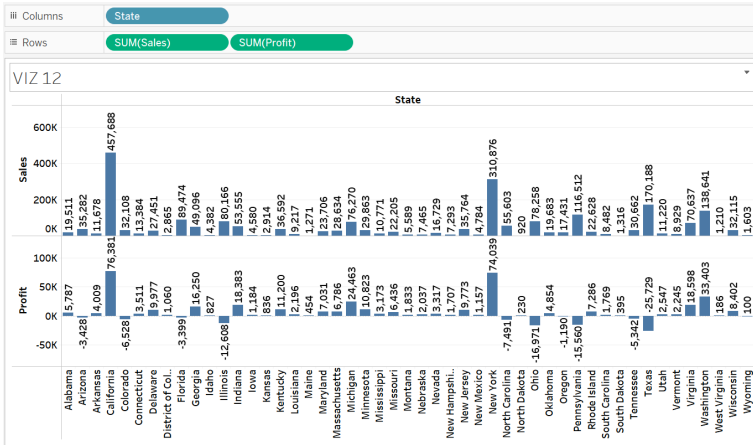
In Tableau, a combined set is a set that is created to merge two or more individual sets using set operations such as union, intersection, or difference. Combined sets are particularly useful when users want to analyze data based on multiple conditions simultaneously.

Exercise 17

Create a visualization to show total **Sales** and **Profit** per **State**. Name the visualization **VIZ 12**. Using **set** and **combined set**, identify the states with total sales and total profit above \$100,000 and \$0, respectively. Colour the states meeting this condition differently.

Solution – Exercise 17

Step 1: Drop the **State** field to the **Columns** shelf. Also, drop both the **Sales** and the **Profit** fields to the **Rows** shelf to create **VIZ 12**.



Step 2: Using similar steps, create another set field to group the profitable states, i.e., states with at least \$0. Name the set **State (Profit above \$0)**.

Create Set
✕

Name:

General

Condition

Top

None

By field:

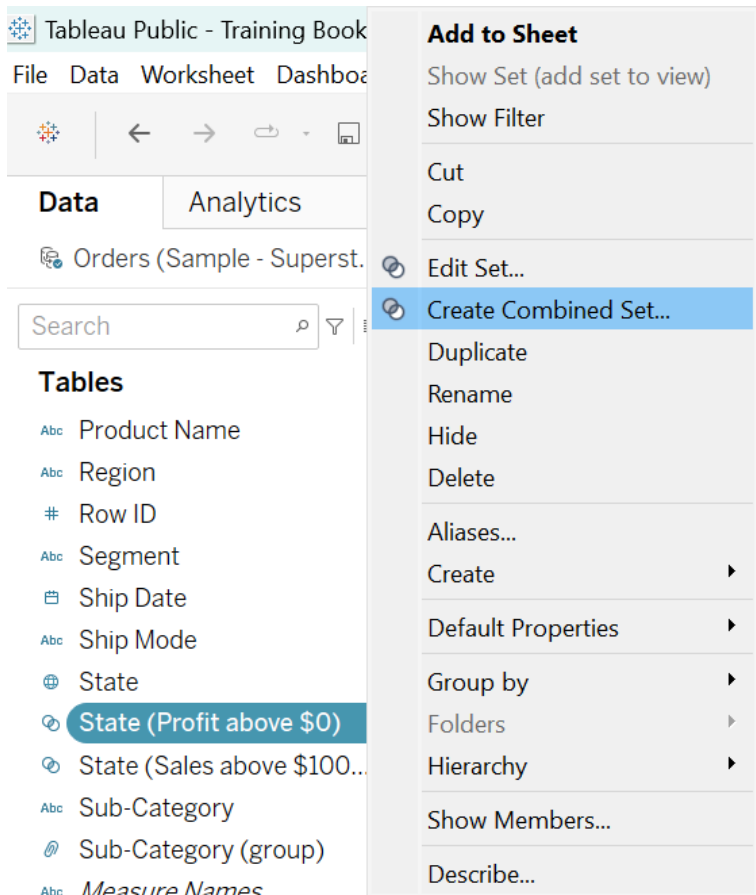
Range of Values

Min:

Max:

Load

Step 3: Click the **State (Profit above \$0)** set in the **Data Pane** and choose **Create Combined Set**.



Step 4: Rename the combined set to **State (Profit above \$0 & sales above \$100,000)**. Choose the **State (Sales above \$100,000)** set to combine with. Pick **Shared Members in Both Sets** to group states that meet both criteria.

Create Set [Set 1] ✕

Name: State (Profit above \$0 & sales above \$100000)

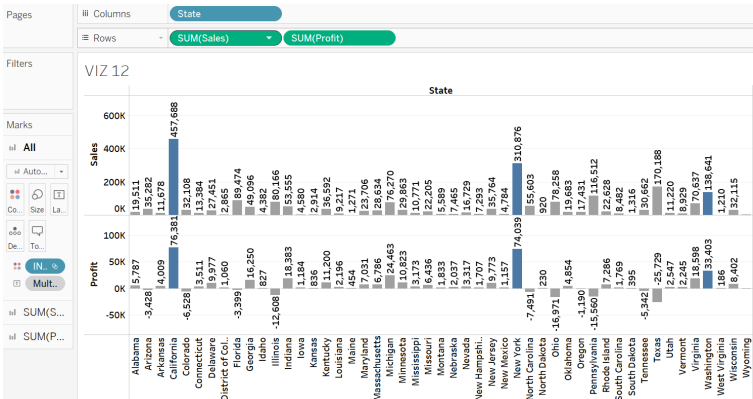
How would you like to combine the two sets?

Sets: State (Profit above \$0) 🔗 State (Sales above \$100,000)

All members in both sets
 Shared members in both sets
 "State (Profit above \$0)" except shared members
 "State (Sales above \$100,000)" except shared members

Separate members by , East, Green Tea, 2012

Step 5: Drag the combined set from the **Data Pane** and drop it onto the **Colour Card**. We can observe that states with total profits and total sales of at least \$0 and \$100,000, respectively, are highlighted in a distinctive colour, such as blue in this instance. The results detect three states meet both conditions: California, New York, and Washington.





An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=154#h5p-14>

5. CALCULATIONS IN TABLEAU



By the end of this chapter, readers will be able to:

- Perform simple calculations in Tableau using Quick Calculation Table
- Create new calculated fields

Quick Calculation Table

In Tableau, the **Quick Calculation Table** feature offers a convenient way to perform common calculations immediately without the need to write complex formulas manually. **Quick Calculation Table** can be accessed by clicking the down arrow next to each field available in the **Data Pane**. When users choose the **Quick Calculation Table**, a list of common calculations that users may want to apply to the selected field appears. These calculations include:

- **Percent of Total:** Calculates the percentage of each value in the selected field relative to the total.
- **Running Total:** Computes the cumulative total of the values in the selected field.
- **Difference:** Calculates the difference between consecutive values in the selected field.
- **Percent Difference:** Computes the percentage difference between consecutive values in the selected field.
- **Rank:** Assigns a rank to each value in the selected field based

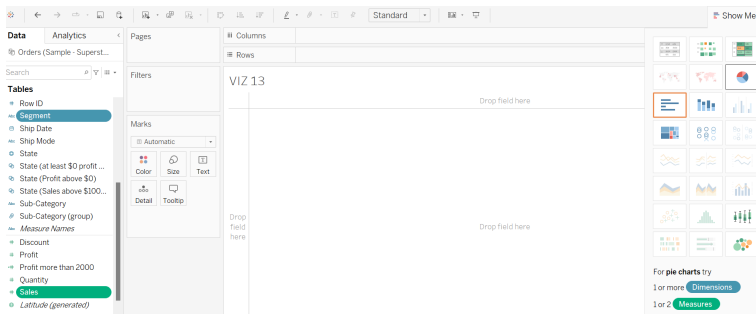
on specified criteria.

Exercise 18

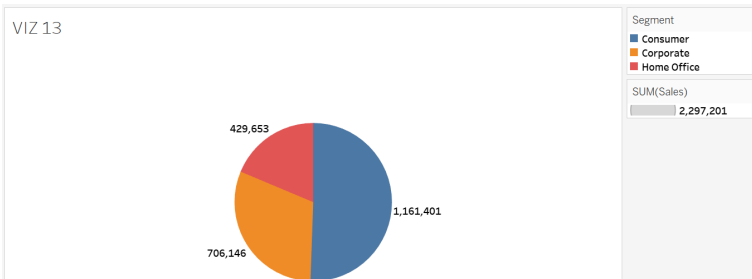
Create a pie chart showing the total percentage of sales contributed by each segment of customers. Rename the chart to **VIZ 13**. What is the total percentage of sales contributed by the home office segment?

Solution – Exercise 18

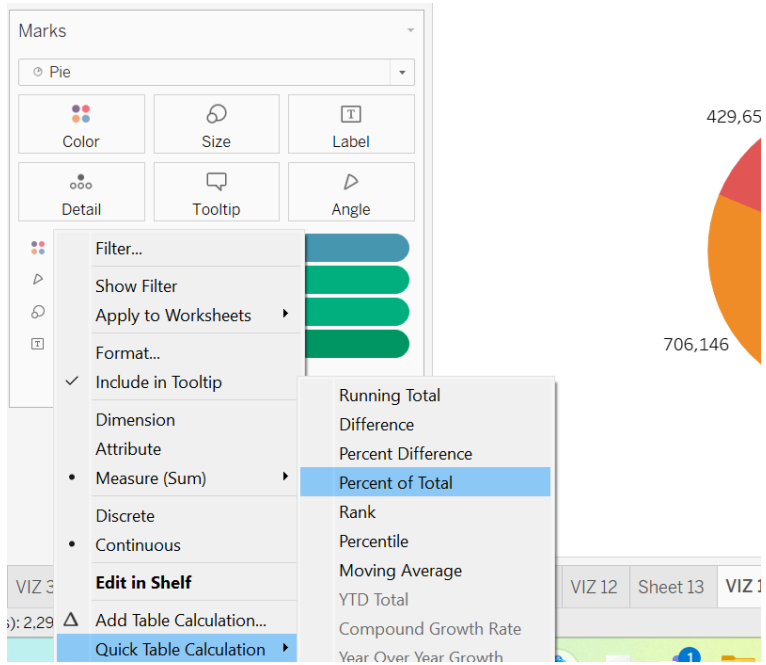
Step 1: Open a new worksheet and rename it to **VIZ 13**. Click both the **Segment** and **Sales** fields in the **Data Pane** by holding the **Ctrl** button. Under **Show Me**, choose the **Pie Chart** icon.



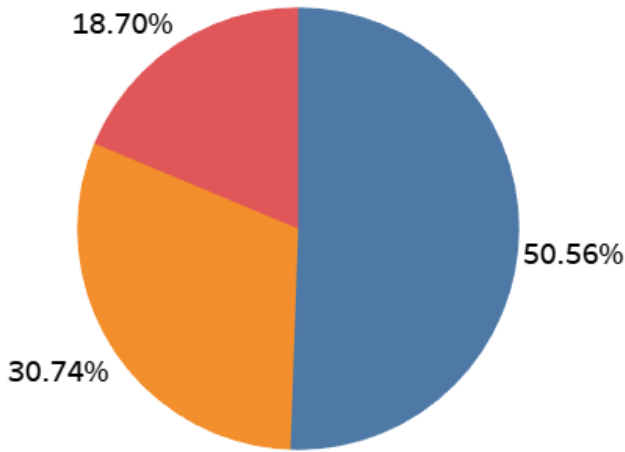
Step 2: Name the pie chart **VIZ 13**. Drag and drop the **Sales** field to the **Label Card** to add total sales information to the pie chart.



Step 3: Click the down arrow next to the **Sales** field added to **Label Card**, choose **Quick Table Calculation**, and pick **Percent of Total**.



Step 4: The pie chart now shows the percentage of sales for each segment relative to total sales. It is clear that the home office segment accounted for just 18.70% of the overall sales.



Exercise 19

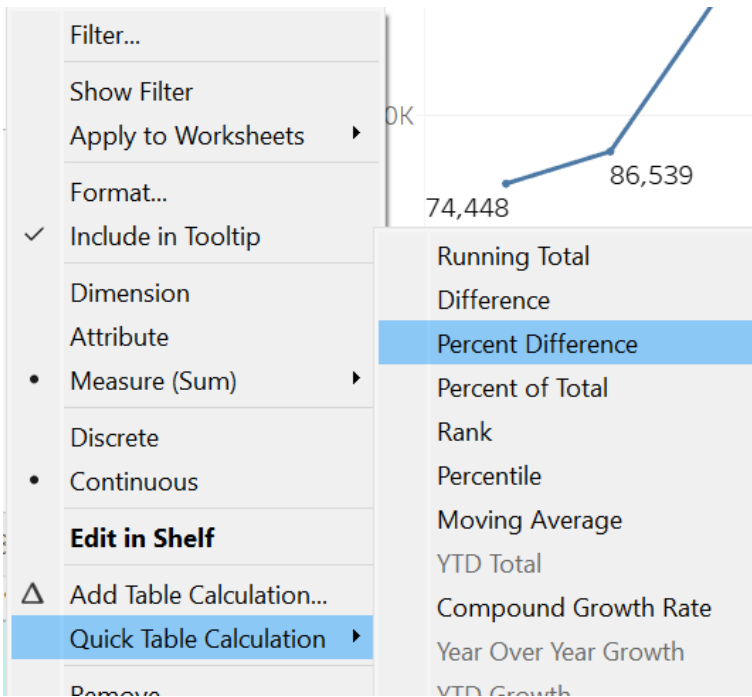
Generate a line chart illustrating **sales** by **quarter per year** and name it **VIZ 14**. Apply the **Percentage Difference** available in the **Quick Table Calculation** to determine which quarter and year experienced a significant decrease in sales compared to the preceding period, and indicate the percentage of the decline.

Solution - Exercise 19

Step 1: Add **Order Date** to the **Columns** shelf and **Sales** to the **Rows** shelf, then rename the worksheet to **VIZ 14**. Click the down arrow next to the **Order Date** field available on the **Columns** shelf. Switch the **Order Date** format from **Year** to **Quarter & Year**. As the **Order Date** is now set as a continuous field, a line chart (not a bar graph) will automatically display.

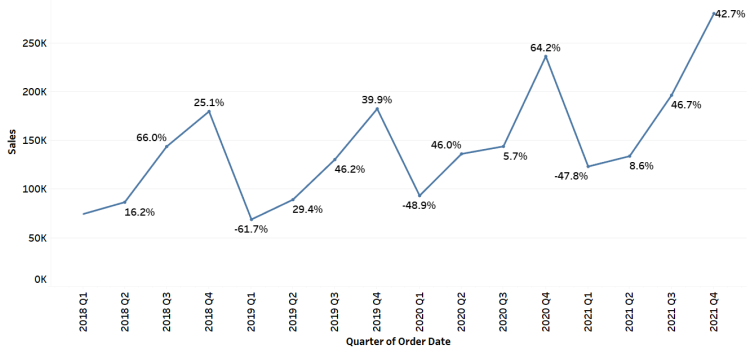
Filter...	
Show Filter	
Show Highlighter	
Apply to Worksheets ▶	
☰	Sort...
Format...	
✓	Show Header
✓	Include in Tooltip
Show Missing Values	
✓	Standard Gregorian
ISO-8601 Week-Based	
•	Year 2015
	Quarter Q2
	Month May
	Day 8
	More ▶
	Year 2015
	Quarter Q2 2015
	Month May 2015
	Week Number Week 5, 2015
	Day May 8, 2015
	More ▶

Step 2: Add **Sales** to the **Label Card**. Click the down arrow next to the added **Sales** field, choose **Quick Table Calculation**, and then select **Percent Difference**.



Step 3: The line chart now displays the percentage change in sales for each quarter of the year compared to the previous time point. It indicates a significant decline in sales during Q1 2019, with a decrease of -61.7% from the prior quarter.

