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## Chapter 09 Introduction to Spreadsheets

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## CHAPTER CONTENTS

<b>Overview</b>	<b>170</b>
<b>What is a Spreadsheet?</b>	<b>171</b>
Managing Spreadsheets	173
Menu Options	174
Entering Cell Data	175
Row and Column Titles	177
Formatting Cells and Worksheets	177
Styles	179
Themes	179
Merging and Splitting Cells	180
Hide and Unhide Columns and Rows	181
Page Layout Options	182
Formulas and Functions	183
Charts and Images	184
Benefits of Charts	185
Images	186
Share and Collaborate	186
<b>Analyzing and Organizing Data</b>	<b>187</b>
Filters	187
Sorting	188
Conditional Formatting	189
Pivot Tables	190
Additional Resources	190
<b>Chapter Terms and Definitions</b>	<b>191</b>
<b>Chapter Case: Sports Tracking Spreadsheet</b>	<b>192</b>

*Data visualization transforms data into powerful visualizations and provides tactical, operational, and strategic insights. No longer merely a spreadsheet, business intelligence visualizations can be used for everything from providing analysis of cybersecurity patterns, to managing workplace efficiency for global companies.*

—Jason Beres, Sr. VP of Developer Tools at Infragistics

## Overview

**Spreadsheets** are electronic documents that help users to manipulate **data**. While word processors and email are probably the most used productivity applications, much of the world's business runs on spreadsheets. This is because spreadsheets are productivity applications designed to store numbers. Spreadsheets make it easy to visualize data and identify trends in that data. Any teacher tracking student grades will find it easiest to do so using spreadsheets. Student clubs will find it easiest to track contributions and expenses if they use spreadsheets. You may not use spreadsheets every day of your life, but your most valuable information is likely to be stored on spreadsheets.

For precisely this reason, spreadsheets were the killer app for computers in business. Just as email encouraged consumers to buy computers and get Internet connectivity, spreadsheets made it worthwhile for businesses to buy computers to track how they were doing. Steve Jobs credits the first spreadsheet program, VisiCalc, as being the driver for early Apple sales.

Dan Bricklin came up with the idea of a visual calculator in 1978 while doing his MBA at Harvard.<sup>123</sup> He initially visualized the user interface of spreadsheets as the cockpit display in aircraft but settled on the current **row-column** format to enable human-friendly names to be applied to data elements. Dan first called his program “Calcu-ledger” but eventually changed it to VisiCalc for Visual Calculator. Dan's business partner, Dan Fylstra, also an MBA from Harvard, and one of the earliest software publishers, demonstrated the VisiCalc program to Steve Jobs.<sup>124</sup> Almost a million copies of VisiCalc were sold at about \$100 each, driving sales for Apple, as well as the adoption of computers in business. Subsequently, Mitch Kapor and Jonathan Sachs created Lotus 1-2-3,<sup>125</sup> which was bought by IBM, and Microsoft came out with Excel. VisiCalc eventually lost its lead in the market.

Of all the applications and technologies discussed in this book, the ability to use spreadsheets productively is perhaps the most marketable skill. No one will hire you strictly because you can write emails or documents. But there is a good chance your expertise in spreadsheets may make you extremely valuable for some organizations.

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123 See Dan's website for his own detailed account of how he came up with the idea of a spreadsheet, <http://www.bricklin.com/> and <http://www.bricklin.com/history/saiidea.htm> for the initial idea (accessed June 2023).

124 Steve Jobs' recollection of the story, “The History of Spreadsheets, from VisiCalc to Causal & beyond,” <https://callmefred.com/the-history-of-spreadsheets/> (accessed June 2023).

125 Computer History Museum profile of Mitch Kapor, creator of Lotus 1-2-3, <https://computerhistory.org/profile/mitchell-kapor/> (accessed June 2023).

## What is a Spreadsheet?

A spreadsheet is a computer program that represents information in rows and columns and makes it easy to perform calculations with the data.<sup>126</sup> In a typical spreadsheet, each column represents a different category of data and each row represents a record. For example, a spreadsheet for a sports club membership would have one row per student, and one column each for data such as first name, last name, sport of preference, email address, phone number, etc.

Spreadsheets are further divided into **cells**, organized in rows and columns. Rows are numbered and columns are named by alphabets, so any unique cell is defined by its row number and column letter. For example, in [Figure 100](#), the cell outlined in white is B6, which indicates column B and row 6. The column letter always comes first in a cell reference.

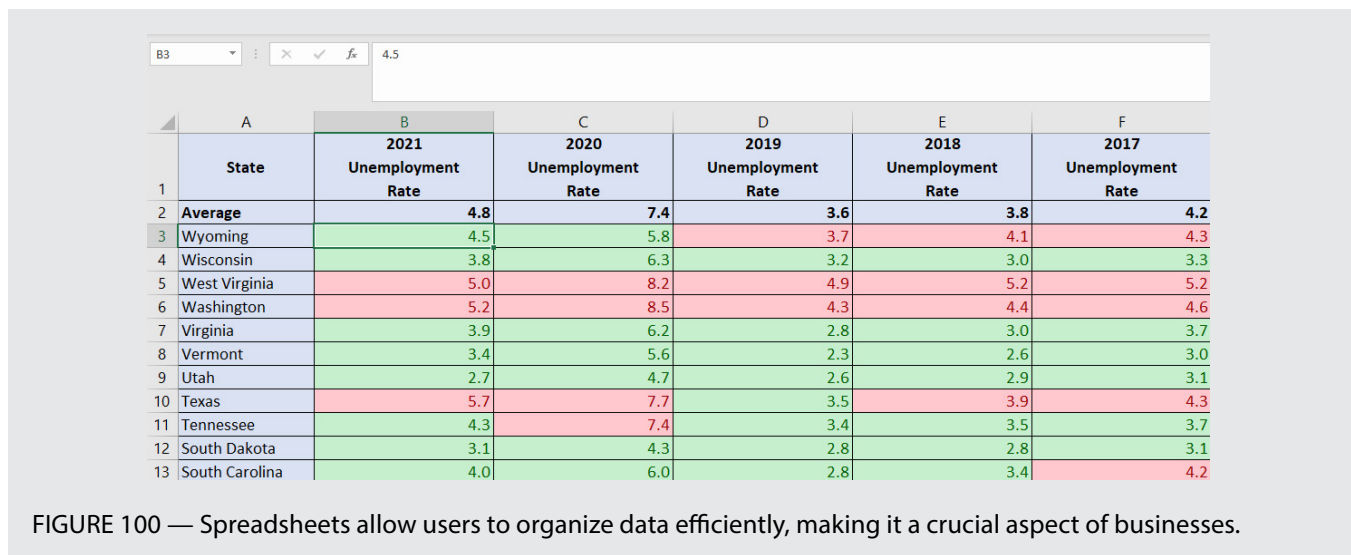


FIGURE 100 — Spreadsheets allow users to organize data efficiently, making it a crucial aspect of businesses.

Spreadsheets are the workhorses in business for a wide range of tasks, such as budgeting, financial forecasting, and data analysis. Spreadsheets include built-in **formulas** for all the data processing tasks common in business. For example, the formula  $\text{PMT}(0.05/12, 60, 3000)$  will calculate the monthly payment for a car costing \$3,000 to be paid off in 5 years (60 months) at an annual interest rate of 5% (monthly interest rate of  $5\%/12$ ).<sup>127</sup>

When working with data, spreadsheets have capabilities that make them far more powerful compared to tables in word processing documents. Whereas word processor tables require you to do manual calculations on cells of data, spreadsheets allow you to type in a formula to process data from other parts of the same spreadsheet or even other spreadsheets. An added advantage of spreadsheets is that the results of the formulas will change automatically if any of the input data changes.

Let's check out a couple of example spreadsheets. Say you are a real estate investor renting out multiple properties. To help you focus on your customers and properties instead of your financials, you can create a spreadsheet and enter your rental income and maintenance expenses, using formulas

126 Spreadsheet definition, adapted from <https://www.britannica.com/technology/spreadsheet> (accessed June 2023).

127 The payment will be \$56.61 per month, for a total payment of \$3,396.82. In other words, the spreadsheet calculation shows that the buyer will pay almost \$400 in interest as the cost of the car loan.

to have the spreadsheet automatically calculate the profit/loss from each property as well as the overall profit/loss of your company. The spreadsheet will also easily highlight any unusual expenses or revenues (Figure 101).

	A	B	C
1	Property Name	Condo	House
2			
3	Annual Rental Income	\$5,000.00	\$10,000.00
4			
5	Expense Categories		
6	Advertising	\$0.00	\$120.00
7	Auto and Travel	\$0.00	\$0.00
8	Cleaning & Maintenance	\$50.00	\$100.00
9	Insurance	\$1,000.00	\$3,000.00
10			
11	Total Expenses	\$1,050.00	\$3,220.00
12			
13	Total Profit/ Loss	\$3,950.00	\$6,780.00

FIGURE 101 — Spreadsheets can benefit a wide range of industries and be customized depending on user needs.