VIZ 14

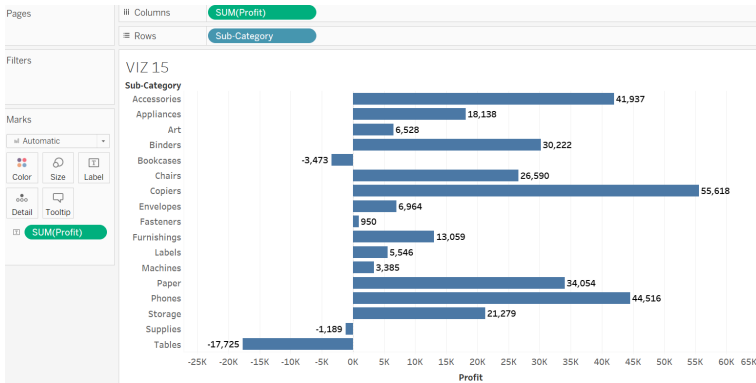


Exercise 20

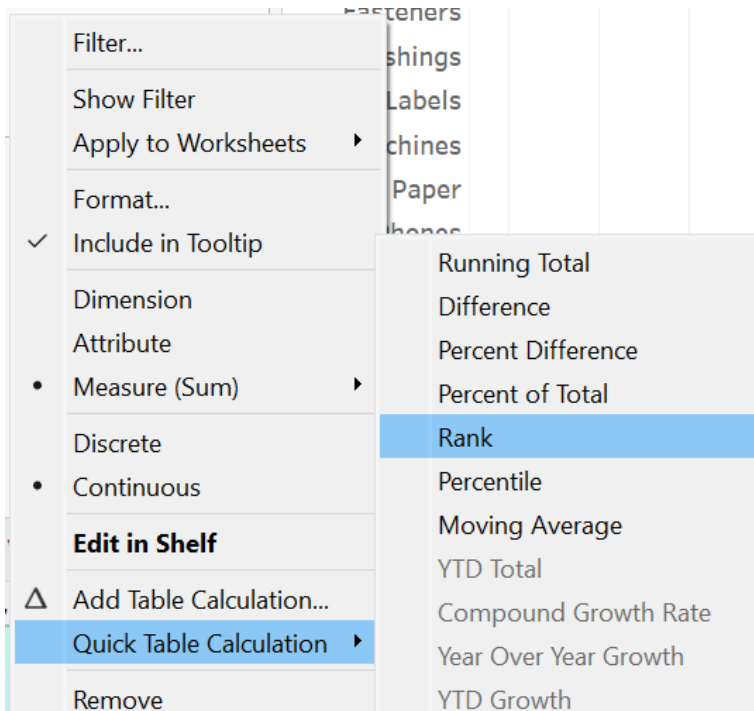
Using the **Quick Calculation Table**, find the rank of bookcases among the other sub-categories in terms of total profit earned.

Solution – Exercise 20

Step 1: Create a bar graph showing the total profit vs. sub-categories. Name it **VIZ 15**. Drop the **Profit** field to the **Label Card**.

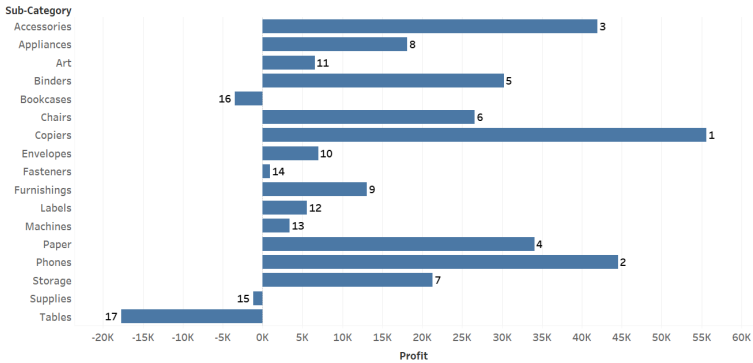


Step 2: Click the down arrow next to the **Sales** field on **Label Card**, choose the **Quick Table Calculation**, and then select **Rank**.



Step 3: The bar graph displays the rank of each sub-category item. Based on the bar graph, bookcases ranked at the 16th position in terms of profitability.

VIZ 15



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=172#h5p-17>

Calculated Fields

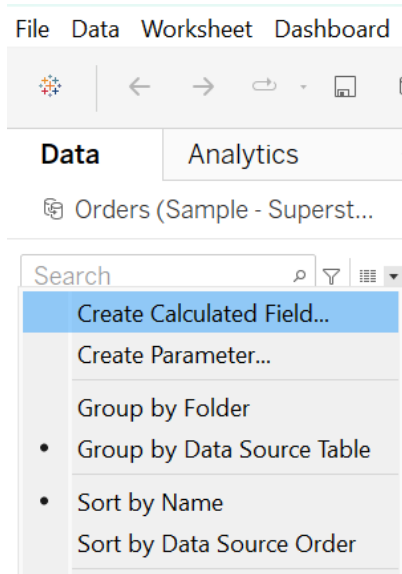
Tableau users have the option to process the current data within a data source to generate a new field, which may be necessary for further analysis. This new field, known as a calculated field, can be created using various mathematical functions available in Tableau. These functions fall into several categories, including basic arithmetic, statistical, logical, date, and string functions.

Exercise 21

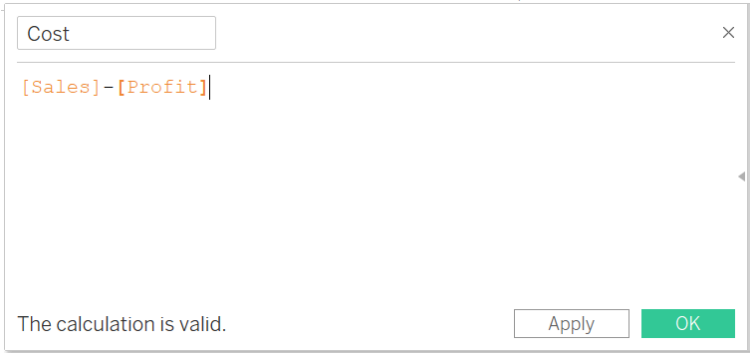
Create a calculated field using the existing data to represent the cost for each order. Note that, $\text{cost} = \text{sales} - \text{profit}$. Construct a bar chart to display the average cost per sub-category. Which sub-category item has the largest average cost?

Solution – Exercise 21

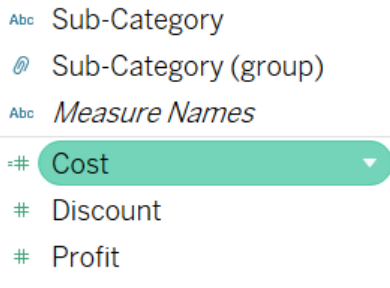
Step 1: Click the down arrow at the top right corner of the **Data Pane** and choose **Create Calculated Field**.



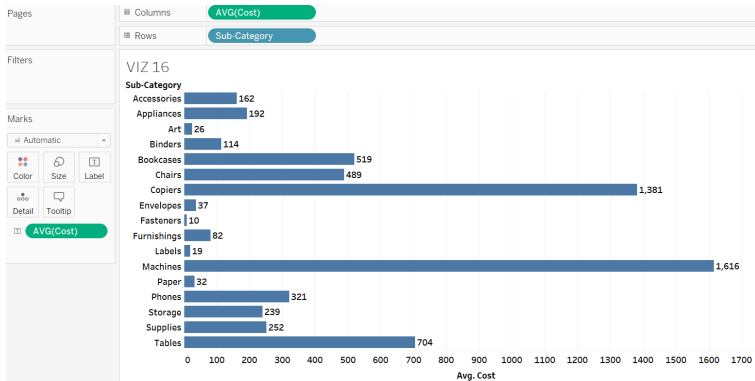
Step 2: Name the new field **Cost**, and enter the needed formula in the available calculation space. Note that the fields required in the formula appear as we type them. Tableau alerts us if the entered formula is invalid either because of illogical calculations or if its expression does not meet Tableau's calculation language.



Step 3: Once clicking **OK**, the newly created calculated will appear in the **Data Pane**.



Step 4: To create the cost vs. sub-category graph, drag and drop the **Cost** and **Sub-Category** fields onto the **Columns** and **Rows** shelf, respectively. Name it **VIZ 16**. Change the aggregation type of cost from sum to average. Also, drop the **Cost** field to the **Label Card** and ensure the aggregation is set to average. The graph points out machine has the highest average cost with \$1616, followed by copiers, and Tables.



Exercise 22

Create a calculated field to classify the sub-category items as “High profit”, “Moderate profit”, “Low profit”, and “Loss”. Apply the conditions listed in the following table for the classification. Also, generate a chart depicting the total profit versus sub-category, and integrate the classification information into the chart. What are the sub-category items that are classified as “Loss” items?

Classification	Condition
High profit	Total profit is \$30,000 and above.
Moderate profit	Total profit is \$10,000 and above.
Low profit	Total profit is \$0 and above.
Loss	Total profit is below \$0.

Solution – Exercise 22

Step 1: Create a calculated field using the logical functions, e.g.,

IF, THEN, and ELSE, to classify the sub-category items based on the conditions given. Name the field **Profit Classification**.

×
Profit classification

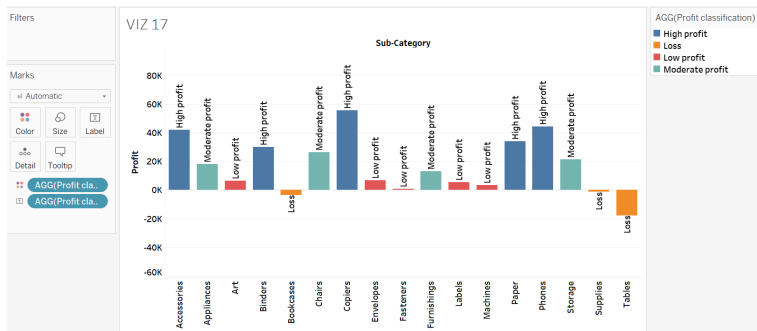
```

IF SUM([Profit])>=30000 THEN "High profit"
ELSEIF SUM([Profit])>=10000 THEN "Moderate profit"
ELSEIF SUM([Profit])>= 0 THEN "Low profit" ELSE "Loss" END
    
```

The calculation is valid.
1 Dependency ▾
Apply
OK

Step 2: Open a new worksheet and rename it to **VIZ 17**. Construct a bar graph depicting the total profit versus sub-category.

Step 3: Drag and drop the **Profit Classification** field to the **Colour** and **Label Cards** to distinguish each sub-category according to its classification. The chart tells that bookcases, supplies, and tables are three sub-category items classified as “Loss”.






An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=172#h5p-16>

6. OTHER CHARTS

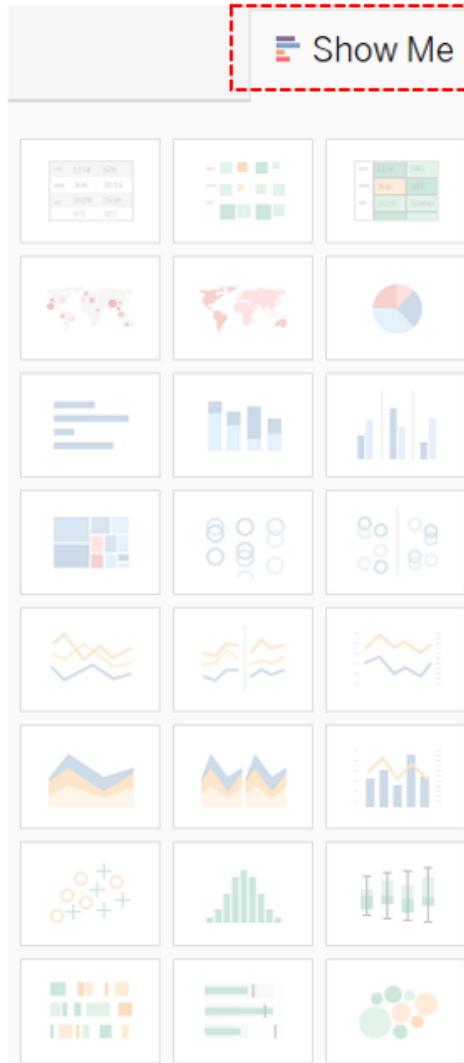


By the end of this chapter, readers will be able to:

- Construct scatter plots using Tableau
- Construct donut charts using Tableau
- Construct crosstabs using Tableau
- Construct tree maps using Tableau
- Construct geo maps using Tableau
- Construct word clouds using Tableau
- Construct dual graphs using Tableau
- Construct calendar heatmaps using Tableau
- Construct bump charts using Tableau

Default Chart Options

Tableau provides several default chart options beyond the traditional bar graph. You can access the list of default charts available in the Tableau environment by clicking on the **Show Me** button located at the top right corner of the worksheet. Some of the default chart options in Tableau include pie charts, geographic maps, scatter plots, histograms, bullet graphs, treemaps, and bubble graphs.



The types or number of the data fields required to build each of these charts can be seen when the users mouse over the related chart icon. For example, mousing over the pie chart icon reveals

that Tableau requires at least 1 or more-dimension fields and 1 or 2 measure fields to construct a proper pie chart.

For **pie charts** try

1 or more **Dimensions**

1 or 2 **Measures**

Scatter Plot

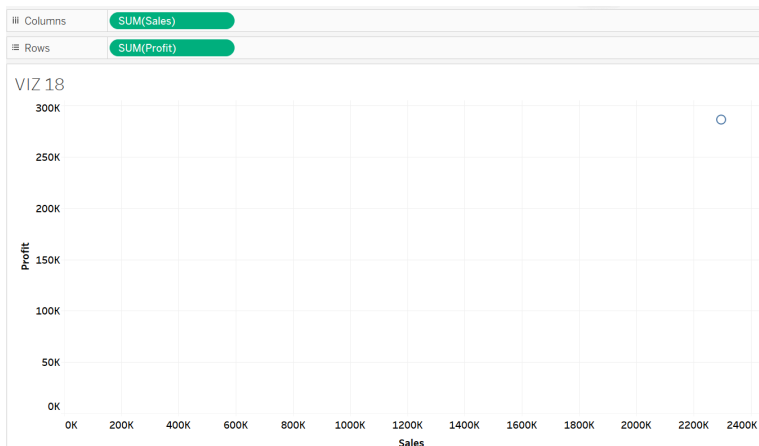
A scatter plot is useful when users wish to explore the relationship between two continuous fields. For example, a scatter plot can be used to examine the relationship between spending on social media advertisements and the profit earned, to determine whether higher spending correlates with higher profit.

Exercise 23

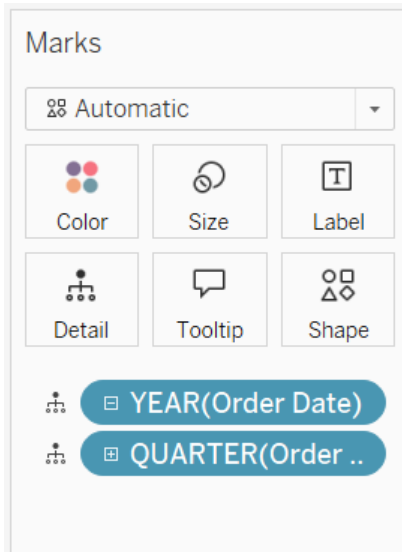
Plot the data of total sales and profit according to quarter and year. Name the chart **VIZ 18**. Describe the relationship that you notice.

Solution – Exercise 23

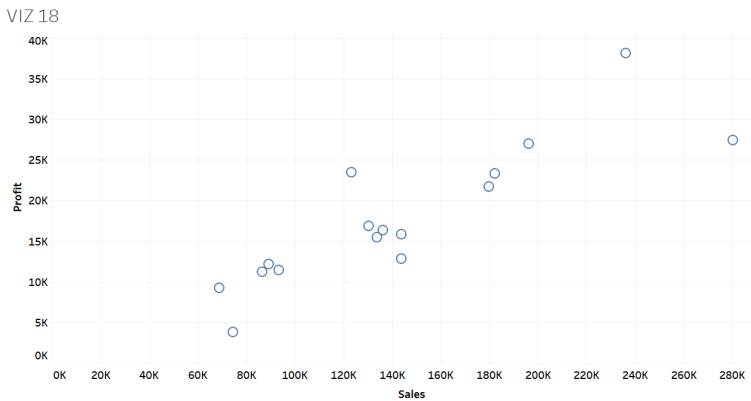
Step 1: Drop the **Sales** field to the **Columns** shelf and the **Profit** field to the **Rows** shelf.



Step 2: Drop the **Order Date** field to the **Detail Card**. Expand the **Order Date** by quarter and year.



Step 3: A detailed scatter plot has been created to show sales and profit by quarter and year. The plot indicates a positive correlation between sales and profit, suggesting that profit tends to increase as sales rise.



Donut Chart

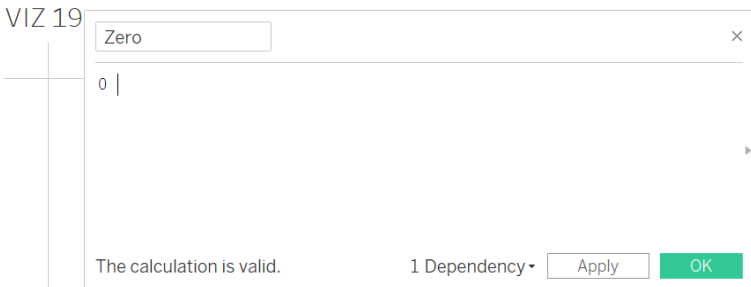
A donut chart is a variation of a pie chart, but with a blank space in the centre, allowing the users to add summary information in the hollow space. Similar to a pie chart, it can be used to represent the data of different dimension items, with summary data made available in the centre space to provide additional information for the audience. For example, users might use a donut chart to visualize the article publications of different faculties within a university, and the central space of a donut chart can be used to display the total publications.