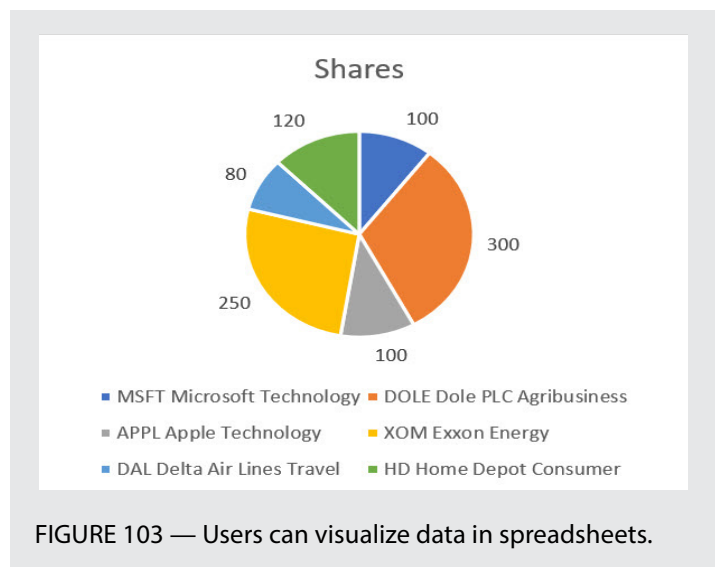
As another common example, say you are a stock market investor. You can track your portfolios by entering the names of companies in your portfolio, the number of shares in each company, the purchase price of each share, and today’s market price. Formulas in your spreadsheet can calculate your profile/loss for each group of shares, the total profit/loss, and the percent weight of each stock by purchase price and by the current market price. This can help you identify winners and losers in your portfolio and manage your investments accordingly. Figure 102 shows an example adapted from a popular investment management spreadsheet (DR 179).<sup>128</sup>

G	H	I	J	K	L
Ticker	Name	Category	Shares	Price	Value
MSFT	Microsoft	Technology	100	\$308.02	\$30,802.00
DOLE	Dole PLC	Agribusiness	300	\$12.11	\$3,633.00
APPL	Apple	Technology	100	\$172.23	\$17,223.00
XOM	Exxon	Energy	250	\$109.40	\$27,350.00
DAL	Delta Air Li	Travel	80	\$34.14	\$2,731.20
HD	Home Dep	Consumer	120	\$289.14	\$34,696.80

FIGURE 102 — Users can track investments using spreadsheets.

128 DR 179 refers to episode 179 of the Dough Roller podcast. The spreadsheet was introduced by the podcast host, Rob Berger, on his podcast in May 2015, <https://www.doughroller.net/podcast/> (accessed June 2023).

In addition to convenient formulas, spreadsheets also offer a variety of visualization tools like [charts](#) and graphs that can be used to represent and analyze data in intuitive and user-friendly ways. Additionally, just like word processing software, spreadsheets also support collaboration and sharing to allow multiple users to work simultaneously on the same spreadsheet. [Figure 103](#) shows the portfolio distribution (column J) of the spreadsheet in [Figure 102](#) as a pie chart. Appropriate visualizations can help users get a sense of the data.



## Managing Spreadsheets

Managing spreadsheets is much like managing word processing documents. To create a new spreadsheet using Google Sheets, go to [sheets.google.com](https://sheets.google.com) and click on “Blank” to open a new sheet. To open an existing worksheet, you click on the sheet among your files. Once you have a spreadsheet open, you could also create a new one by using the “File” → “New” → “Spreadsheet” menu option. You can save any open worksheet the same way you save any electronic document, by clicking on the “File” menu and then selecting “Save.” If you would like to change the name of the spreadsheet while saving, give the saved spreadsheet the preferred name and choose where you want to save it in your Google Drive.

You can share the spreadsheet with colleagues by clicking on the “Share” button and entering the email addresses of your colleagues. This will allow your colleagues and friends to access and edit the spreadsheet from their own Google accounts.

Spreadsheets typically provide templates for common tasks like managing a monthly budget, a team roster, or weekly time sheets. These templates have a predefined look and feel and appropriate formulas. Generally, these templates are available from the “File” → “New” dialog as a “Template Gallery.” [Figure 104](#) shows the user interface for Google Sheets (top) and Microsoft Excel (bottom).

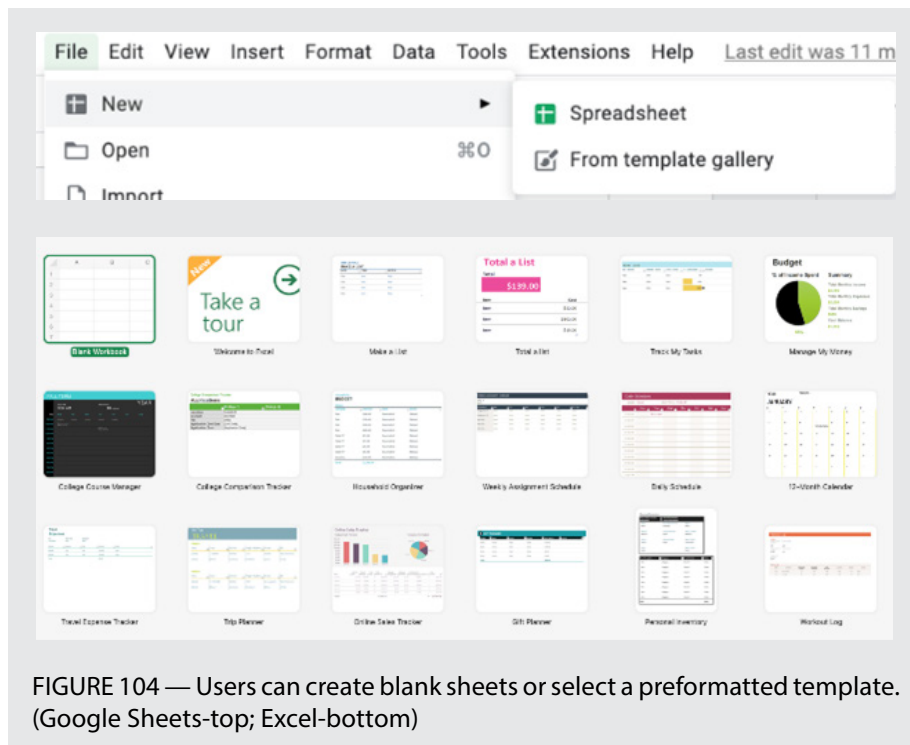


FIGURE 104 — Users can create blank sheets or select a preformatted template. (Google Sheets-top; Excel-bottom)

## Menu Options

Both Excel and Google Sheets provide many menu options to simplify complex operations to organize and manage data and generate output. For example, Google Sheets has a standard toolbar to format cell contents, including font size, currency signs, indentation, and background color. The “File” menu in Google Sheets is used to perform file management operations, like creating new files or opening existing files (Figure 105).

The “Edit” menu in Google Sheets is used to copy, paste, and find and replace. “View,” as the name suggests, is used to manage the visible content on the screen. “Insert” has options to insert rows, cells, columns, charts, pivot tables, images, and drawings in documents. A

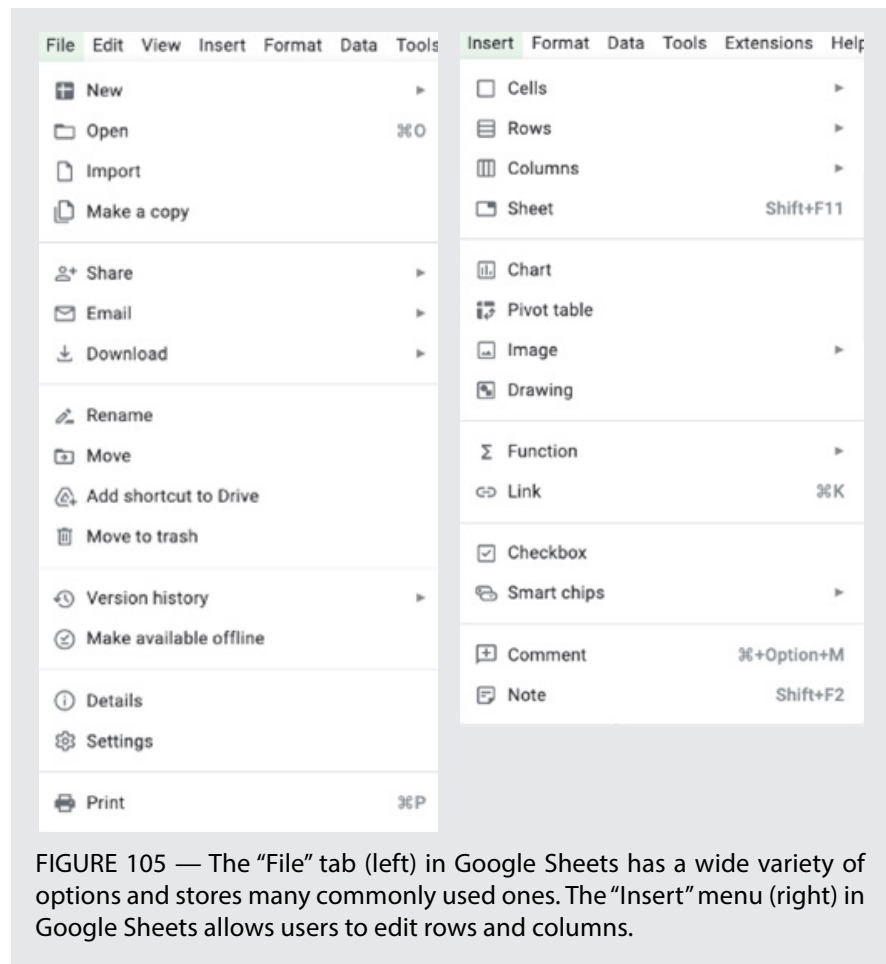


FIGURE 105 — The “File” tab (left) in Google Sheets has a wide variety of options and stores many commonly used ones. The “Insert” menu (right) in Google Sheets allows users to edit rows and columns.

common use of the insert menu is to insert charts. If you go to the “Data” menu in Google Sheets, you can sort and **filter** data, set up data validation, cleanup, and perform other operations with the data in the spreadsheet.

As in Google Sheets, Microsoft Excel is feature-rich, allowing you to manipulate data in complex ways (Figure 106). The “Insert” tab is also used in Excel to insert images, charts, rows, columns, shapes, and pivot tables.

The “Formula” tab in Excel has many predefined formulas that you can use to perform mathematical, financial, and other calculations. You can use the features under the “Data” tab in Excel to import data, sort and filter data, remove duplicate values, and set up data validation rules. Under the “View” tab, you have options to change the grid layout and freeze different sections of the document. If your document has macros (programs to automate spreadsheet tasks), you can view your macros from the view menu, and also record new macros.