Exercise 24

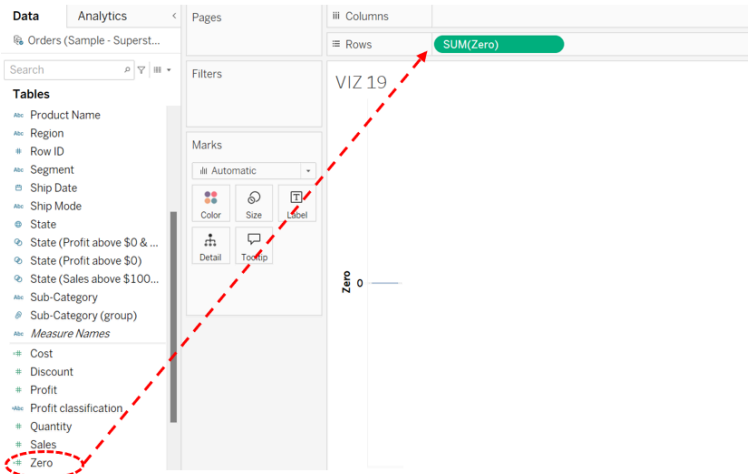
Create a donut chart where the outer ring displays sales by region, and the centre shows the overall sales. Name the donut chart **VIZ 19**.

Solution – Exercise 24

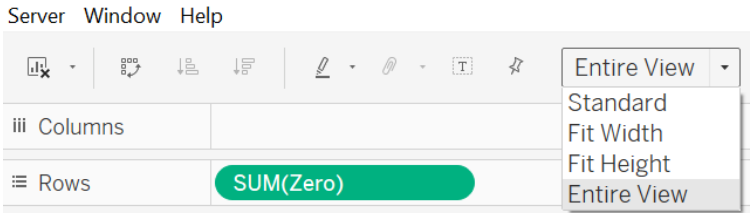
Step 1 – Open a new worksheet and name it **VIZ 19**. Create a constant field with the value “0”. To do so, click Create Calculated Field, name it **Zero** and enter the value in the calculation space before clicking **Apply**.



Step 2 – Drag and drop the newly created **Zero** field onto the **Rows** shelf.

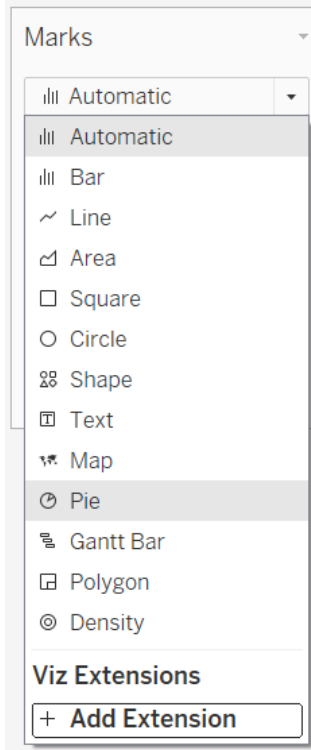


Step 3 – Switch the view from the **Standard** to the **Entire View**.

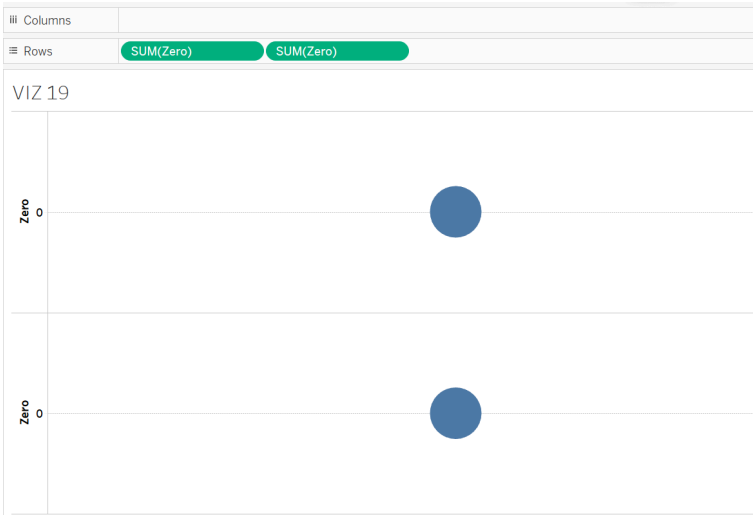


VIZ 19

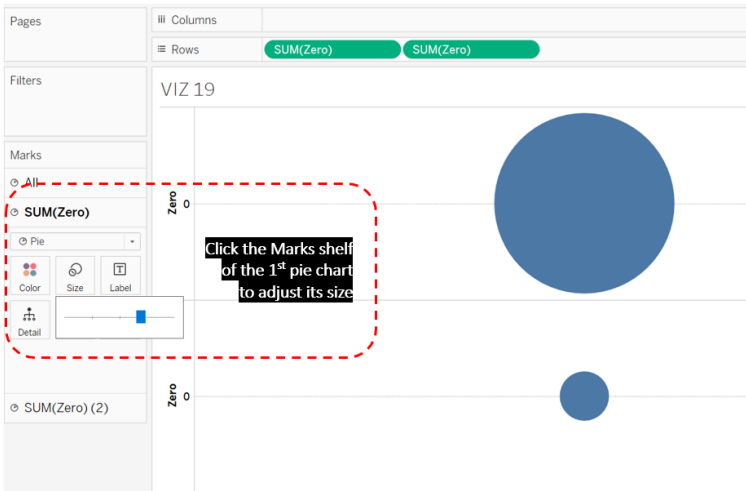
Step 4 – Switch the type of marks to **Pie**.



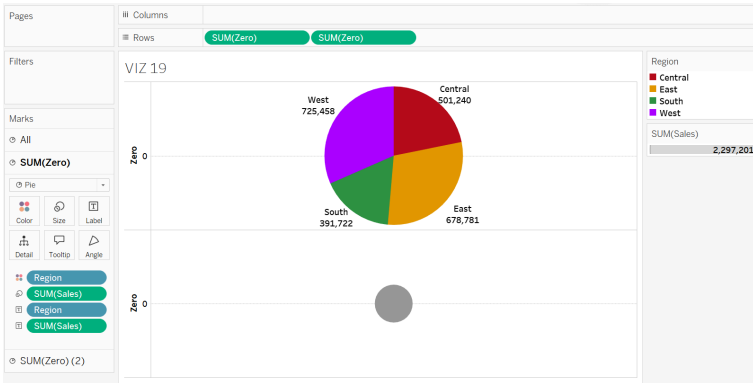
Step 5 – Drag and drop the **Zero** field onto the **Rows** shelf once more to generate an additional axis and pie chart.



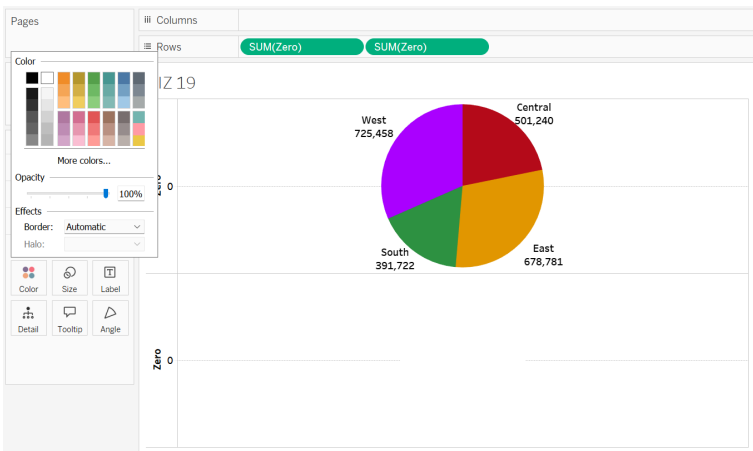
Step 6: Click the **Marks** shelf of the first pie chart and adjust the size of the pie chart so that it appears slightly larger than the second one.



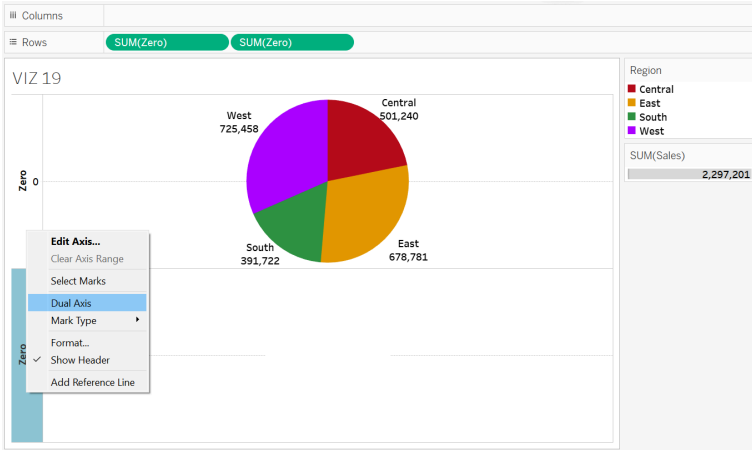
Step 7: In the same **Marks** shelf, drop the **Region** field to the **Colour** card, and the **Sales** field to the **Size Card**. At the same time, drop both **Region** and **Sales** to the **Label Card**.



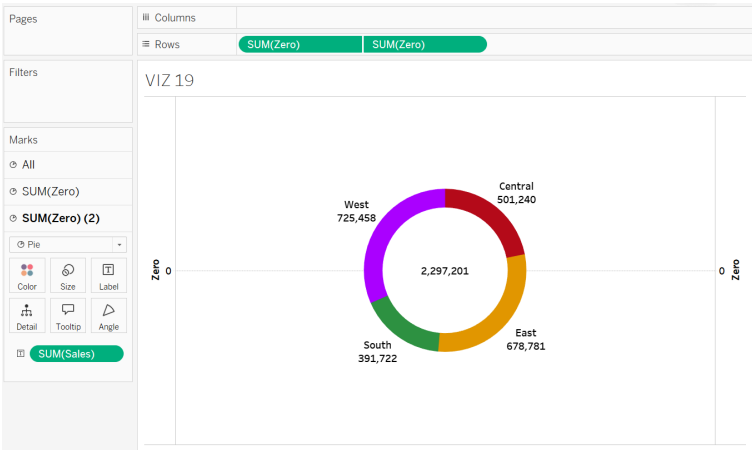
Step 8: Switch to the second **Marks** shelf and adjust the size of the second pie chart as needed, making sure it does not exceed the size of the first pie chart. Additionally, change the colour of the second pie chart to white using the **Colour Card**.



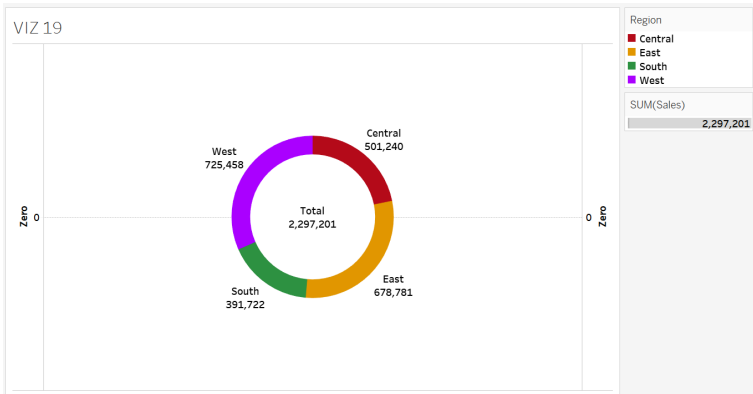
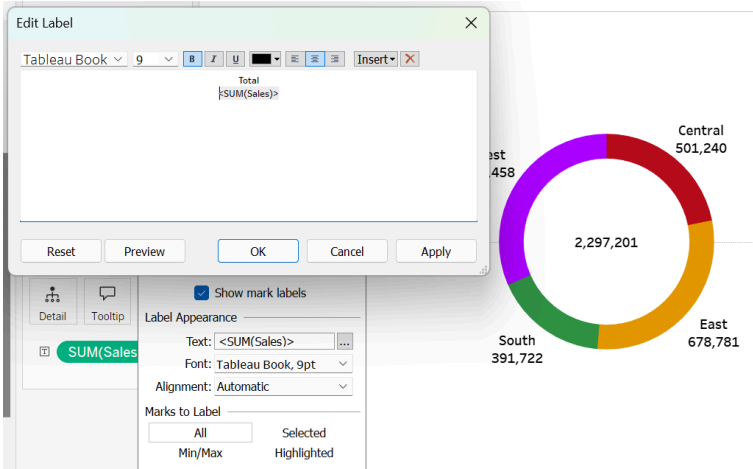
Step 9: Right-click the axis of the second pie chart. Choose **Dual Axis** to merge both pie charts.



Step 10 – Click on the **Marks** shelf of the second pie chart. Then, drag the **Sales** field to the **Label Card** to show the figure in the centre.



Step 11: Edit the **Label** to add the term “Total” before the sales figure.



Crosstab

A crosstab, also known as a pivot table, is ideal for summarizing data

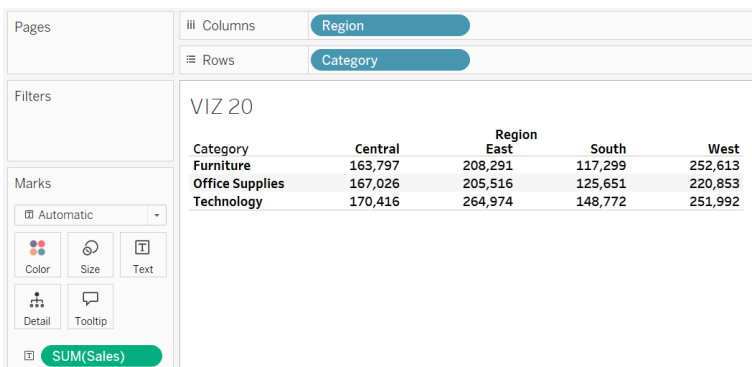
across two dimensions. For example, it can be used to summarize sales by region and product category in a tabular format. Typically, the data in a crosstab is presented as percentages, which helps provide clearer insights into proportions and relative importance. Tableau offers functionality to enhance crosstabs by adding grand totals to columns or rows through the **Total** option in the **Analysis** menu. Additionally, you can easily convert the data into percentages relative to the column, row, or grand total using the **Percentage Of** feature also found under **Analysis**.

Exercise 24

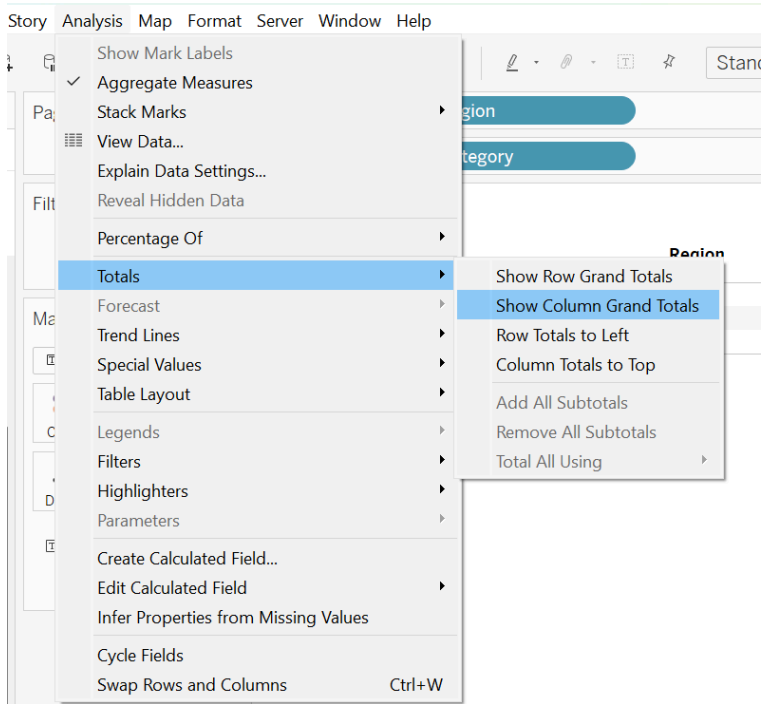
Create a table that summarizes the sales data by region and product category. Name it **VIZ 20**. Arrange the regions as columns and the product categories as rows. Include a grand total for each region. Additionally, calculate the percentage of sales attributed to furniture items relative to the total sales in the Central region.

Solution – Exercise 24

Step 1: Place the **Region** field on the **Columns** shelf and the **Category** field on the **Rows** shelf. Drop the **Sales** field to the **Label Card** to create the crosstab. Rename the worksheet to **VIZ 20**.



Step 2: In the toolbar, click on **Analysis**, select **Totals**, and then choose **Show Column Grand Totals** to display the total sales for each region.