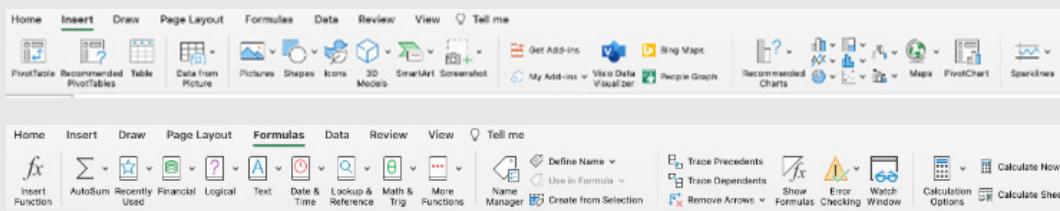


FIGURE 106 — In Excel the “Insert” tab (top) displays many features for editing the spreadsheet and adding elements, while the “Formula” tab (bottom) helps users perform calculation.

## Entering Cell Data

While word processing documents are freeform, spreadsheets are structured and divided into cells. Once you click on a cell, the text you type will stay within the boundaries of that cell.

Spreadsheets are smart and do their best to understand what you are entering and give appropriate suggestions. One nifty feature that helps you copy data or generate a series is called autofill. Autofill is the ability of spreadsheets to extend a data series (e.g., numbers, dates, or text) to neighboring cells. Autofill is accessed from the autofill handle. If you click on a cell, you will see a tiny square box in the lower right corner. This is the autofill handle. If you put your mouse on the autofill handle, the mouse pointer will turn into a cross sign indicating that it is ready to autofill. You can drag the cross sign to autofill data in neighboring cells.

Custom category	\$32	\$0	-\$32
-----------------	------	-----	-------

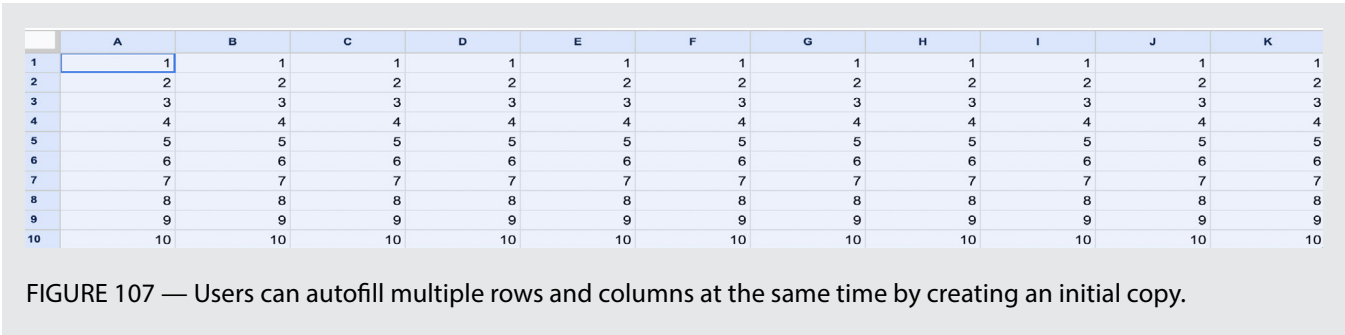
The autofill handle in a highlighted cell is located in the bottom right corner.

Custom category	\$32	\$0	-\$32
	\$32		
	\$32		
	\$32		
	\$32		
	\$32		
	\$32		

Users can drag the autofill handle to other cells to populate data.



The autofill concept works across rows too. You can even autofill series across rows and columns at the same time (Figure 107). To create an initial series, just enter the first few numbers of the series, select the cells, then drag the autofill handle to extend the series.

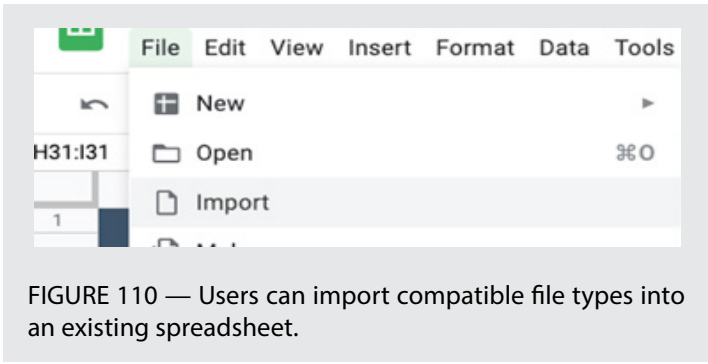
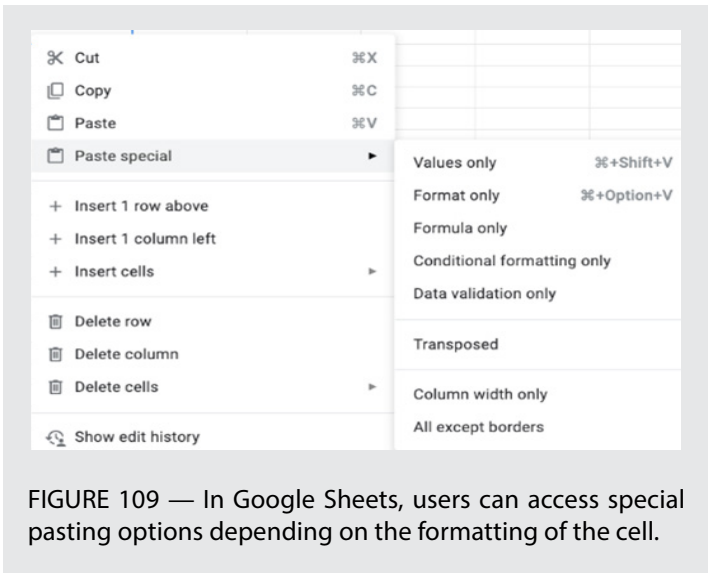
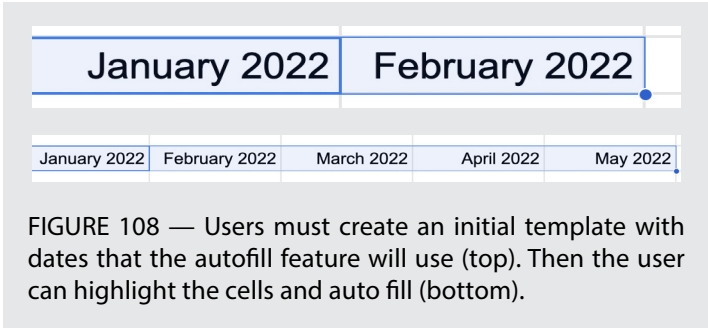


Autofill can also help you enter a series of dates (Figure 108).

Copy/Paste is another great way to enter data in spreadsheets. You can copy from any location on the web, another spreadsheet, or another section of the same spreadsheet and paste the data into your spreadsheet. When you paste data into a spreadsheet, the software will convert the data appropriately into cells and rows. If you copy data from another spreadsheet, just highlight the cells to copy and right-click to bring up the context-sensitive menu. You can then either cut or copy the selected data and paste it into the desired location in your spreadsheet.

When you paste data in a spreadsheet, you have the option to paste just the data values or bring along the associated formulas, references, and formatting from the source spreadsheet. To take advantage of the various pasting options, right-click on your spreadsheet and choose “Paste Special” (Figure 109).

If your data is in the CSV format, you can import it into spreadsheets by choosing the import option, generally accessed from “File” → “Import” (Figure 110). Excel offers a dedicated “From Text/CSV” button in the “Data” tab to import CSV. The spreadsheet software will let you select any existing data source and then walk you through a step-by-step import process. Data import is useful when you collect data from different sources



to create your own unified spreadsheet. For example, to create a spreadsheet to plan club meetings, you may import club member names from your membership directory and import meeting locations from the county's parks listing.

## Row and Column Titles

Row and column titles, also known as labels, are the names/headers that appear at the beginning of each column/row in a spreadsheet. These labels are very useful and you should be deliberate about their values. Not only do labels make spreadsheets easy to understand, but they are also used to identify and describe the rows and columns of data in charts, tables, and other outputs. For example, in a spreadsheet containing sales data, the column titles might be different time periods, such as "Month," "Year," or "Region," or categories, such as "Sales," "Profit," or "Cost."

<b>Expenses</b>			
	<b>Planned</b>	<b>Actual</b>	<b>Diff</b>
<i>Totals</i>	\$950.00	\$1,000.00	-\$50.00
Food			
Gifts			
Health/Medical			
Home	\$950.00	\$1,000.00	-\$50.00
Transportation			
Personal			

FIGURE 111 — When creating labels, users should be concise and clear to ensure values are properly represented and the spreadsheet is easy to understand.

The table in [Figure 111](#) shows Planned and Actual expenses and the column titles are Planned, Actual, and Diff. The items for which the cost is tracked, such as Food, Gifts, and Health/medical, are the row titles. Column titles are used in conjunction with row titles to provide a complete picture of the data in a spreadsheet. Titles can be especially useful when working with complex data sets to help readers make sense of the information.

## Formatting Cells and Worksheets

To make data easy to comprehend, spreadsheet software provides extensive formatting options. As spreadsheets grow large, these formatting options become increasingly critical to understand the data. [Figure 112](#) shows some data without formatting. Even though it is a very simple spreadsheet, it is difficult to understand what the data says without any formatting.

Expenses	Planned	Actual	Diff
Totals			0
Food	0	0	0
Gifts	0	0	0
Health/medical	0	0	0
Home	950	1000	-50
Transportation	0	0	0
Pets	0	0	0
Utilities	0	0	0
Travel	0	0	0
Debt	0	0	0
Other	0	0	0
Custom category 1	0	0	0
Custom category 2	0	0	0
Custom category 3	0	0	0

FIGURE 112 — While the data is understandable, formatting helps improve clarity and usability.

Expenses				
	Planned	Actual	Diff	
Totals	\$950.00	\$1,000.00	-\$50.00	
Food	\$0.00	\$0.00	\$0.00	
Gifts	\$0.00	\$0.00	\$0.00	
Health/Medical	\$0.00	\$0.00	\$0.00	
Home	\$950.00	\$1,000.00	-\$50.00	
Transportation	\$0.00	\$0.00	\$0.00	
Personal	\$0.00	\$0.00	\$0.00	
Pets	\$0.00	\$0.00	\$0.00	
Utility	\$0.00	\$0.00	\$0.00	
Travel	\$0.00	\$0.00	\$0.00	
Debt	\$0.00	\$0.00	\$0.00	
Other	\$0.00	\$0.00	\$0.00	
Customer Category 1	\$0.00	\$0.00	\$0.00	
Customer Category 2	\$0.00	\$0.00	\$0.00	
Customer Category 3	\$0.00	\$0.00	\$0.00	

FIGURE 113 — When data in a spreadsheet application is formatted, it becomes easy to identify the key features.

Now let's use some formatting options and update the same table by adjusting the font size, text color, background color, and header elements. You can also include currency symbols and comma separators and have the negative numbers show up in a different color. Suddenly, the same data set not only looks pretty but also becomes easier to digest (Figure 113).

To format cells in Google Sheets, select the cells you want to format and choose the "Format" menu option. If your cells have numbers, you can choose the "Number" option and select any one of the available formatting options for numeric, financial, and date values. You can also set the font size, alignment, and how data should wrap in a cell.

In Microsoft Excel, you can select the cells you want to format, right-click to open the context menu, and select the "Format Cells" menu option. A window opens where you can specify several formatting options including number display and the look and feel of the cells—alignment, font, border, or fill (Figure 114).

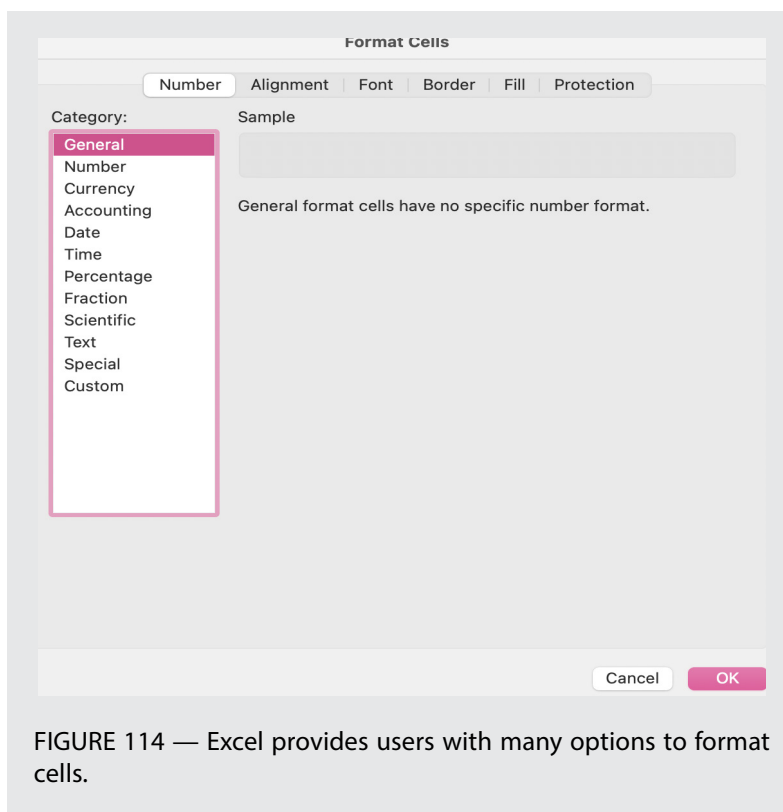


FIGURE 114 — Excel provides users with many options to format cells.

## Styles

Just as in word processing software, styles in spreadsheets are a collection of predefined formats that give your document a consistent look and feel. If you want all your numbers to have a currency symbol, two decimal places of accuracy, and appear in red if negative, you could apply the formatting features one at a time, which might turn out to be cumbersome and error-prone. Alternatively, if you are using Excel, you could pick an existing “Cell/Table” style from the “Styles” group under the “Home” tab and apply the selected style to cells and tables (Figure 115).

If the existing styles don’t meet your needs, you can create a new style by clicking on “New Cell Style” or “New Table Style” (Figure 116). Once you format the new style by opening the formatting window and selecting all the features you want, you can give the style a new name and reuse the style to format any cell or table in your sheet.

If you like the formatting of a cell and want to copy it, click on that cell, then go to the styles dropdown and select “New Cell Style” (Figure 117). All the styling features of the cell are preselected for you. Just give the style a name and use it wherever you want unless it is copyrighted material.

## Themes

Spreadsheets offer themes to let you have a consistent look and feel with respect to the choice of colors, fonts, cell borders, and background colors. Changing a spreadsheet’s theme will change the fonts, colors, and effects across the entire spreadsheet. In Excel,

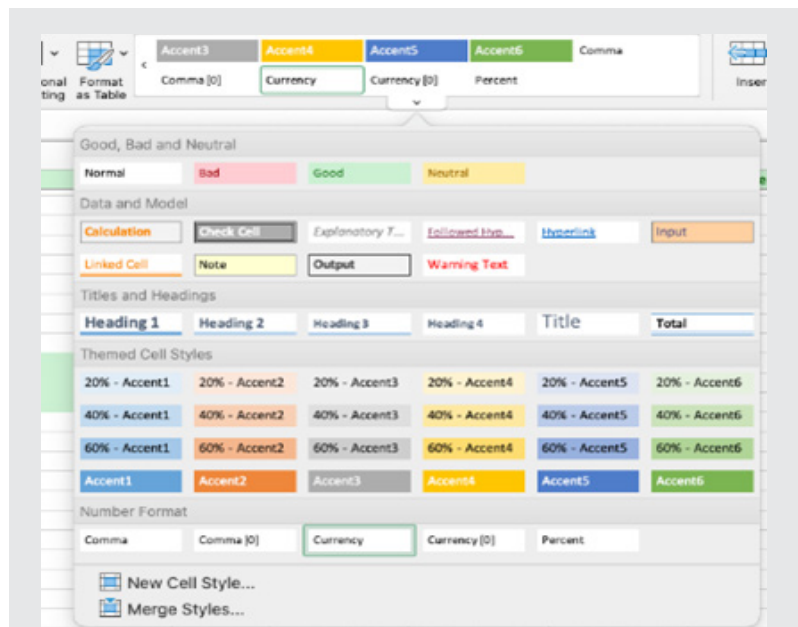


FIGURE 115 — Excel offers a wide variety of cell styles.

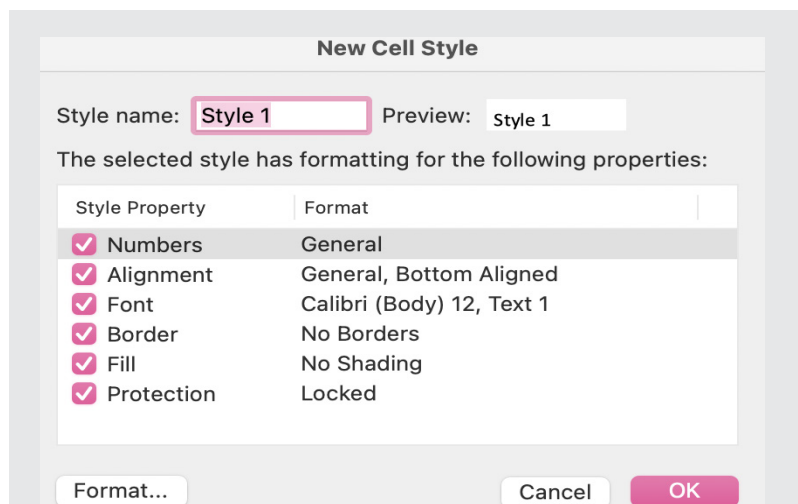


FIGURE 116 — Users can create their own cell styles.

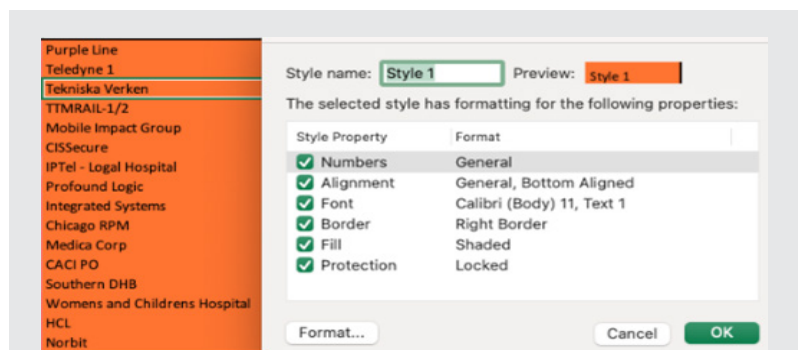


FIGURE 117 — Excel allows users to copy formatting used in an existing spreadsheet.

the “Page Layout” tab has a themes menu with many predefined themes (Figure 118). Google Sheets has “Themes” under the “Format” menu with a range of themes and the ability to customize existing ones. As with other properties of spreadsheets, you can also change existing themes and create new ones.

### Merging and Splitting Cells

Merging cells allows you to combine multiple adjacent cells into one cell. This technique is particularly useful when creating a header row for a table in a spreadsheet (Figure 119).

In the “Expenses Table,” even though all the rows have the same number of cells, the title row appears to be a single cell because several cells have been merged to create one cell for the title. To merge cells in a spreadsheet, you can select the cells that you want to merge and then use the “Merge Cells” command. This will combine the cells into a single cell and adjust the formatting of the merged cell to match the formatting of the first cell in the selection. In Google Sheets, you find “Merge cells” under the “Format” menu and Microsoft Excel has various options to merge and unmerge cells on the ribbon under the “Home” tab (Figure 120).