Pages

Columns: Region

Rows: Category

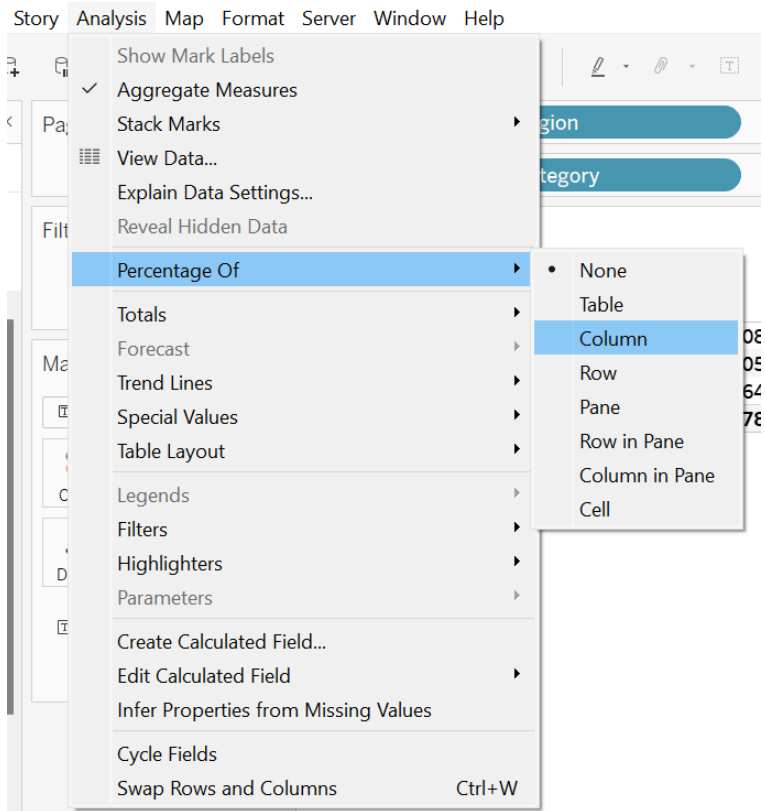
Filters

Marks: SUM(Sales)

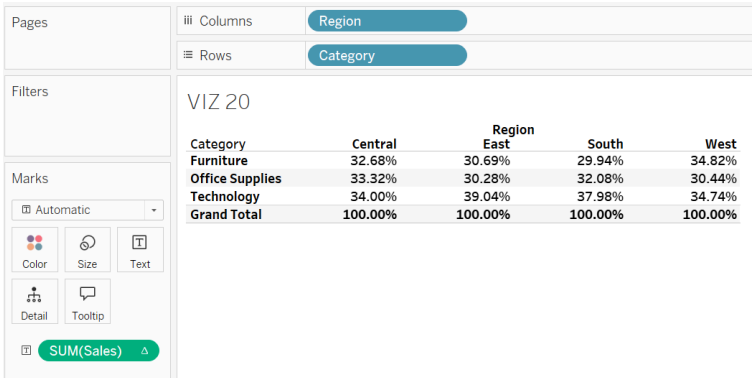
VIZ 20

Category	Region			
	Central	East	South	West
Furniture	163,797	208,291	117,299	252,613
Office Supplies	167,026	205,516	125,651	220,853
Technology	170,416	264,974	148,772	251,992
Grand Total	501,240	678,781	391,722	725,458

Step 3: In the toolbar, click on **Analysis**, select **Percentage Of**, and then choose **Column** to convert the existing crosstab into a column-based percentage crosstab.



Step 4: Based on the percentage crosstab, we can conclude that 32.68% of the total sales in the Central region was contributed by furniture items.



Tree Map

A tree map is a visualization chart used to display hierarchical (tree-structured) data using nested rectangles. Each rectangle represents a category or subcategory, and the size and colour of the rectangles provide insights into the data.

Exercise 25

Generate a tree map displaying sales data by product categories and sub-categories. Rename the tree map to **VIZ 21**. What insights can you derive from the tree map?

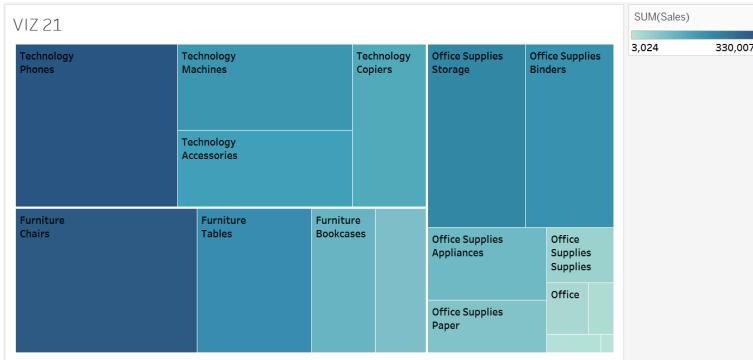
Solution – Exercise 25

Step 1: Open a new worksheet and rename it **VIZ 21**. Click all three fields in the **Data Pane** section by holding the **Ctrl** button: **Category**, **Sub-Category**, and **Sales**.

Step 2: Under **Show Me**, choose the tree map icon.



Step 3: Add the **Category** and **Sub-Category** fields onto the **Label Card**. From the treemap, it can be confirmed that phones generate the highest sales within the Technology product category compared to other technology items such as machines, copiers, or accessories. For the **Furniture** category, chairs lead in sales revenue, outperforming other products like tables, desks, or cabinets. It indicates that chairs are a major revenue driver in the **Furniture** category and may require focused inventory management and marketing efforts. In the **Office Supplies** category, storage solutions and binders generate the most revenue. This means that these items are the most essential products within **Office Supplies**, compared to other items like pens, notebooks, or office furniture.



Geo Map

Geo maps let users visualize data with geographic components like districts, states or countries. They are great for showing geographic-based data like sales by region or population by city. By plotting data on a map, users can quickly spot patterns and differences between areas, such as which regions are performing well or growing fast. This helps with understanding regional trends and making strategic decisions. To create a proper geo map in Tableau, users will need at least one geographic field and one measure field.

Exercise 26

Build a geo map that shows sales data for each state. Rename the treemap to **VIZ 21**. Highlight the top 15 states with the highest sales figures.

Solution – Exercise 26

Step 1: Open a new worksheet and rename it to **VIZ 22**. Click the

State and **Sales** fields simultaneously in the **Data Pane**, by holding the **Ctrl** button.

Step 2: Choose **Maps** under the **Show Me** menu.



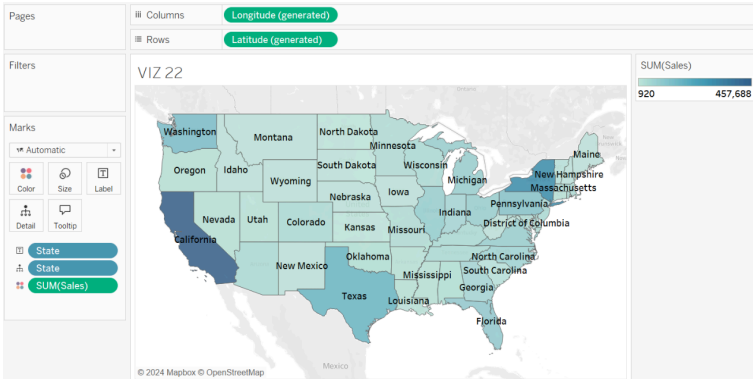
The image shows the 'Show Me' menu in Tableau, which provides various visualization options. The menu is organized into a grid of icons representing different chart types. The 'Maps' option, which shows a world map, is highlighted with a red dashed border. Below the grid, there are instructions for using maps:

For **maps** try

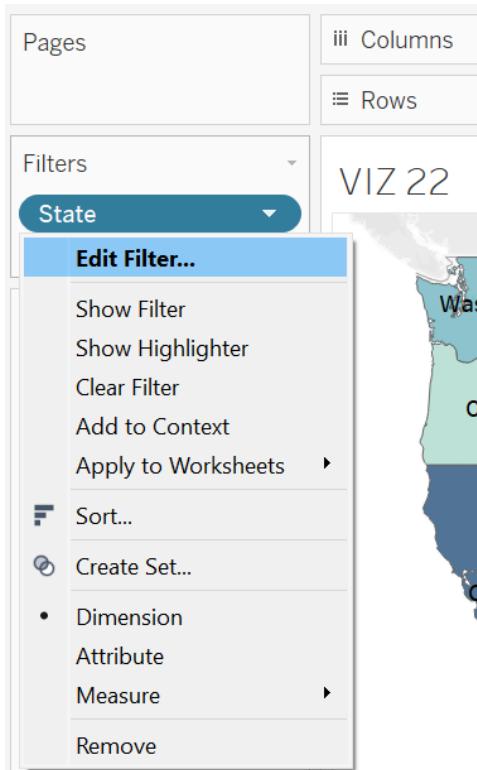
- 1 geo \oplus **Dimension**
- 0 or more **Dimensions**
- 0 or 1 **Measure**

May use spatial measure in place of geo dimension

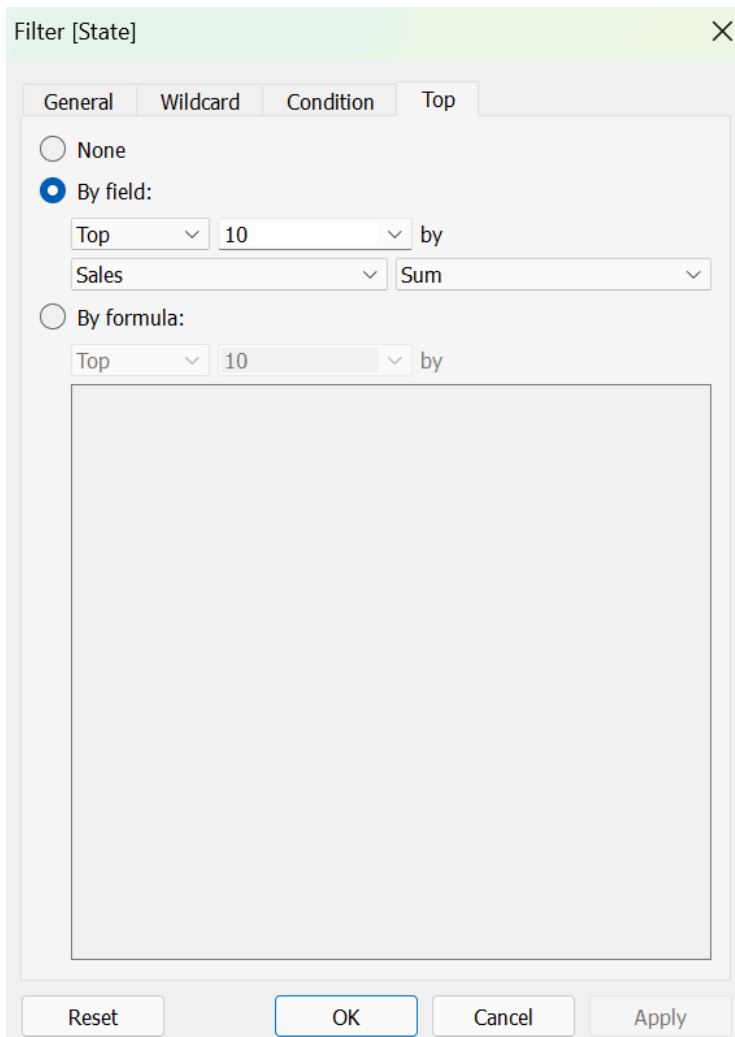
Step 3 – Drop the **State** and **Sales** fields to the **Label Card**.



Step 4: Add the **State** field to the filter shelf. Click the down arrow next to the **State** field available in the **Filters** shelf and choose **Edit Filter**.

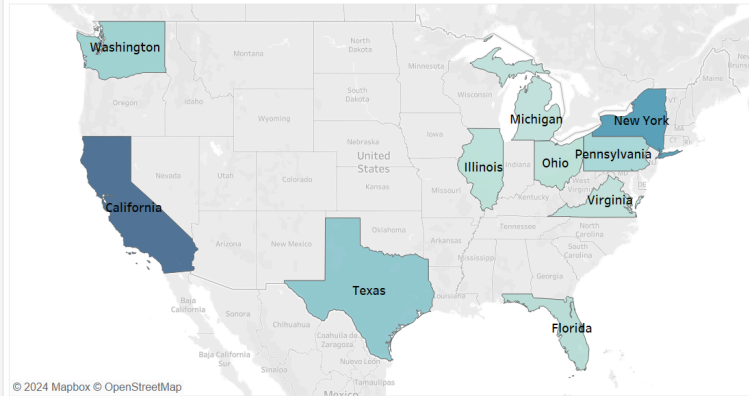


Step 5: Switch to the **Top** tab, choose **By Field**, and set the values according to the needs of the analysis.



Step 6 – Clicking the **OK** button will update the geo map to display only the top ten countries by sales, with California in the lead and New York next.

VIZ 22



Word Cloud

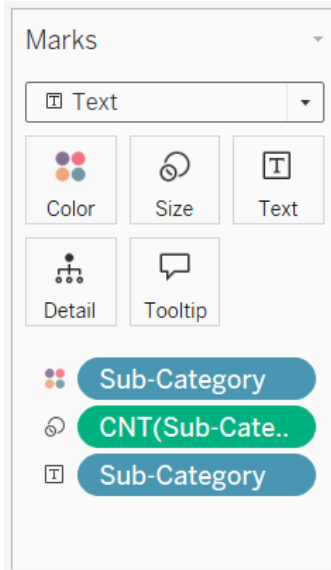
Word clouds are most effective for summarizing text data, where the size of each word corresponds to its frequency of occurrence in the dataset. They visually highlight the most frequently occurring words, making it easy to observe which terms are most significant or relevant. For example, feedback data collected from moviegoers can be converted into a word cloud, which may highlight keywords such as ‘action movies,’ ‘Korean cinema,’ ‘expensive tickets,’ and ‘online booking.’ These keywords can indicate current preferences or major issues encountered by moviegoers.

Exercise 27

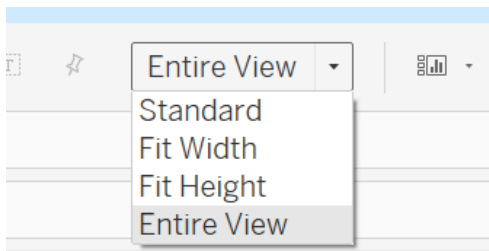
Create a word cloud to identify the most popular sub-category items based on the number of orders received. Name the word cloud **VIZ 23**.

Solution – Exercise 27

Step 1: Open a new worksheet and name it **VIZ 23**. Add the **Sub-Category** field to the **Label**, **Colour**, and **Size Cards**.

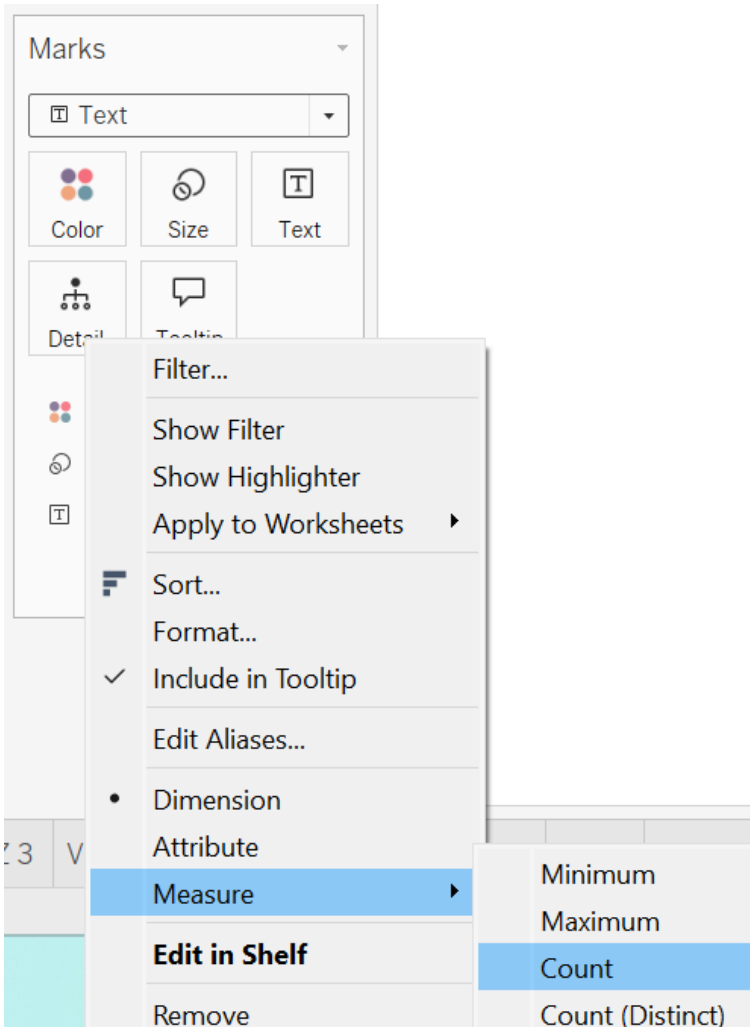


Step 2: Ensure the view mode on the toolbar is switched to **Entire View**.

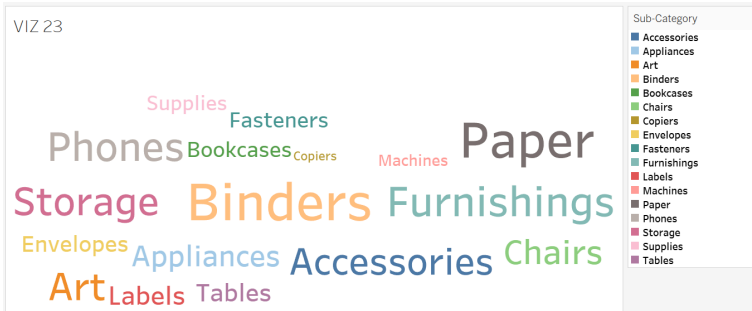


Step 3: Click the down arrow next to the **Sub-Category** field on the **Size Card**, then select **Measure** and choose **Count**. This action

prompts Tableau to calculate the number of occurrences for each sub-category item, reflecting their total orders.