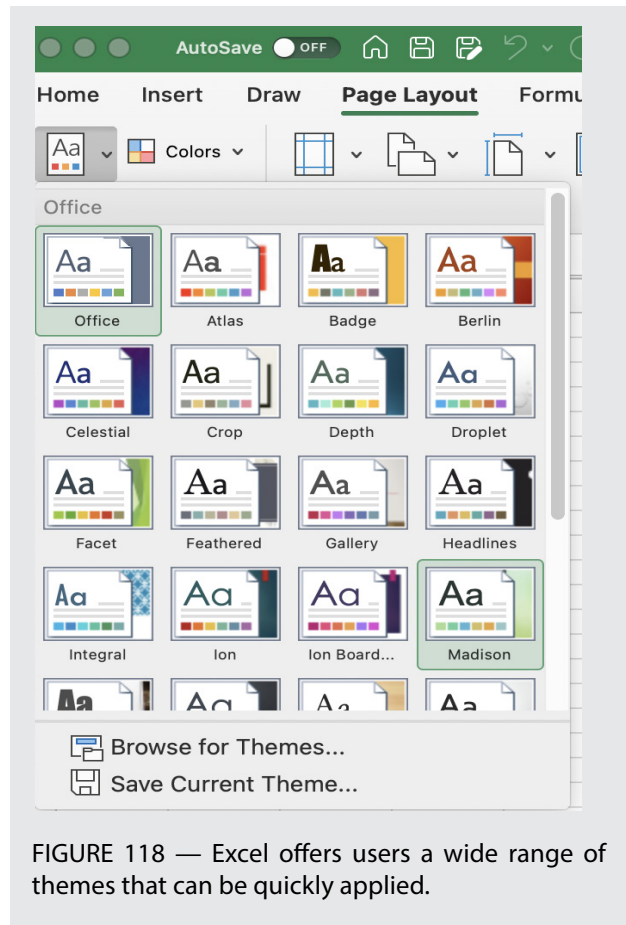


FIGURE 118 — Excel offers users a wide range of themes that can be quickly applied.

Expenses Table			
	Planned	Actual	Diff
Totals	\$1,000	\$1,050	-\$50
Food	\$350	\$375	\$25
Gifts	\$300	\$300	\$0
Health/Medical	\$350	\$375	\$25

FIGURE 119 — Headers can be created by merging cells.

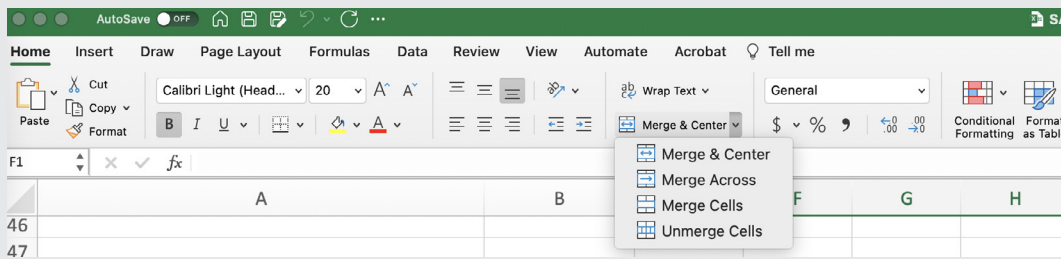
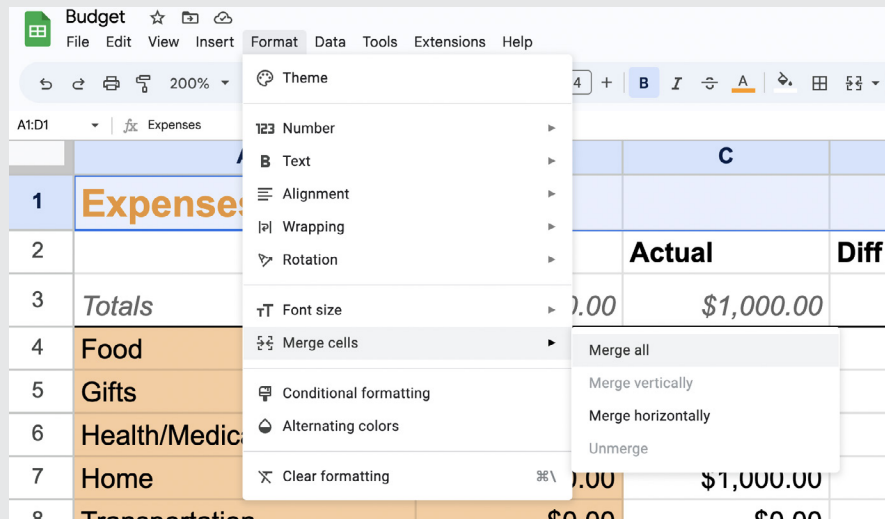


FIGURE 120 — In Google Sheets (top), the merge cell feature is in the format menu. In Excel (bottom), the merge cell feature is under the home tab.

Keep in mind though that you can't merge cells that don't form a proper rectangle, as in [Figure 121](#).

If things change, you can use the "Split Cells" command to split a merged cell back into its original cells. This can be useful if you want to make changes to the individual cells within the merged cell.

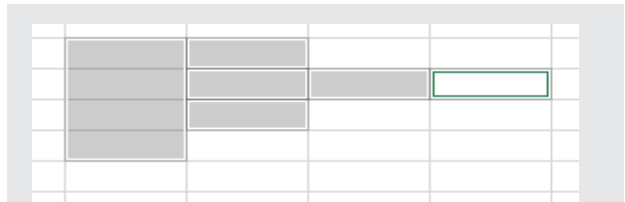


FIGURE 121 — These cells can't be merged as they don't form a rectangle or square.

### Hide and Unhide Columns and Rows

Spreadsheets can easily expand to fill many columns and rows. But your monitor typically only allows a few rows and columns to be visible at a time. Spreadsheets have an interesting capability to hide rows and columns to allow you to focus on the columns and rows of interest. To hide a column in Google Sheets, simply click on the column letter at the top of the spreadsheet and choose "Hide" ([Figure 122](#)). If you are using Excel, go to the "Cells" group under the "Home" tab and click "Format." In the "Visibility" section, you will see "Hide" and

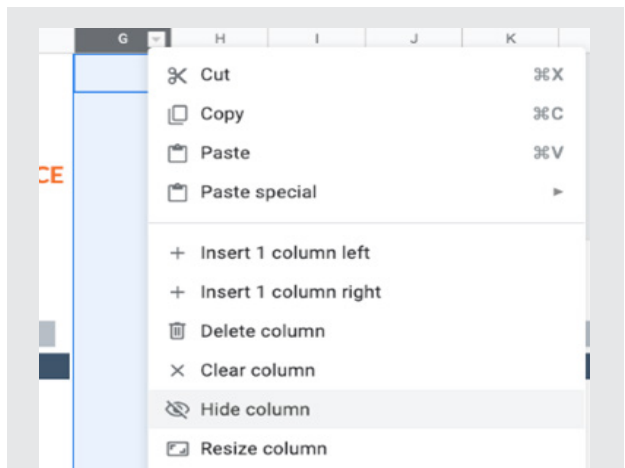


FIGURE 122 — Users can hide columns to better manage large volumes of data.

“Unhide.” You can also click on the column or the row header to select a column or row, then right-click to bring the context menu and select “Hide” or “Unhide.”

When columns or rows are hidden, you will see a break in the sequence of column headers or row numbers. In [Figure 123](#), column G is missing. Clicking on the gap will unhide the column. In our experience, it is far more common to need to hide columns than to hide rows.

### Page Layout Options

Users often want to print out spreadsheets to present to managers or other decision-makers. Spreadsheets allow you to format and preview the spreadsheet for printing. The page layout determines how a spreadsheet will look when printed. As a spreadsheet is a collection of cells organized into large numbers of rows and columns, printing it can be a challenge unless you set it up well. To solve the problem, spreadsheet software gives you page layout options that will allow you to have a presentable look when you print it on paper or view it as a PDF. There are many ways to get to the “Page Layout” option and many features to consider. In Excel, click on the “Page Layout” tab, then in the “Page Setup” group, click the “Dialog Box Launcher” in the bottom right corner to bring up the page setup dialog ([Figure 124](#)).

You can also make a few quick choices directly from the “Page Layout” menu options ([Figure 125](#)).

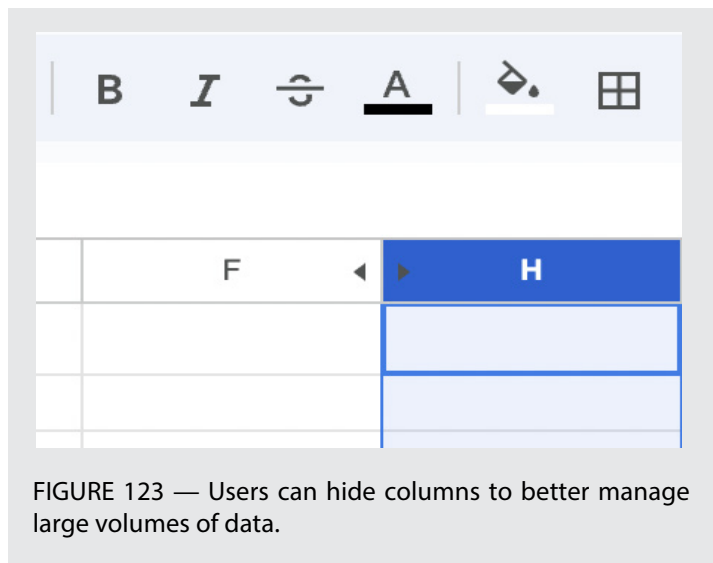


FIGURE 123 — Users can hide columns to better manage large volumes of data.