Step 4: The size of the items in the word cloud suggests that binders, furnishings, papers, phones, and storage are among the most popular sub-category items, receiving substantial orders.



Dual Graph

A dual graph enables users to overlay two different measures on the same axis, which is particularly helpful when comparing metrics with different scales. For instance, users may want to plot sales revenue and profit margin on the same axis within a chart, allowing them to compare both metrics to each other.

Exercise 28

Develop a dual graph to analyze both total sales and profit for each year, and title it **VIZ 24**. What conclusion can you draw from the dual graph?

Solution – Exercise 28

Step 1: Open a new worksheet and name it **VIZ 24**. Click the **Order Date**, **Profit** and **Sales** fields all together by holding the **Ctrl** button.

Step 2: Under **Show Me**, choose the **Dual Graph** option.

Show Me



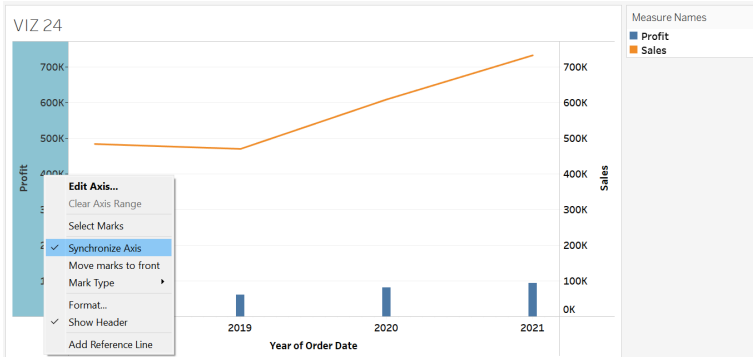
For **dual combination** try

1 date 📅

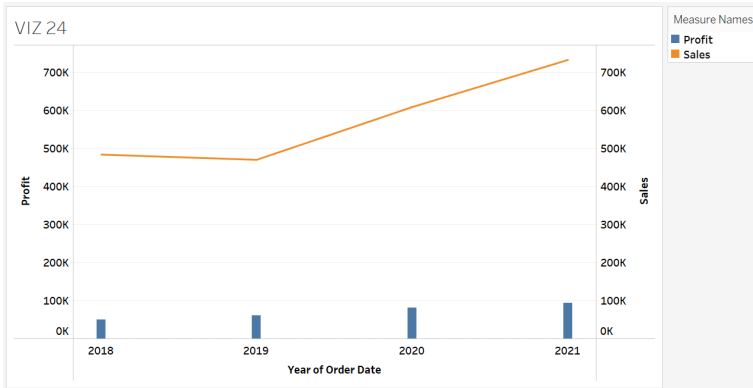
0 or more **Dimensions**

2 **Measures**

Step 3: Once generating the dual graph, users have the option to standardize both axes to the same scale for a more accurate comparison. To align both axes to a uniform scale, right-click on either axis and select **Synchronize Axis**.



Step 4: The synchronized dual graph shows that both sales and profit have been rising consistently together since 2019.



Calendar Heatmap

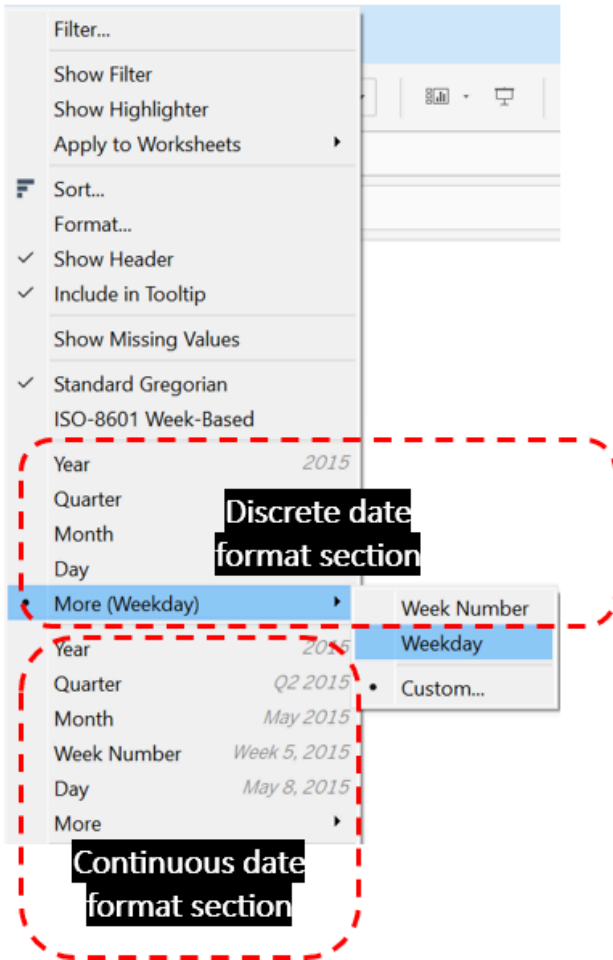
A calendar heatmap is ideal for displaying data that has a daily component. For example, it can show daily sales figures, website usage rates, or customer activity over a month. Each day is represented as a cell, and colours indicate the magnitude of the data. By visualizing data in a calendar format, users can easily recognize seasonal trends and repeating patterns. For instance, users might witness increased sales during specific days of the week.

Exercise 29

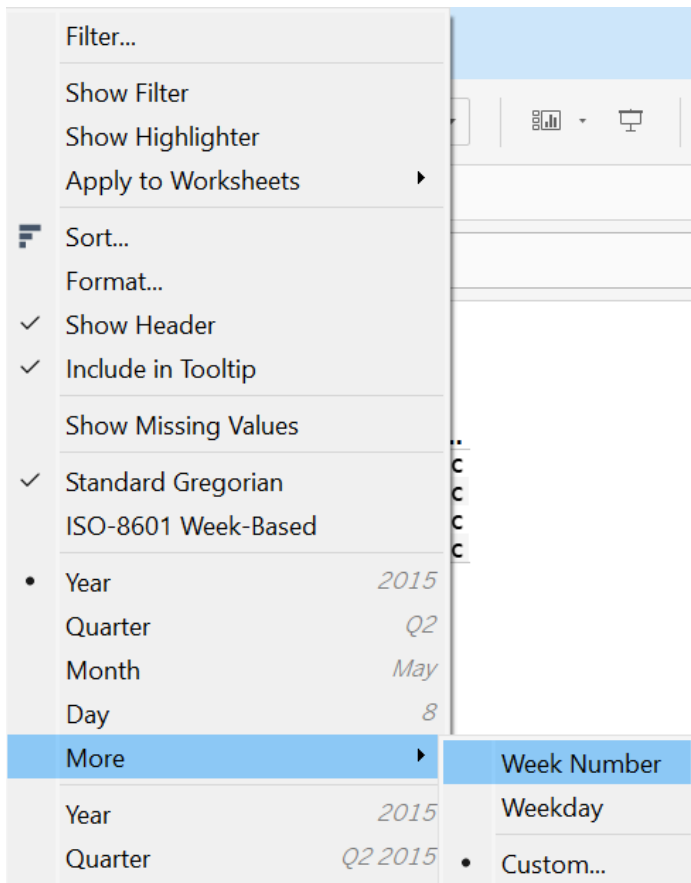
Design a calendar heatmap to observe daily sales patterns across each month and year. Name it **VIZ 25**.

Solution – Exercise 29

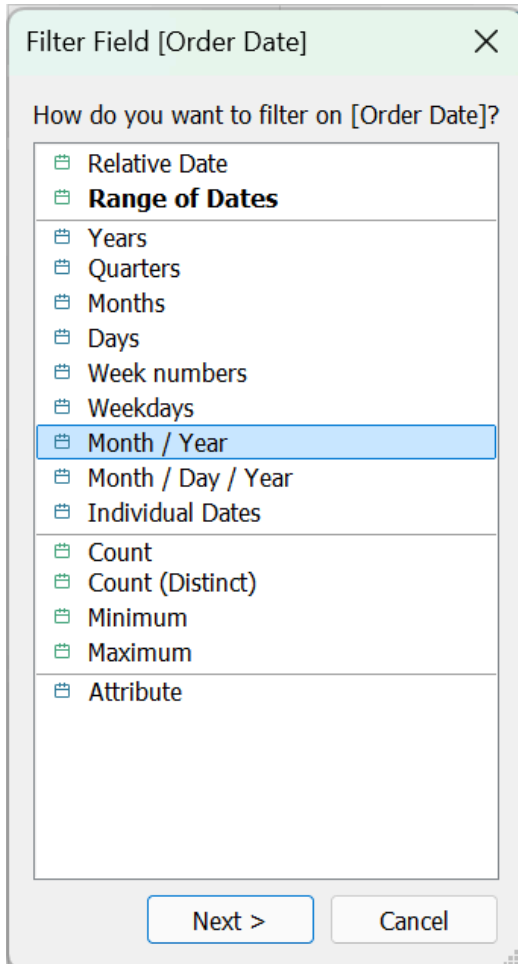
Step 1: Open a new worksheet and name it **VIZ 25**. Drag and drop the **Order Date** field onto the **Columns** shelf. Click the down arrow to choose **More** under the discrete date format section and choose **Weekday** to display days in the **View**.



Step 2: Drag and drop the **Order Date** field onto the **Rows** shelf. Click the drop-down arrow, select **More** under the discrete date format section, and choose **Week Number** to display the number of weeks in the **View**.



Step 4: Drop the **Order Date** field to the **Filters** shelf and choose **Month/Year** to allow the users to control the data in the **View** according to month and year.



Step 5: Display the filter card, and randomly pick any one option. For example, in this case, choose April 2018.

MY(Order Date)

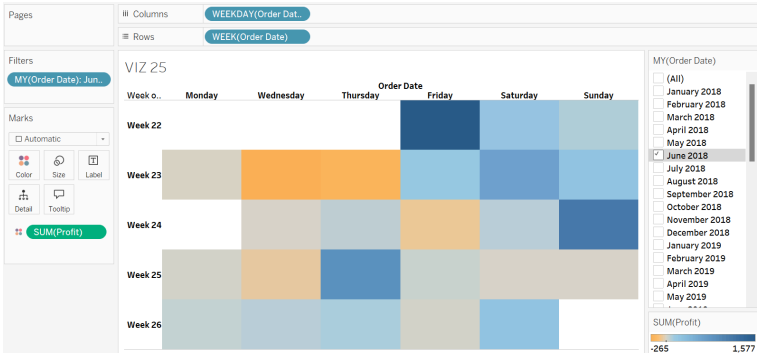
- (All)
- January 2018
- February 2018
- March 2018
- April 2018
- May 2018
- June 2018
- July 2018
- August 2018
- September 2018

Step 6: Ensure that the view mode in the toolbar is set to **Entire View**.

The screenshot shows a data visualization interface. At the top, there is a toolbar with a dropdown menu for 'Entire View' which is currently selected. Other options in the dropdown include 'Standard', 'Fit Width', 'Fit Height', and 'Entire View'. A red dashed box highlights the 'Entire View' option and the text 'View mode' next to it. Below the toolbar is a table with columns for days of the week (Monday, Wednesday, Thursday, Friday, Saturday, Sunday) and rows for weeks (Week 22 to Week 26). The table contains 'Abc' values in various cells. To the right of the table is a filter menu for 'MY(Order Date)' with a list of months from January 2018 to September 2019. 'June 2018' is selected in this menu.

Week o...	Monday	Wednesday	Order Date Thursday	Friday	Saturday	Sunday
Week 22				Abc	Abc	Abc
Week 23	Abc	Abc	Abc	Abc	Abc	Abc
Week 24		Abc	Abc	Abc	Abc	Abc
Week 25	Abc	Abc	Abc	Abc	Abc	Abc
Week 26	Abc	Abc	Abc	Abc	Abc	

Step 7: Drop the **Profit** field to the **Colour** card.



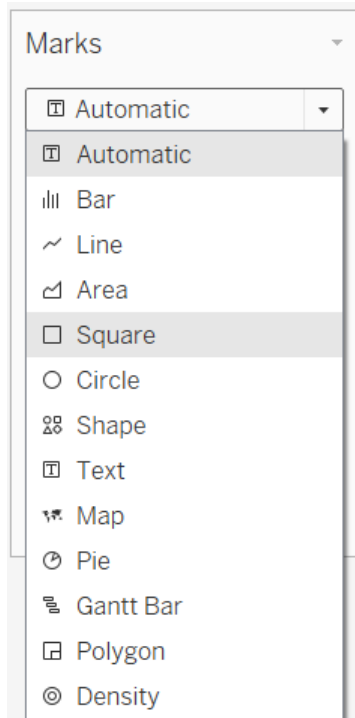
Step 8: Drop the **Order Date** field to the **Label Card**. Click the down arrow next to the **Order Date** field and change the date format to **Day** to display the exact date information in the calendar.

	Filter...
	Show Filter
	Show Highlighter
	Apply to Worksheets ▶
☰	Sort...
	Format...
✓	Include in Tooltip
✓	Standard Gregorian
	ISO-8601 Week-Based
•	Year <i>2015</i>
	Quarter <i>Q2</i>
	Month <i>May</i>
	Day <i>8</i>
	More ▶
	Year <i>2015</i>
	Quarter <i>Q2 2015</i>
	Month <i>May 2015</i>
	Week Number <i>Week 5, 2015</i>
	Day <i>May 8, 2015</i>
	More ▶
	Exact Date

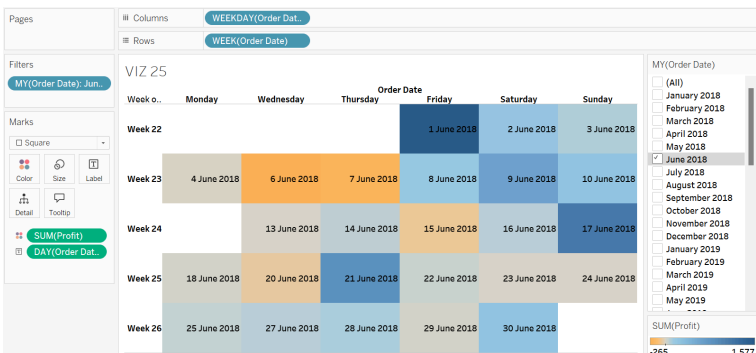
VIZ 25

Week o..	Monday	Wednesday	Order Date Thursday	Friday	Saturday	Sunday
Week 22				1 June 2018	2 June 2018	3 June 2018
Week 23	4 June 2018	6 June 2018	7 June 2018	8 June 2018	9 June 2018	10 June 2018
Week 24		13 June 2018	14 June 2018	15 June 2018	16 June 2018	17 June 2018
Week 25	18 June 2018	20 June 2018	21 June 2018	22 June 2018	23 June 2018	24 June 2018
Week 26	25 June 2018	27 June 2018	28 June 2018	29 June 2018	30 June 2018	

Step 9: Switch the type of the marks to **Square** to obtain the final calendar heatmap.



Step 10: Users can use the filter card to navigate between different months and analyze the daily profit trends.



Bump Chart

Bump charts are ideal to observe how the rank of various dimension items e.g., the product categories, sales teams, or regions changes, changes across different time points. For example, we can monitor the rankings of different sales teams by their monthly performance, showing which teams have developed or declined in rank.

Exercise 30

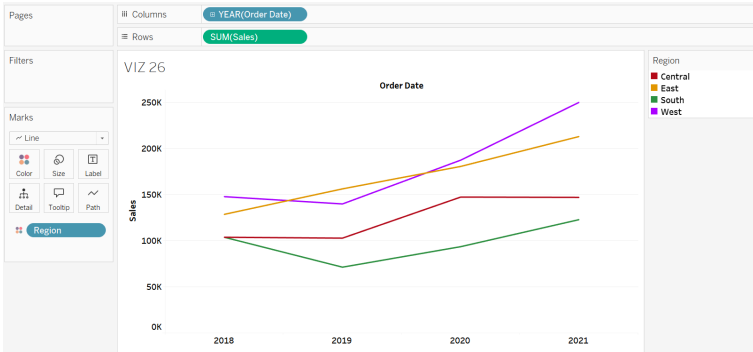
Build a bump chart to compare the ranks of different regions in terms of their yearly sales. Name the chart **VIZ 26**. What insights can you offer based on the bump chart?

Solution – Exercise 30

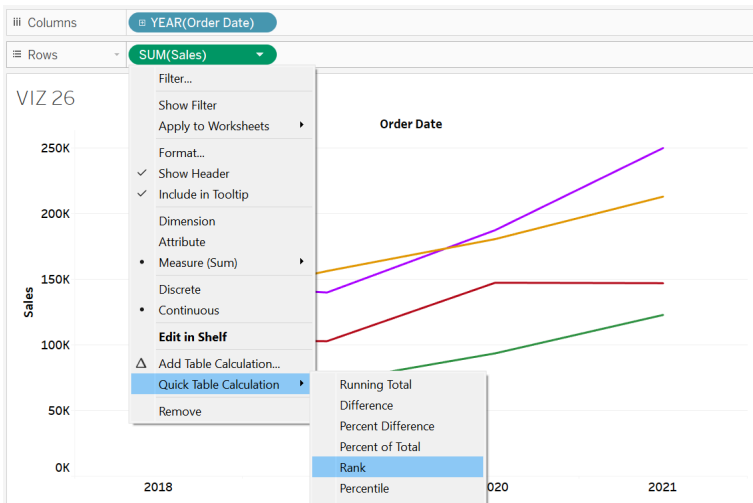
Step 1: Create a new worksheet and name it **VIZ 26**. Next, drag the **Order Date** field onto the **Columns** shelf and the **Sales** field onto the **Rows** shelf.

iii Columns	YEAR(Order Date)
☰ Rows	SUM(Sales) Δ

Step 2: Drop the **Region** field to the **Colour** card.