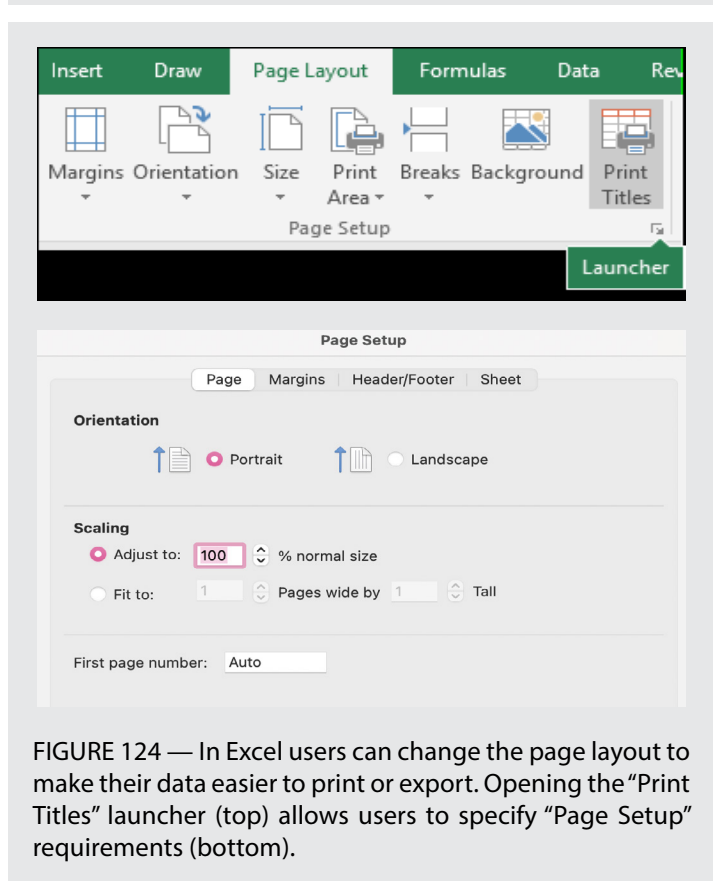


FIGURE 124 — In Excel users can change the page layout to make their data easier to print or export. Opening the “Print Titles” launcher (top) allows users to specify “Page Setup” requirements (bottom).

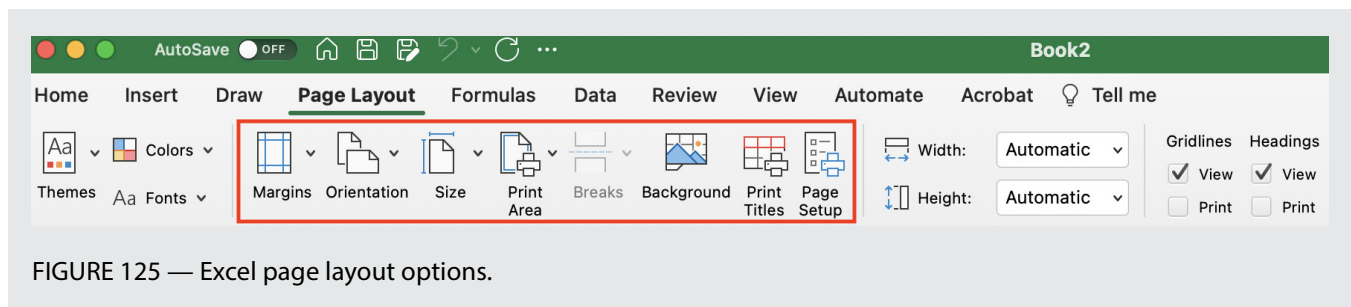


FIGURE 125 — Excel page layout options.

Here are a few things to consider to make your spreadsheet visually appealing.

**Page orientation:** Just like word processing software, spreadsheets can have either portrait (vertical) or landscape (horizontal) orientation. In Excel, the “Page Layout” tab has menu options to set the orientation. In Google Sheets, when you select “File” → “Print,” you see a “Print Preview” of the pages and have the option to adjust the paper size, orientation, headers and footers, grid visibility, alignment, and other properties.

**Page size:** You can specify whether you want to print/export your spreadsheet to PDF as a letter sized, A4 sized, or any of the other standard or customized paper sizes.

**Margins:** You can adjust the size of the margins to have the look you want.

**Headers and footers:** You can add headers and footers to the top and bottom of each page. In Excel, go to the “Insert” tab and click on the “Header & Footer” menu to insert headers and footers. As mentioned earlier, in Google Sheets you can add headers and footers, page numbers, workbook tiles, and other information when you try to print the document.

**Page breaks:** You can insert page breaks to control where the spreadsheet gets divided across multiple pages when it is printed/exported.

**Gridlines:** If you want, you can choose to display gridlines on the printed/exported version of the spreadsheet.

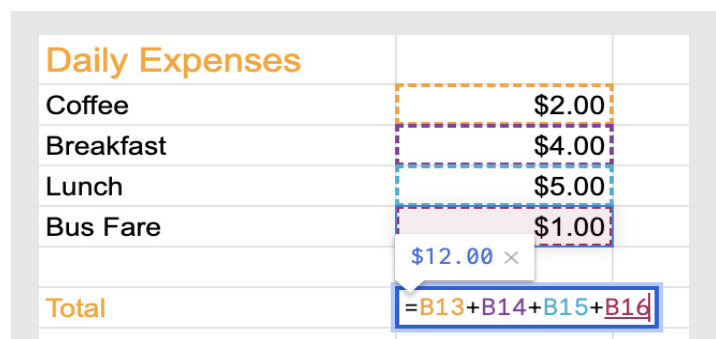
**Scaling:** You can adjust the scaling of the spreadsheet to fit it on a specified number of pages by making it a percentage of its original size.

## Formulas and Functions

You can supercharge your spreadsheet by employing formulas and **functions** to calculate values using the data in cells. Formulas are simple. When you write a formula in a cell, you begin with the equals (=) sign and specify the cells to use for the calculation and what operations to perform on the data. For example, if you want to add the values in cells A1 and B1, you could type the following formula in any cell “=A1+B1.” The result will get displayed in the cell where you type the formula.

If you have a table with your daily expenses, you can use a formula to calculate the sum of all your expenses. The total cell in [Figure 126](#) has the sum of expenses (=B13+B14+B15+B16). As you enter the formula and press “Enter,” you will get the total. As you change the data in cells, the calculations change automatically, which makes spreadsheets a very powerful tool. If you want to calculate the average daily expense over a month, you can add the daily total expense for a month and divide it by the number of days in the month. As soon as you enter a new set of values for the next month, you will immediately get the new daily average.

Spreadsheets also have powerful functions ranging from simple functions like Sum, Average, Count, Max, and Min to complex engineering, statistical, math, and financial



Daily Expenses	
Coffee	\$2.00
Breakfast	\$4.00
Lunch	\$5.00
Bus Fare	\$1.00
Total	=B13+B14+B15+B16

FIGURE 126 — Spreadsheet formulas allow users to quickly perform calculations with the help of visual aids.



functions. To use the sum function to add your expenses in [Figure 126](#), just type =SUM(B13:B16). To access the “SUM” functions in Google Sheets, select a range of cells and click “Insert” → “Functions” → “SUM.” In Excel, functions are located under the “Formulas” tab and are further organized by financial, logical, text, date & time, math & trig, and other menu options ([Figure 127](#)).

## Charts and Images

Charts offer a graphical representation of data and can help analyze data in a more meaningful and visually appealing way. You might not see a pattern or discrepancy by staring at 1000s of numbers, but a chart can bring out anomalies to the forefront quickly. In the language of British journalist and author David MacCandless, charts allow you to use the language of the eyes (pictures) along with the language of the mind (numbers), greatly speeding up data comprehension.<sup>129</sup>

To create a chart, select the data that you want to include—a range of cells or a table—then use the charting tools in the spreadsheet software. In Google Sheets, you can use the “Insert” → “Charts” option to bring up an interactive tool that lets you pick the chart type you want ([Figure 128](#)). Bar charts, line charts, pie charts, and scatter plots are each suited for different types of data and can help you visualize information in different ways.

It is important to identify the chart type that will be most useful for a given task. For example, if you are trying to chart your school expense in [Figure 128](#), let’s consider some options.

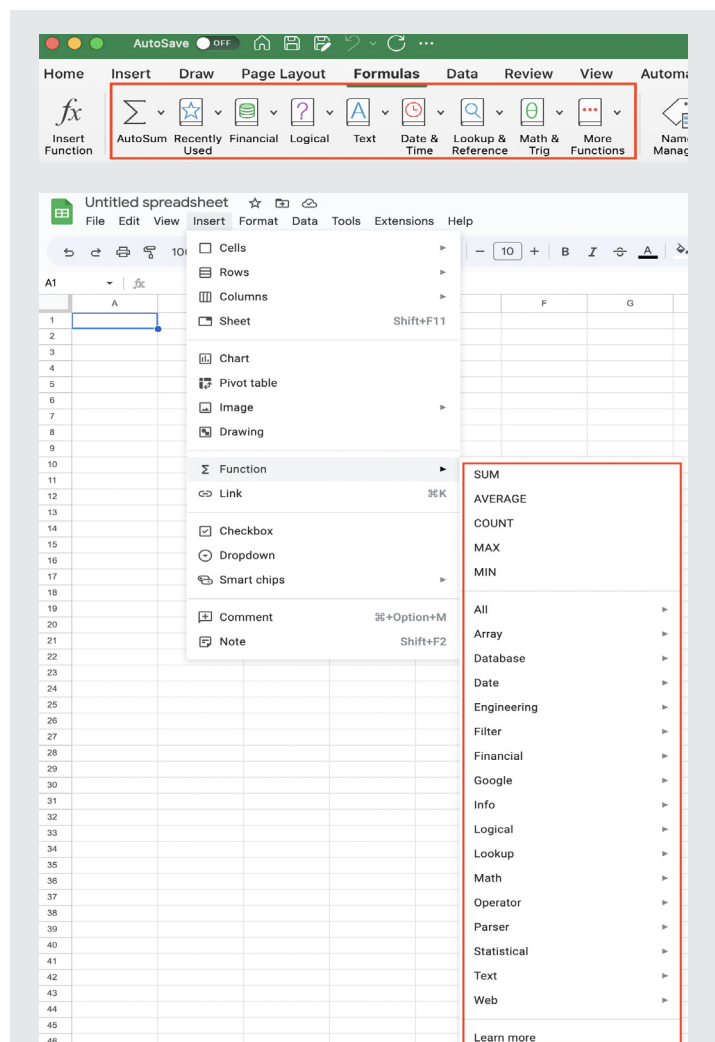


FIGURE 127 — Both Excel (top) and Google Sheets (bottom) offer a range of formulas to perform calculations.

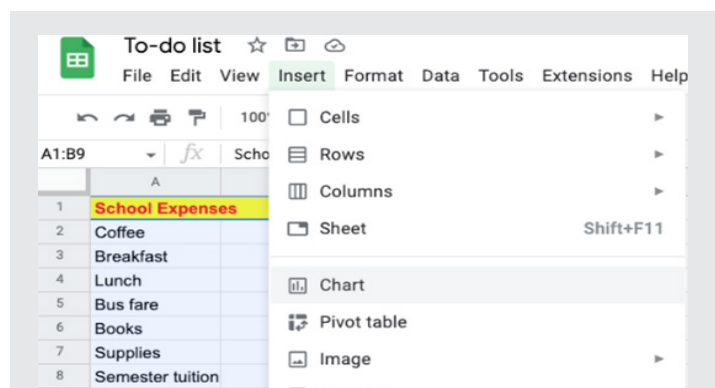
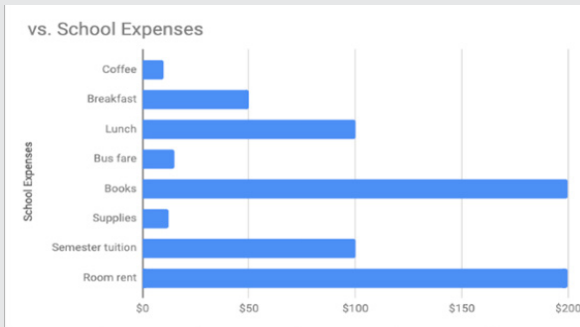
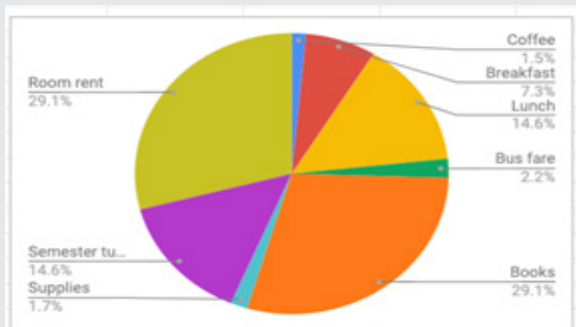


FIGURE 128 — Navigate to the chart menu to select a chart type.

129 The beauty of data visualization, TED talk by David MacCandless in 2010, [https://www.ted.com/talks/david\\_mccandless\\_the\\_beauty\\_of\\_data\\_visualization](https://www.ted.com/talks/david_mccandless_the_beauty_of_data_visualization). David also maintains a website with novel visualizations at <https://informationisbeautiful.net/> (accessed June 2023).



Expense data can be compared using bar charts.



Pie charts allow users to visualize percentages.

A line chart is a good choice for showing trends over time, and a scatter plot is good at showing the relationship between two variables. So, if you wanted to compare your expenses against an average student's expenses, you may consider a scatter plot (Figure 129 and Figure 130).

School Expenses			
	My Expenses	Average Student	
Coffee	\$10	\$30	
Breakfast	\$50	\$80	
Lunch	\$100	\$300	
Bus fare	\$15	\$35	
Books	\$200	\$310	
Supplies	\$12	\$15	
Semester tuition	\$100	\$150	
Room rent	\$200	\$300	

FIGURE 129 — A table of expenses.

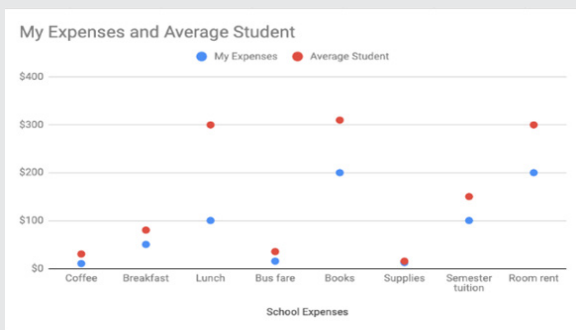


FIGURE 130 — Scatter plots allow users to compare two or more sets of data.

Once you create a chart, you can customize it by changing the appearance and layout of the chart and adding labels, titles, and data markers.

## Benefits of Charts

Charts can give users a quick visual summary of large volumes of data. A well-known example to demonstrate the utility of charts was published in 1973 by Yale statistician Francis Anscombe and is popular as Anscombe's Quartet.<sup>130</sup> The quartet consists of 4 sets of 11 numbers each, with very different distributions but almost identical statistical properties. While the differences are not readily apparent from the data, the differences are immediately apparent from a chart. The data and their charts are shown below. The mean and variance of  $y$  for each series are 7.5 and 4.125. The example is meant to show that though numerical data is considered precise, and charts are considered approximate, charts help with analysis and detecting the underlying phenomena.

130 Anscombe, F. J. (1973). "Graphs in Statistical Analysis," *American Statistician*. 27 (1): 17–21. See also the Wikipedia page on "Anscombe's Quartet" at [https://en.wikipedia.org/wiki/Anscombe%27s\\_quartet](https://en.wikipedia.org/wiki/Anscombe%27s_quartet) (accessed June 2023).

I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

Anscombe's Quartet data series

The series is plotted in [Figure 131](#). It becomes immediately clear that the series is describing different phenomena and that there are outliers in some data series that merit further investigation.

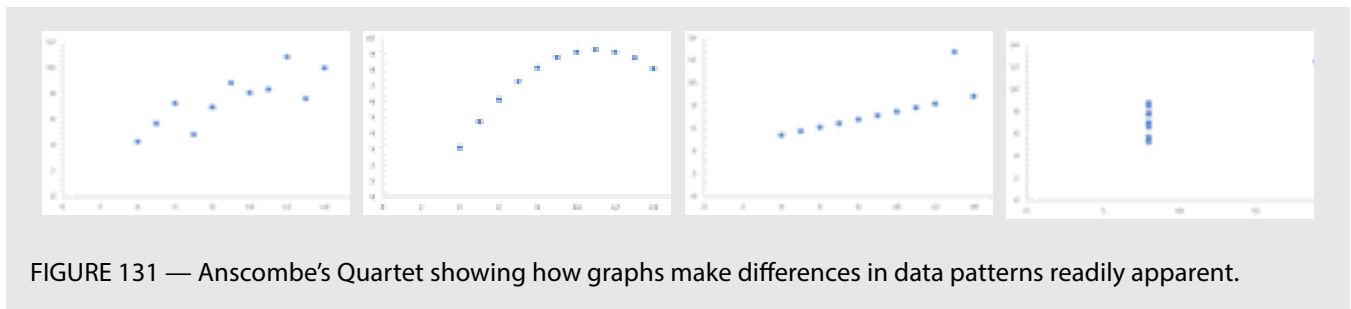
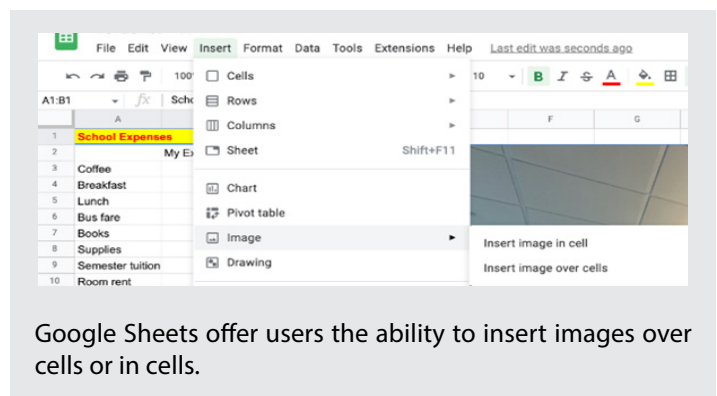


FIGURE 131 — Anscombe's Quartet showing how graphs make differences in data patterns readily apparent.

## Images

While charts are graphs created based on the data in your spreadsheet, images are pictures you can directly insert into your spreadsheet. In Google Sheets, you can click on any cell and then choose "Insert" → "Image." If you choose to insert the image in a cell, then it is constrained by the dimensions of the cell. If you choose to insert it over cells, then the picture floats on top of cells and can be sized independently of the underlying cells. In Excel, you can go to the "Insert" tab and click on the pictures menu to insert pictures in your spreadsheet. Inserting images adds organizational branding to spreadsheets.



Google Sheets offer users the ability to insert images over cells or in cells.

## Share and Collaborate

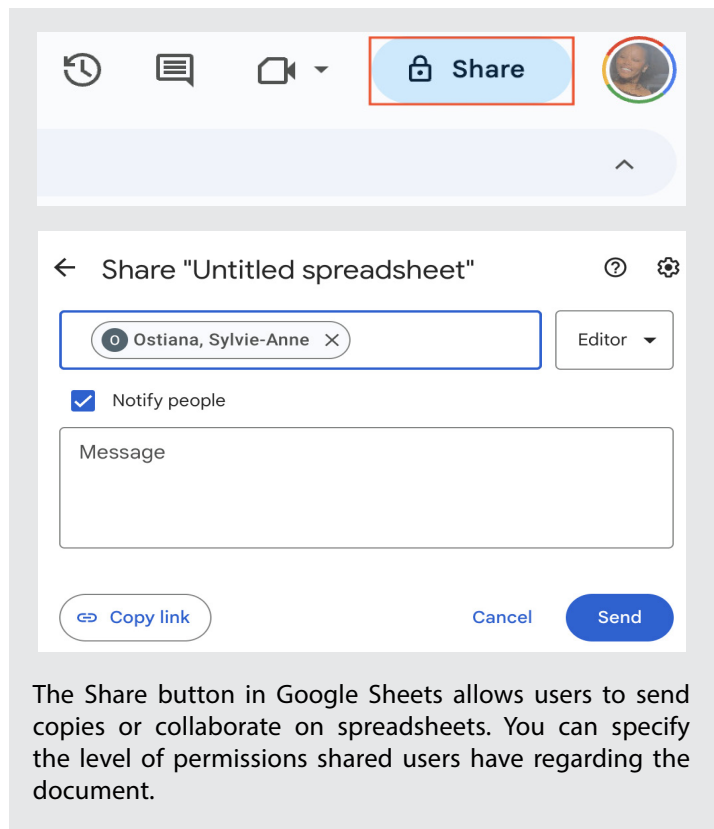
Just like word processing documents, you can share spreadsheets with others in your team, so more

than one person can view and edit the spreadsheet in real-time. In Google Sheets, you will see the “Share” button on the top right side of your screen.