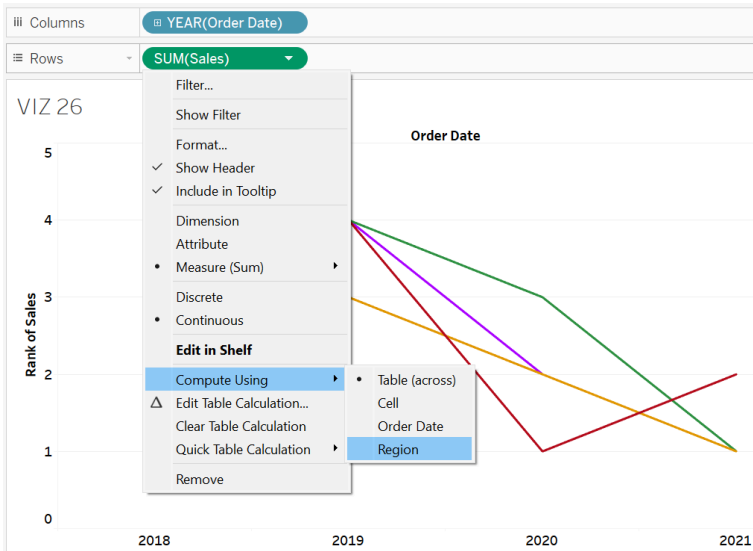


Step 3: The axis must be converted to rank values. To do this, click the down arrow next to the **Sales** field in the **Rows** shelf. Then, select **Quick Table Calculation** and choose **Rank**.



Step 4: The ranks within each year should be calculated based on the regions. To do this, click the down arrow next to the **Sales**

field in the **Rows** shelf. Then, hover over **Compute Using** and select **Region**.



Step 5: The current version of the bump chart displays regions with a better rank appearing lower on the chart, while those with a poorer rank appear higher. To have regions with a better rank appear at the top of the chart, you need to reverse the scale on the axis. To do this, right-click the axis, select **Edit Axis**, and then, in the **Edit Axis** settings, check the **Reversed** option under the **Scale** section.

Edit Axis [Rank of Sales] ×

General Tick Marks

Range

Automatic Include zero

Uniform axis range for all rows or columns

Independent axis ranges for each row or column

Custom

Automatic ▼ Automatic ▼

0 5

Scale

Reversed

Logarithmic

Positive Symmetric

Axis Titles

Title

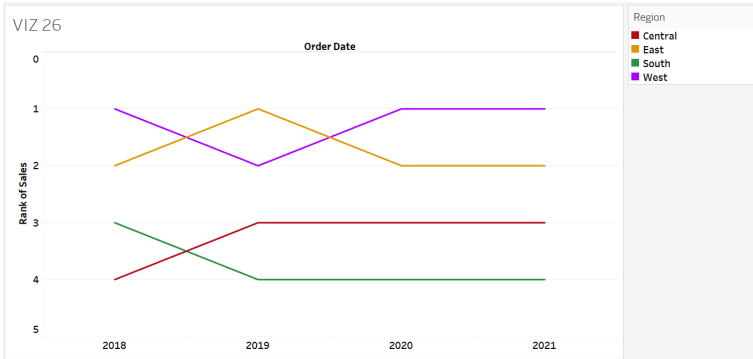
Custom ▼ Rank of Sales

Subtitle

Subtitle Automatic

[↶ Reset](#)

Step 6: The bump chart clearly shows that from 2018 to 2021, the West and East regions consistently held the 1st or 2nd ranks. In contrast, the Central and South regions remained the lowest performers, struggling to surpass the top two regions.



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=226#h5p-18>

7. MOTION VISUALIZATIONS



By the end of this chapter, readers will be able to:

- Build motion line charts using Tableau
- Build race bars using Tableau

Motion Line Chart

Motion line charts, also known as animated line charts, not only make data presentations more engaging but also allow us to observe how values fluctuate over a specific time range. This helps in identifying any exciting or abnormal value transitions. In Tableau, you can create a motion line chart by placing a date field on the Pages shelf. This will split the line chart into a series of pages, creating animations that clearly show how values change over time, such as years, quarters, or months.

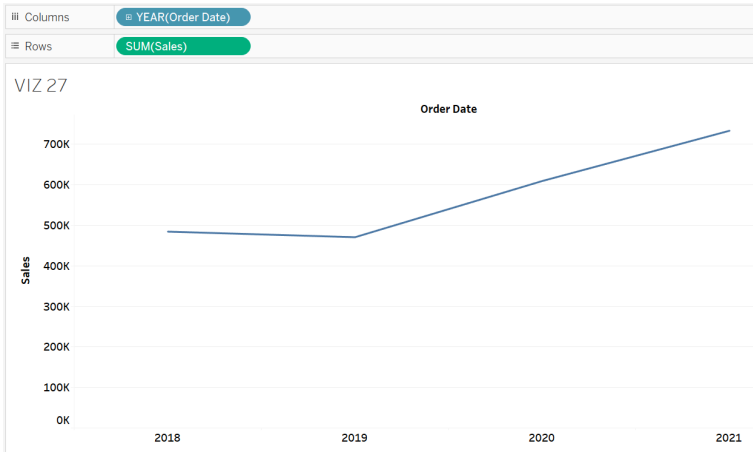
Exercise 31

Create a motion line chart to illustrate the fluctuations in total sales across different regions over various quarters and years.

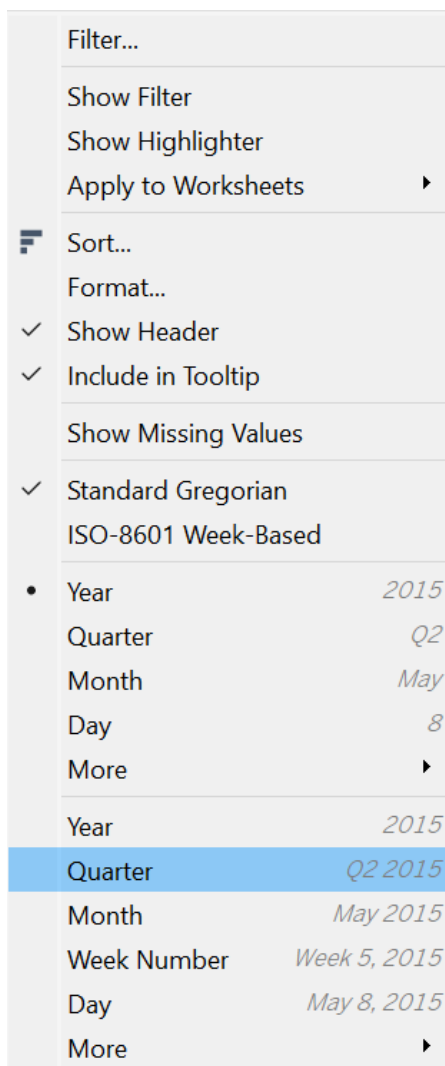
Solution – Exercise 31

Step 1: Drag and drop the **Order Date** onto the **Columns** shelf and

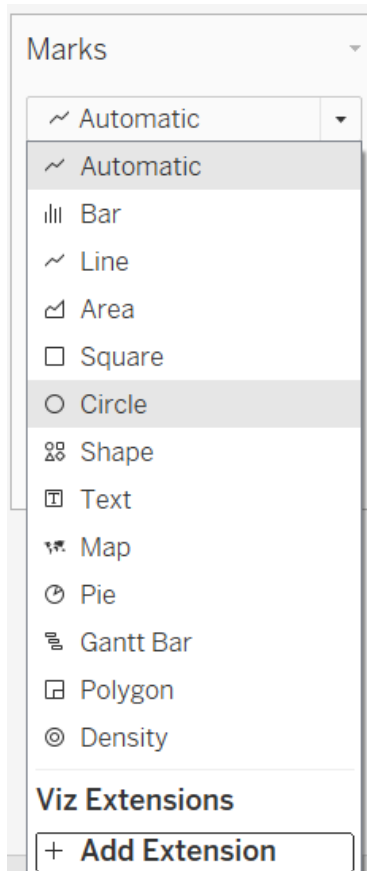
the **Sales** field onto the **Rows** shelf. Name the resulting line chart **VIZ 27**.



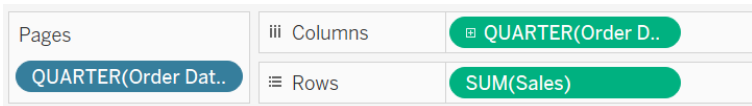
Step 2: Click the down arrow next to the **Order Date** field in the **Columns** shelf. Under the continuous date format section, choose **Quarter** to change the time frame to quarters by year.



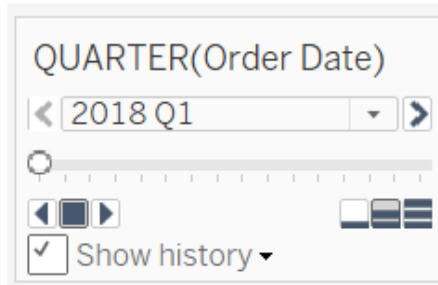
Step 3- Change the type of marks to **Circle**.



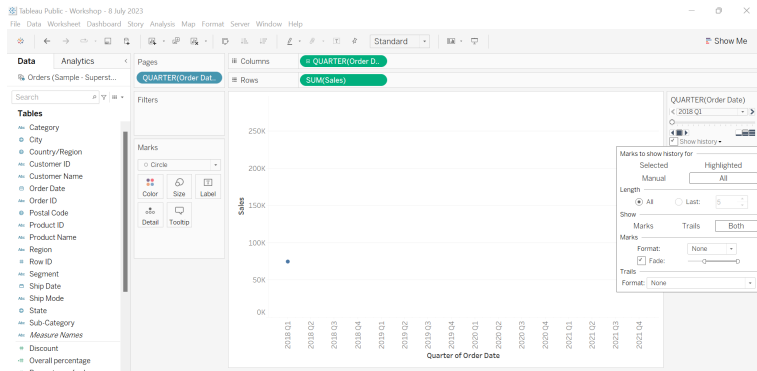
Step 4: Press and hold the **Ctrl** key, then click and drag the **QUARTER(Order Date)** field from the **Rows** shelf to the **Pages** shelf.



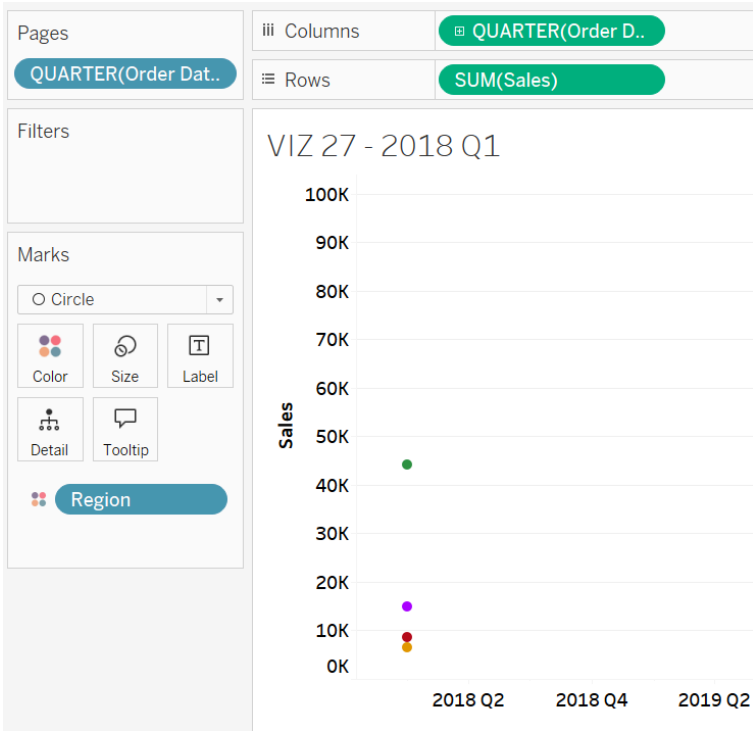
Step 5: Check the **Show History** box in the **Pages** card, appearing to the right of the worksheet.



Step 6: Click the down arrow next to **Show History**. For a standard animated chart, choose **All** under the **Marks to Show History For**, and choose **Both** in the **Show** section.

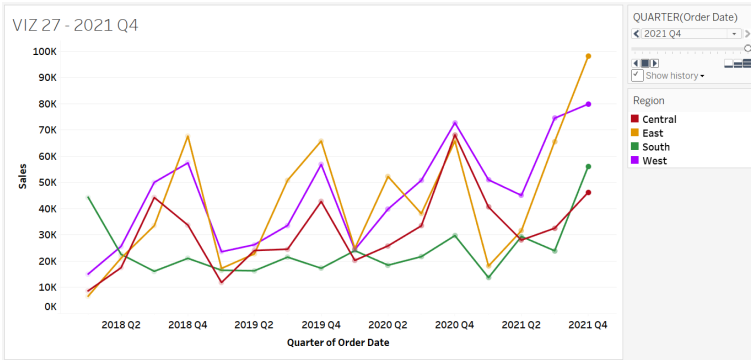


Step 7: Add the **Region** field to the **Colour Card** to display different lines for each region within the same chart.



Step 8: Click the **Play** button on the **Pages** card to observe how sales fluctuate for each region across different periods. Note that we can also control the speed of the animations using the options available on the **Pages** card.

imageSpeed control



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=247#h5p-19>



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=247#h5p-20>

Race Bar

Race bars help illustrate how multiple items, such as states, regions, or companies, perform or change over time. A race bar helps trace

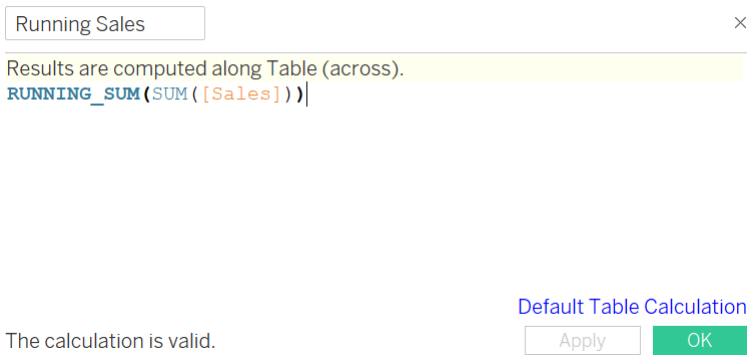
progress, evaluate growth, or detect shifts in data. In Tableau, a race bar can be created using the Pages shelf to animate changes in the data, allowing users to show how values evolve over different periods.

Exercise 32

Construct a race bar chart to display the top ten states for each quarter and year, based on total sales.

Solution – Exercise 32

Step 1: Open a new worksheet and name it **VIZ 28**. Create a calculated field for the running sales using the **RUNNING_SUM** function. Name the calculated field **Running Sales**.



Step 2: Create a calculated field using the **Rank_Unique** function to rank the running sales. Use the following expression, which incorporates the **Running Sales** field. Name the calculated field **Ranking Sales**.

Ranking Sales

×

Results are computed along Table (across).

RANK_UNIQUE ([Running Sales])

Default Table Calculation

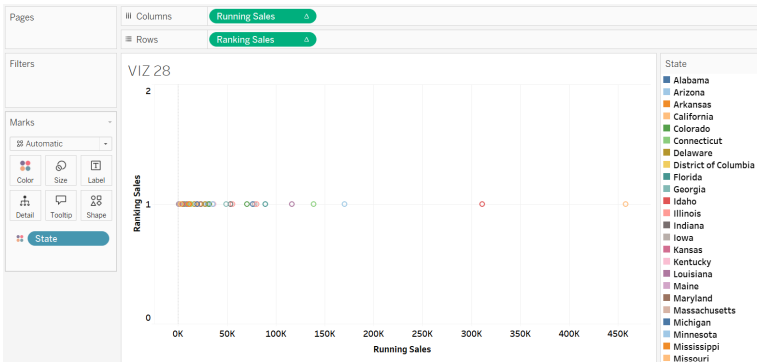
The calculation is valid.

1 Dependency ▾

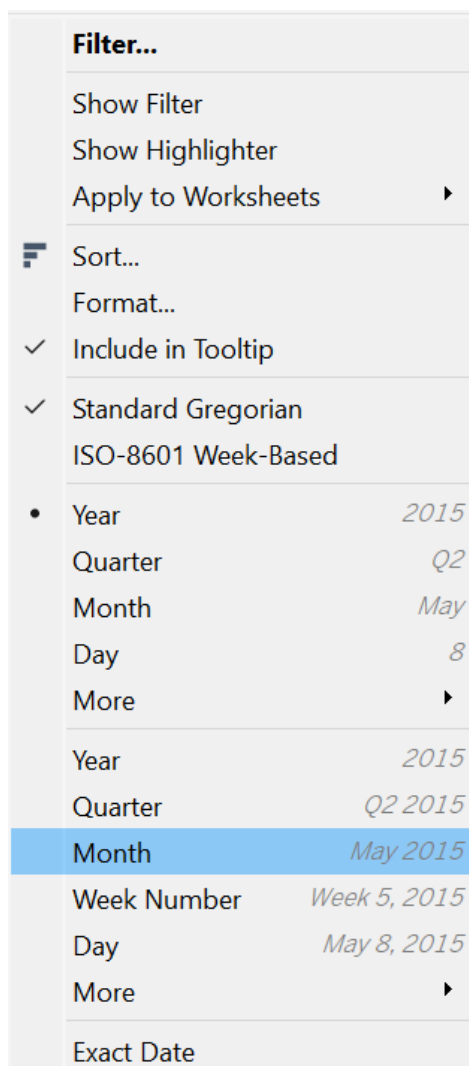
Apply

OK

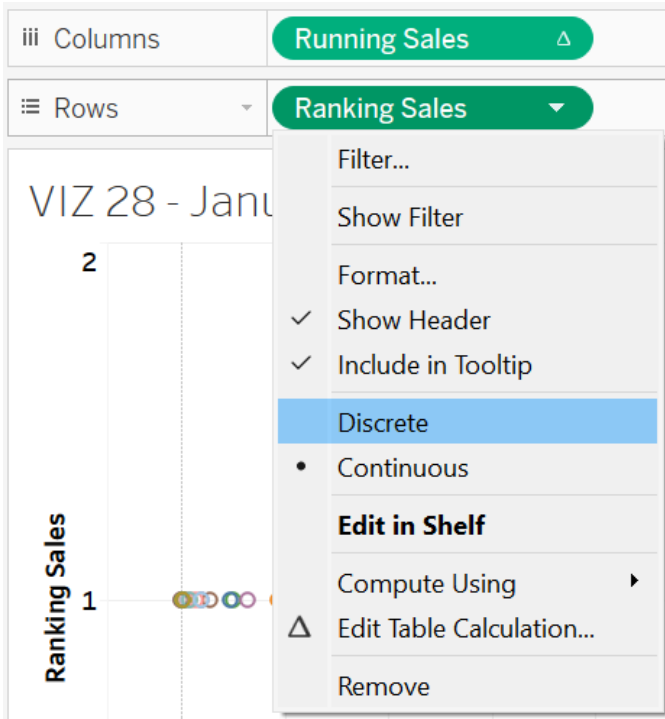
Step 3: Drag the **Sales** field onto the **Columns** shelf and the **Ranking Sales** field onto the **Rows** shelf. Add the **State** field to the **Colour Card**.



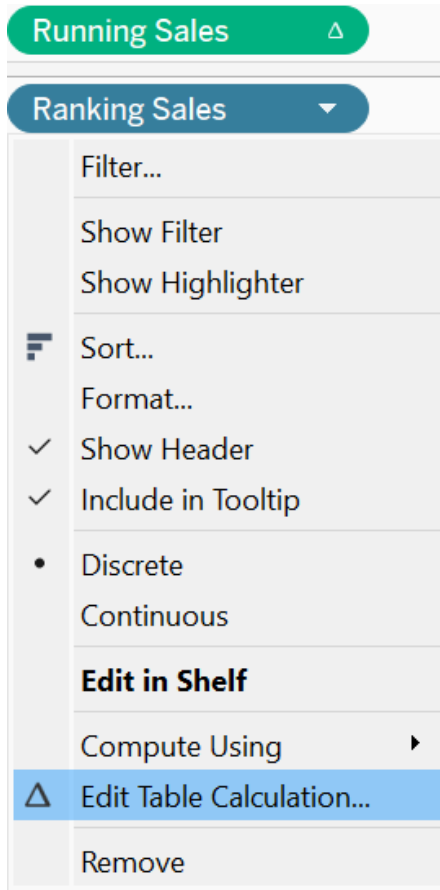
Step 4: Add the **Order Date** field to the **Pages** shelf. Click the down arrow next to the added **Order Date** and choose **Month** under the continuous date options. This allows Tableau to organize the data into separate pages by month and year.



Step 5: Click the down arrow next to the **Ranking Sales** field in the **Rows** shelf. Set the **Ranking Sales** field to **Discrete**.



Step 6: Click the down arrow next to the **Ranking Sales** field in the **Columns** shelf and choose **Edit Table Calculation**.



Step 7 – Under **Compute Using**, choose **Specific Dimensions** to select the **State** field. Then, switch the **Nested Calculations** option to **Running Sales**, and click **Specific Dimensions** to choose **Month of Order Date**. Also, make sure the **Running Sales** field on the **Columns** shelf has the same calculation setting by verifying its **Table Calculation**; it should be computed using the **Month of Order Date**. This setup ensures that Tableau calculates the ranking sales by

State for each **Month of Order Date**, with running sales computed by **Month of Order Date** for each **State**.

Table Calculation



Ranking Sales

Nested Calculations

Ranking Sales



Compute Using

Table (across)

Cell

Specific Dimensions

State

Month of Order Date

At the level



Restarting every



Show calculation assistance

Table Calculation ×
Ranking Sales

Nested Calculations

Running Sales ▾

Compute Using

Table (across)
Cell
Specific Dimensions
<input checked="" type="checkbox"/> Month of Order Date
<input type="checkbox"/> State

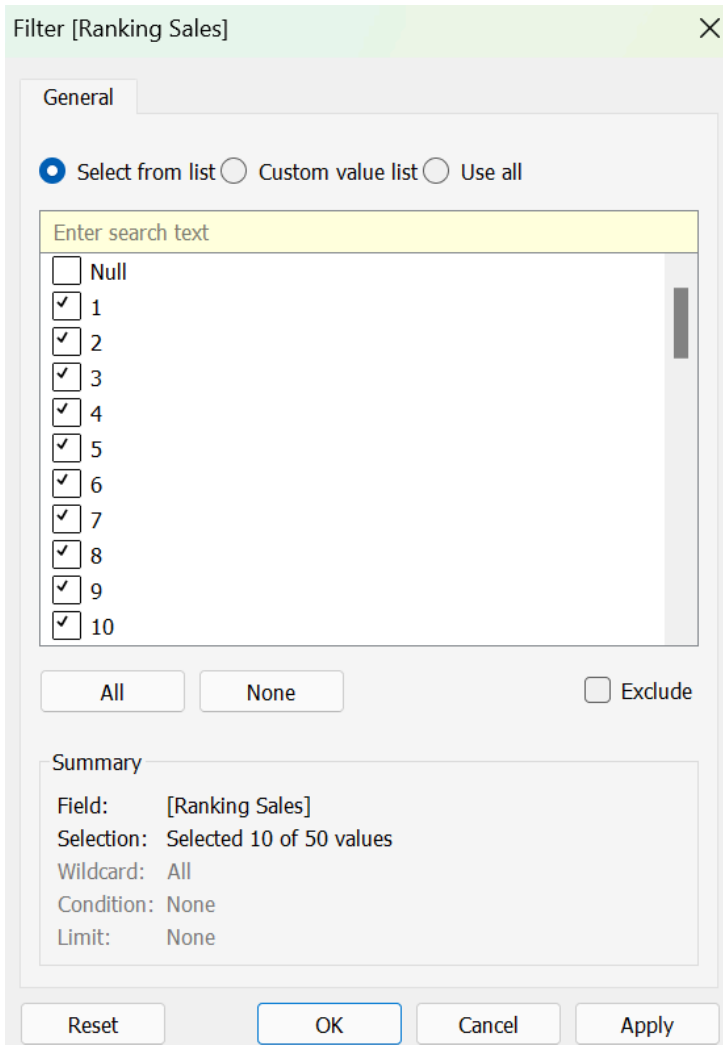
At the level ▾

Restarting every ▾

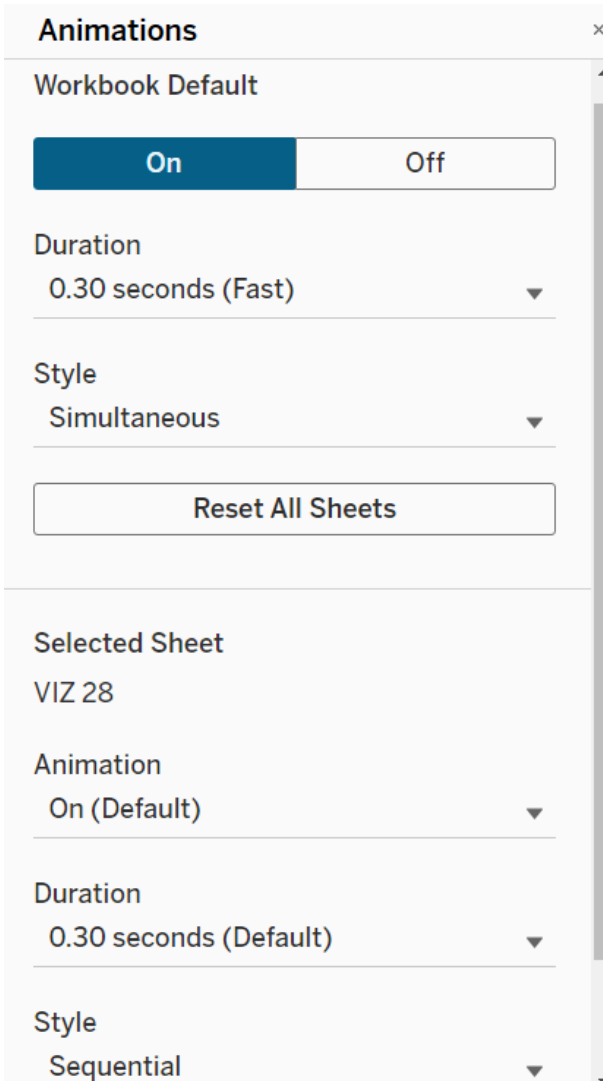
Sort order Specific Di... ▾

Show calculation assistance

Step 7: Copy the discrete **Ranking Sales** field from the **Rows** shelf and add it to the Filter shelf. To do this, hold the Ctrl button, click the **Ranking Sales** field in the **Rows** shelf, and drag it onto the **Filter** shelf. Then, edit the filter to display only the ten states with the highest running sales.

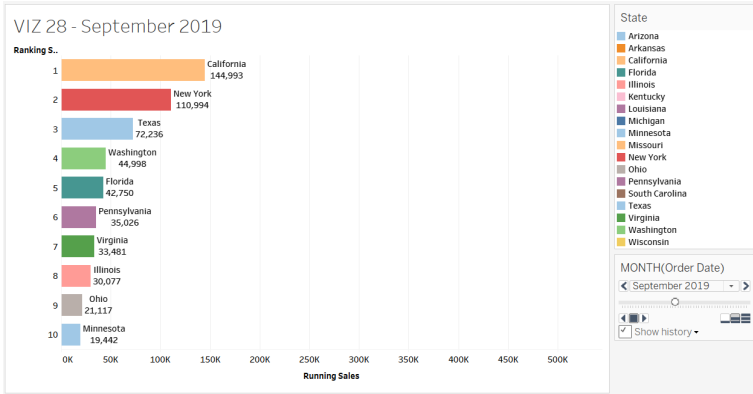


Step 8: Click **Format** on the toolbar and choose **Animations**. In the **Animations** setting, configure the Style and Duration of the animation according to your preferences.



Step 9: Add the **State** and **Running Sales** fields to the **Label Card**. For an improved animation experience, save the completed race bar

to your Tableau Public profile and press play in the Pages control card to see the transitions between bars at different time points.



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=247#h5p-21>

8. DASHBOARDS



By the end of this chapter, readers will be able to:

- Appreciate the use of dashboards
- Identify the characteristics of a good dashboard
- Build simple dashboards using Tableau

The Use of Dashboards

A dashboard combines multiple related visualizations into a cohesive view, providing a comprehensive overview of key data. It typically combines two or more visualizations to present all critical information needed for effective performance monitoring and decision-making. For instance, a faculty might create a dashboard that merges various charts encapsulating key performance indicators related to teaching, publications, research grants, innovations, community services, and more. This consolidated view helps monitor lecturers' performance and formulate strategies for improvement.

Dashboards allow users to instantaneously compare and explore different data sets within a single interface. They also uncover how changes in specific data points can influence other related areas. By offering this holistic perspective, dashboards enhance users' understanding of the data and enable more informed decision-making.





An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=266#h5p-22>

Characteristics of a Good Dashboard

A good dashboard possesses several key qualities. Here are some characteristics to consider when constructing a dashboard using Tableau:

- **Clear purpose and relevant data:** A dashboard should have a clear purpose and compile all necessary key data needed for targeted decision-making. It should focus on delivering insights that align with its intended objectives.
- **Simple design:** A dashboard with a simple design efficiently communicates key messages to users. Avoid cluttering it with unnecessary information or elements that can confuse users or make it difficult to interpret the data.
- **Consistent colour theme:** While designing a dashboard, it's important not to overuse colours. Choose a consistent colour theme that reflects the organization's branding or the dashboard's purpose. For instance, if comparing business KPIs, using the main colour from the organization's logo can enhance the dashboard's professional appearance and coherence.
- **Interactivity:** Interactivity is a crucial feature of a good dashboard. Incorporate filters or parameters to allow users to explore different aspects of the data within a single interface. This functionality enables users to perform comparisons or

conduct what-if analyses, leading to deeper insights and more informed decisions. Additionally, highlight features can draw attention to key data points during presentations.

- **Appropriate chart types:** Use the right types of charts for the data being presented. For example, use line charts to display trends and bar charts to make comparisons. Ensure that the charts are chosen to facilitate easy identification of trends, outliers, and actionable insights without requiring extensive analysis.



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=266#h5p-23>

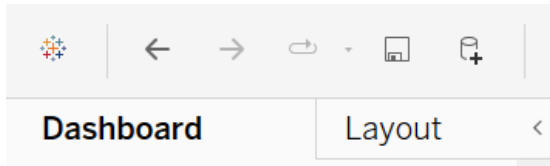
Creating Dashboards in Tableau

Users need to click the **New Dashboard** icon available at the bottom right of the worksheet to launch the dashboard workspace.

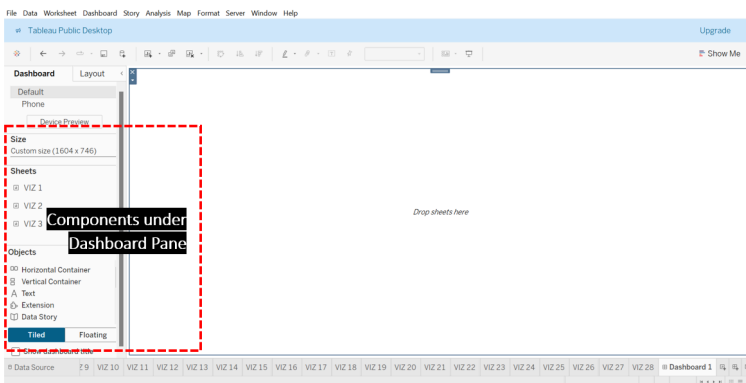


The dashboard workspace interface has some unique components compared to the standard worksheet. These components are

organized based on two primary panes namely, the **Dashboard Pane** and **Layout Pane**.



The **Dashboard Pane** features three primary sections: **Size**, **Sheets**, and **Objects**.

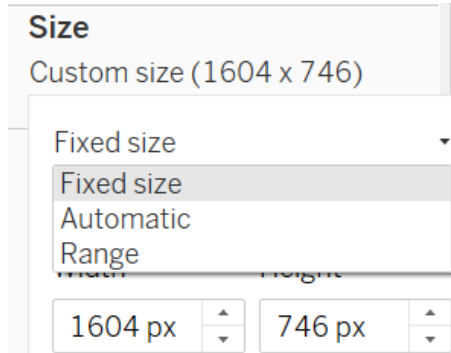


In the **Size** section, users can customize the appearance and dimensions of their dashboard on the screen. Tableau offers three sizing options: **Fixed Size**, **Automatic Size**, and **Range Size**.

- **Fixed Size:** Choose this option to set a specific, static width and height for the dashboard. The dimensions will remain constant regardless of the device or screen space.
- **Automatic Size:** This option allows the dashboard to dynamically adjust its dimensions to fit the available screen space, ensuring it optimally fills the viewer's screen. This

makes the dashboard more flexible for various screen sizes but may necessitate extra design considerations to ensure readability and usability.

- **Range Size:** With this option, users can specify a minimum and maximum size for their dashboard. The dashboard will re-size within these predefined limits according to the screen space available. This provides a balance between fixed and automatic sizing.

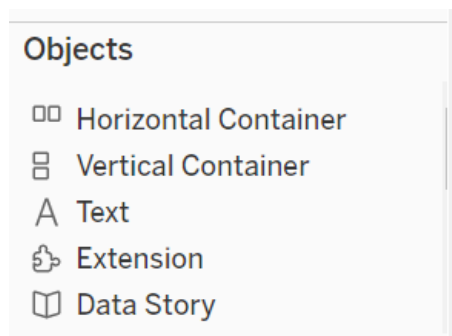


The **Sheets** section displays all individual visualizations and worksheets available within the Tableau workbook. From this section, users can drag and drop the selected visualizations onto the **View** space to design the desired dashboard.



The **Objects** section presents various items that can be added to a dashboard to enhance its functionality or provide additional information. Following is some of the items available under **Objects** and their usage:

- **Horizontal Container** and **Vertical Container** can be used to organize dashboard elements like charts and filters. These containers adjust their size to fit their contents.
- **Text** can be applied to add titles, instructions, and descriptions to the dashboard.
- **Extension** allows users to add third-party tools, custom visuals, or advanced analytics to the dashboard.
- **Blank** is used to create empty spaces between the elements on the dashboard.
- **Image** can be used to include images, such as logos or product pictures, in the dashboard.
- **Webpage** helps embed web content directly into the dashboard.
- **Navigation**: Allows users to move between different sheets in a workbook for more detailed insights.
- **Download**: Creates PDF or image files of your visualizations for documentation, presentations, or sharing.



On the other hand, the **Layout Pane** provides tools such as outer

and inner padding to help refine the alignment of elements on the dashboard. Additionally, it allows us to adjust borders and background colours for each visualization.

Exercise 33

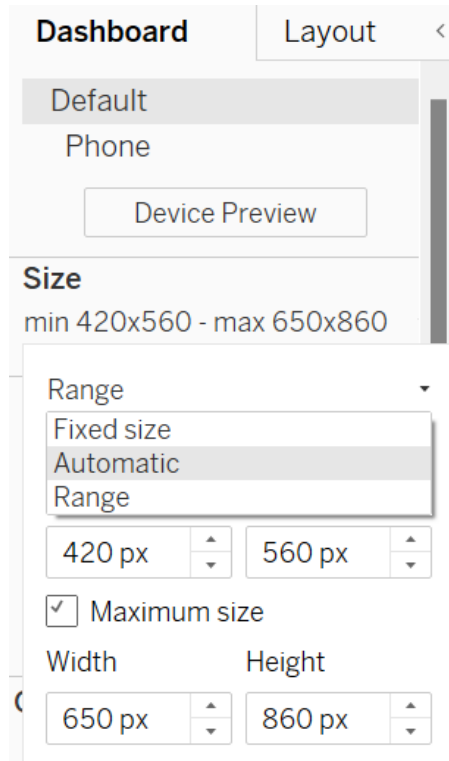
Build a simple sales dashboard combining **VIZ 19**, **VIZ 21**, and **VIZ 22**:

- **VIZ 19** is a donut chart that illustrates sales across four regions.
- **VIZ 21** is a geo map showcasing the top ten countries by sales.
- **VIZ 22** is a tree map detailing sales by category and sub-category items.

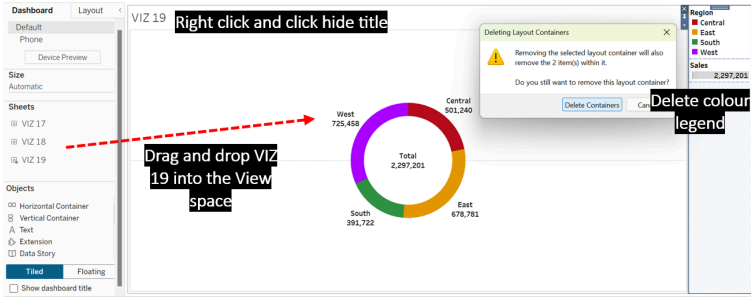
Apply automatic sizing to the dashboard and set **VIZ 19** as a filter. After clicking on the West region in the donut chart, describe the changes observed throughout the dashboard.

Solution – Exercise 33

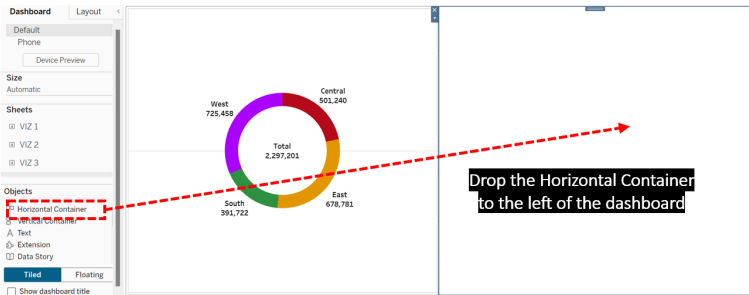
Step 1: Click the **New Dashboard** icon to open the dashboard workspace. Then, in the **Dashboard Pane**, click the drop-down menu in the **Size** section and select **Automatic**.



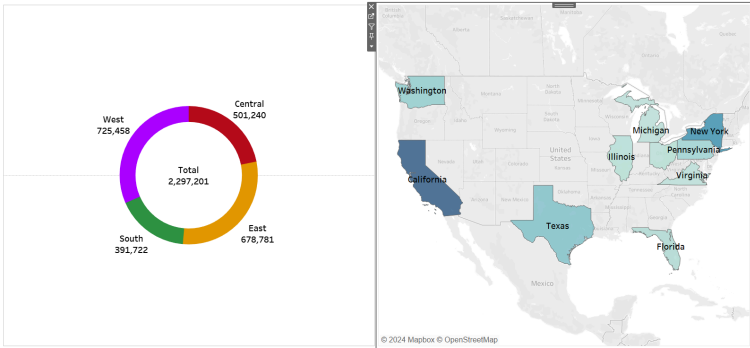
Step 2: Drag and drop **VIZ 19** from the **Sheets** section onto the **View** space. To keep the dashboard organized and uncluttered, it is advisable to remove unnecessary titles, headers, filters, and legends from each visualization. For instance, in **VIZ 19**, we can delete the colour legend and hide the title to enhance the overall clarity of the dashboard.



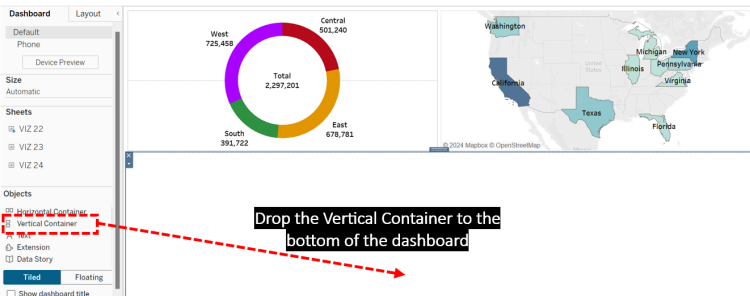
Step 3: To keep the dashboard layout more organized, place **VIZ 21** within a **Horizontal Container**. Start by dragging the **Horizontal Container** from the **Objects** section and dropping it on the left side of the dashboard.



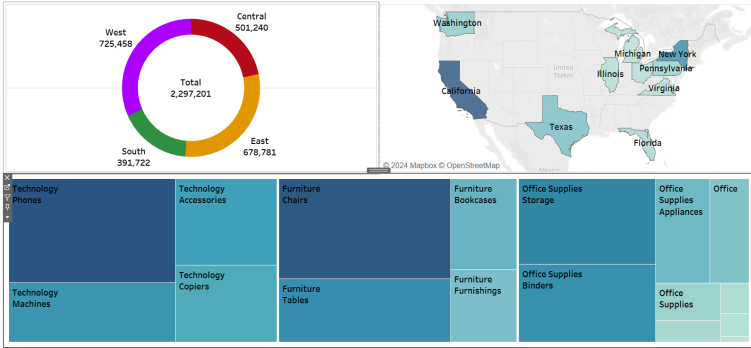
Step 4: Drag **VIZ 22** from the **Sheets** section and drop it into the **Horizontal Container**. Remove the geo map's colour legend and hide its title.



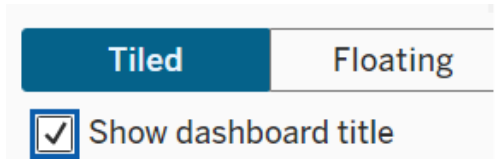
Step 5: Drag a **Vertical Container** and drop it to the bottom of the dashboard.



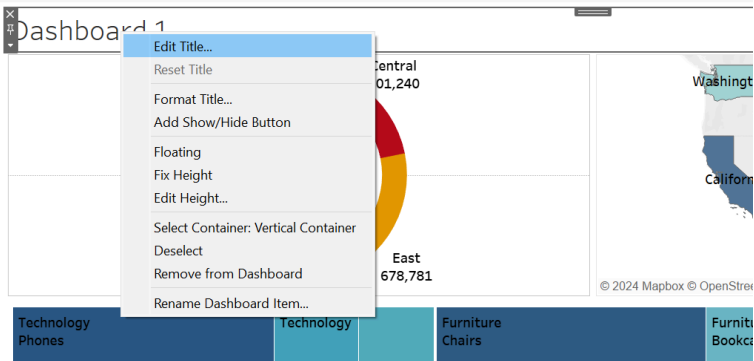
Step 6: Add **VIZ 21** to the **Vertical Container**. Hide the tree map's title and discard the colour legend.



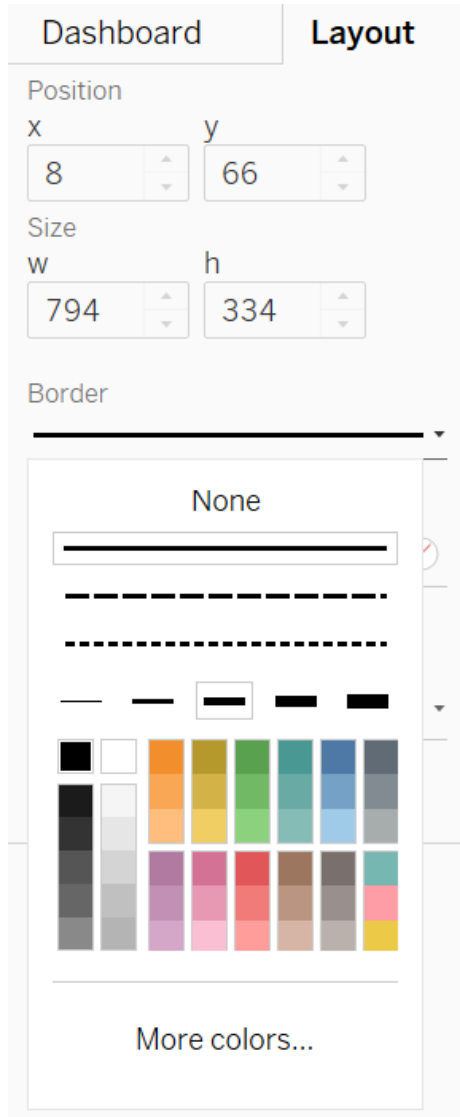
Step 7: Check the **Show Dashboard Title** box, which is located at the bottom of the **Dashboard Pane**.



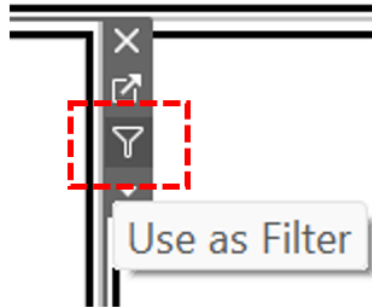
Step 8: Right-click on the default title that popped up, and choose **Edit Title** to rename the dashboard to **SALES ANALYSIS DASHBOARD**.



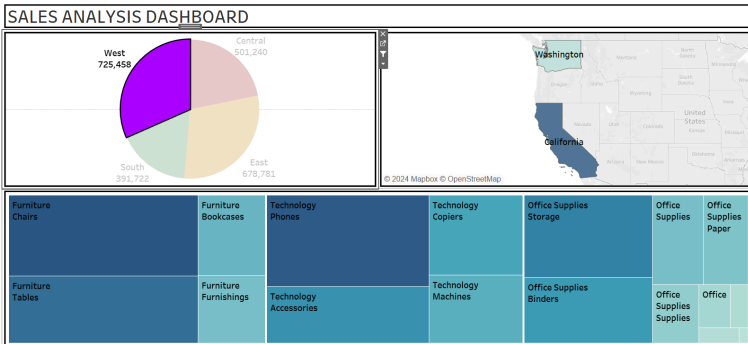
Step 9: Switch to **Layout Pane** to add a thicker black border for each element in the dashboard to make the dashboard look neater.



Step 10: To use **VIZ 19** as the filter for the whole dashboard, click **VIZ 19**, and click the funnel icon that pops up at the top corner of its container.



Step 11: Test by clicking the West region in the **VIZ 19**. It can be observed the other two charts in the dashboard respond accordingly to show data specific to that region. The geo map indicates that California and Washington are the top contributing states for sales in the West region. Meanwhile, the tree map reveals that chairs from the furniture category and phones from the technology category are the top sellers in this region.





An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://openbook.ums.edu.my/essentialsofdatavisualizationwithtableau/?p=266#h5p-24>

9. CONCLUSION: ADVANCING YOUR TABLEAU SKILLS AND NEXT STEPS

Upon completing this book, you have acquired a foundational understanding of Tableau and the core principles of data visualization. You have gained practical knowledge of essential techniques, including connecting data sources, constructing visualizations, applying filters, and designing interactive dashboards. The hands-on exercises provided throughout the book have equipped you with the skills necessary to effectively convey insights through visual means, enhancing your ability to analyze and present data in a business or research context.

However, the mastery of Tableau and data visualization is an ongoing process. To deepen your expertise and refine your skills, consider the following avenues for further study and development:

- **Engage with advanced Tableau features:** While this book focuses on introductory concepts, Tableau offers more sophisticated functionalities, including data blending, advanced calculations, and predictive analytics. To further enhance your capabilities, it is recommended that you explore these advanced features in greater depth. Developing proficiency in these areas will enable you to tackle more complex datasets and produce advanced visualizations that provide deeper insights.
- **Apply skills to real-world data:** It is crucial to continue practicing with diverse data sets, ideally from real-world scenarios. Seek out publicly available data or incorporate data from your own professional or academic projects. By working

with authentic datasets, you will not only strengthen your analytical abilities but also gain experience in addressing the unique challenges associated with real-world data.

- **Participate in the Tableau community:** Tableau's user community is an invaluable resource for ongoing learning and development. Engaging with online forums and consulting Tableau's official knowledge base and blog will provide you with access to a wealth of shared knowledge and practical advice. Staying connected to the community will help you remain informed about updates, new features, and best practices in the field.
- **Pursue Tableau certification:** For those seeking to formally validate their Tableau expertise, pursuing Tableau's professional certification exams is a highly recommended next step. Certification not only serves as formal recognition of your skills but also enhances your professional credentials, positioning you as a qualified expert in the field of data visualization and business intelligence.

The knowledge and skills you have developed through this book represent a strong foundation in data visualization. However, true mastery comes with continued practice, exploration, and application of these techniques in various contexts. By pursuing further learning and engaging with the broader data community, you will enhance your ability to extract meaningful insights from data and contribute to informed, data-driven decision-making.

Glossary

Aggregation

The process of summarizing data, typically using operators like SUM, AVG, COUNT, etc., to synthesize values into a single result.

Calculated Field

A user-defined field that is derived from other fields using formulas or expressions.

Colour Card

A component in the marks shelf that allows users to assign colours to data points based on dimensions or measures.

Dashboard

A collection of visualizations, filters, and other components displayed on a single view for interactive data comparisons.

Data Connection

The linkage between Tableau and a data source that enables users to access and visualize data.

Detail Card

A component in the marks shelf where users can add dimensions or measures to increase the granularity of a visualization, resulting in more marks being displayed.

Dimension Fields

Dimensions are fields that encompass categorical or qualitative data types, such as strings, dates, Boolean values, and geographic information.

Filters

Tools that allow users to slice or control the data displayed in visualizations based on specific criteria.

Group

A way to merge related dimension members into a single entity for simplified analysis.

Hierarchical Field

A structured arrangement of fields in a parent-child relationship,

allowing users to drill down or roll up data across different levels (e.g., Year > Quarter > Month).

Label Card

A component in the marks shelf that enables users to display text labels on the data points within a visualization.

Marks Shelf

A section in the Tableau worksheet where users can customize how data points (marks) are displayed in a visualization. It allows users to customize the visual properties of marks.

Measure Fields

Fields that contain numeric or quantitative values are referred to as measures.

Parameter

A dynamic value that can replace a constant in calculations or filters, enabling interactive data exploration.

Sets

Sets are custom groups of data points based on specific criteria.

Size Card

A component in the marks shelf that permits users to adjust the size of marks in a visualization based on a measure.

Tooltip

A pop-up text box that appears when hovering over a data point, providing additional information.

Visualization

A graphical depiction of data, such as a chart, graph, or map, developed to summarize raw data and convey insights.

Workbook

A workbook is a Tableau file that contains one or more worksheets, dashboards, and stories.

Worksheet

A worksheet is a single sheet within the workbook where you create specific visualizations.

AUTHOR AND CONTRIBUTORS

Author

Anath Rau Krishnan
UMS

Reviewers

Dr Mohammad Fadhli Asli, PhD
FAKULTI KOMPUTERAN & INFORMATIK, UNIVERSITI MALAYSIA
SABAH

Information Visualization

Prof. Madya Ts. Dr. Farhan Mohamed, PhD
FACULTY OF COMPUTING, UNIVERSITI TEKNOLOGI MALAYSIA

Data Visualization