Clicking “Share” will open a window where you can enter your team members’ email addresses and make them viewers, commenters, or editors.

As the names imply, editors can edit the content, commenters can add comments, and viewers can see the changes.

If you use an online version of Excel (OneDrive, SharePoint, or Excel for the web), you can share it with teams, and the changes made by each member will be visible to others.



The Share button in Google Sheets allows users to send copies or collaborate on spreadsheets. You can specify the level of permissions shared users have regarding the document.

## Analyzing and Organizing Data

### Filters

If you have a humongous spreadsheet, you may find it useful to look at a narrower set of data to focus your attention on one or two aspects of the data. By applying a filter, you can choose which rows are visible and which ones are hidden. Keep in mind, filtering doesn’t change the underlying data. Only the data set that matches the filtering criteria gets displayed. When you remove the filters, you will have the original spreadsheet with all the rows, just as before.

For example, you may have your company’s sales data for every Division, Sub-Division, and product (Figure 132). If you want to focus only on the data for your Division, Sub-Division, or product, setting up a filter may be a great idea.

In Google Sheets, click on the filter icon and select “Create new filter” view. Then click on the column header of any column to filter data (Figure 133).

Division	Sub-Division	Product Number	Number of Units	Price per unit
east	1	1111	140	\$10
west	2	1111	21	\$9
west	3	1111	18	\$12
east	3	1111	16	\$8
west	1	1111	11	\$10
east	4	1111	11	\$9
west	3	2222	16	\$12
west	2	2222	15	\$10
east	2	2222	15	\$11
west	1	2222	12	\$10
east	3	2222	12	\$9
east	4	2222	12	\$9
east	1	2222	10	\$9
east	2	2222	9	\$13

FIGURE 132 — When working with large sets of data, users may choose to filter specific columns.

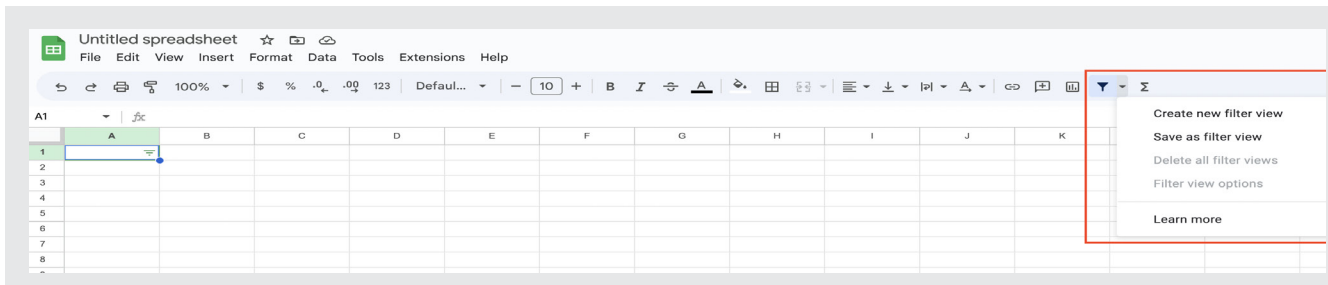


FIGURE 133 — Google Sheets provides users the ability to filter data, making large datasets easier to use.

To create a filter on the division column, click on the column header “Division.” If you only want to see sales data for the West Division, you should deselect “East” and click “Ok” (Figure 134). When you create filters in Google Sheets, the sidebars change in color to indicate that a filter is in place (Figure 135).

You could create additional filters on top of an existing one. For example, if you wanted to only see a particular Sub-Division within your Division, you can create a filter on the “Sub-Division” column (Figure 136). Removing the filters will bring the original data and the color changes back to normal.

To filter in Excel, select any cell within the range of data. Then go to the “Data” tab and click on the “Filter” menu. On the column headers, you will see the option to filter.

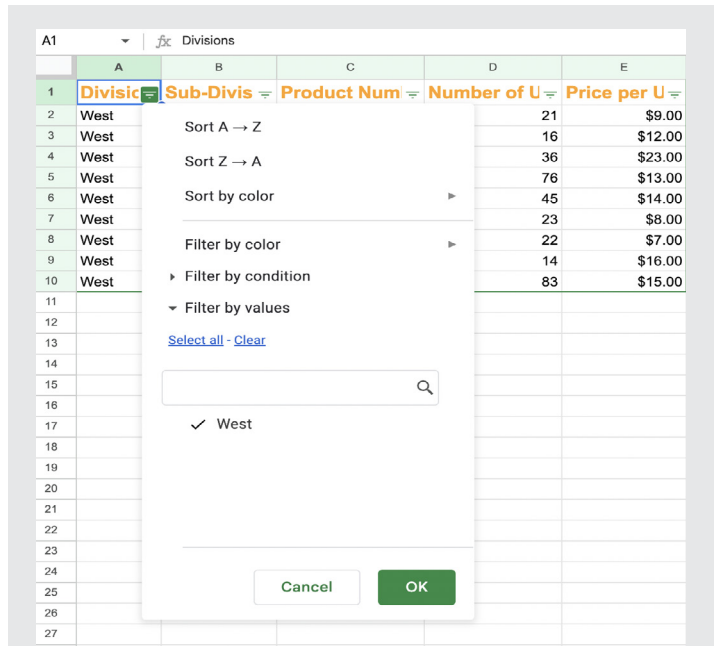


FIGURE 134 — Once in the “Create new filter” view of Google Sheets, users can filter columns of data.

## Sorting

**Sorting** organizes data in an ascending or descending order and facilitates searching for data. Some spreadsheet operations such as VLOOKUP and Remove Duplicates also expect data to be sorted. For example, if you have a list of students with First Name, Last Name, City, and GPA in a spreadsheet, it may be useful to group all the students in a city together. Just sort the data by City to reorganize the underlying data and see all the students from one city in one place. If mayors want to award the top-performing students in their cities, they can sort by City and then by GPA to figure out which students will receive awards. If you choose to sort from the largest to the smallest (descending

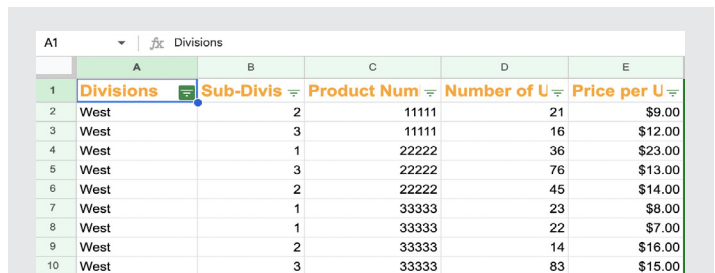


FIGURE 135 — Once a filter has been established, you only see the data you are interested in.

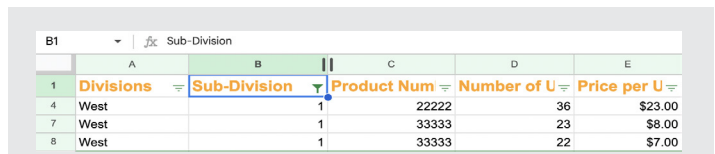


FIGURE 136 — Users can filter multiple columns at the same time.

order), the student with the highest GPA will be at the top.

Just like Filtering, Sorting doesn't alter the underlying data. What you change is how rows get ordered compared to the other rows in the data set.

To sort by Division in Google Sheets, we simply select the column and then do "Data" → "Sort" (Figure 137).

If you want to do more complex sorting (first by one column, then by another), in Google Sheets simply select the cells that comprise your data set and choose "Data" → "Sort Range" option. "Advanced range sorting options" will let you sort by as many columns as you like (Figure 138).

In Excel, go to the "Data" tab and click "Sort" to open the "Sort" window and sort by as many columns as you like. Don't forget to select the checkbox "My data has headers," if your top row has headers. This will make sure only the data gets sorted, not the headers.

### Conditional Formatting

Conditional formatting allows you to apply formatting, such as cell shading and text color, to cells based on conditions. This can be useful in highlighting important information or for making data easier to read and understand. You can use a formula or a set of rules to determine which cells should be formatted.

Going back to our company sales data, let's say we want to highlight any sales of more than 15 units in green and those with less than 10 units in red. In Google Sheets, select the cells you want to format, then choose "Format" → "Conditional Formatting" (Figure 139). In the conditional formatting window, make sure the cells you want to format are selected, then create rules to see the formatting results (Figure 140).

In Excel, the "Conditional Formatting" menu is under the "Home" tab. Just select "Highlight Cells Rules" and create the conditional formatting rules you want.

Division	Sub-Division	Product Number	Number of Units	Price per unit
east	1	1111	140	\$10
west	2	1111	21	\$9
west	3	1111	18	\$12
east	3	1111	16	\$8
west	1	1111	11	\$10
east	4	1111	11	\$9
west	3	2222	16	\$12
west	2	2222	15	\$10
east	2	2222	15	\$11
west	1	2222	12	\$10
east	3	2222	12	\$9
east	4	2222	12	\$9
east	1	2222	10	\$9
east	2	2222	9	\$13

Division	Sub-Division	Product Number	Number of Units	Price per Unit
east	1	1111	140	\$10
east	2	1111	21	\$9
east	3	1111	18	\$12
east	3	1111	16	\$8
east	1	1111	11	\$10
east	4	1111	11	\$9
east	3	2222	16	\$12
east	2	2222	15	\$10
west	2	2222	15	\$11
west	1	2222	12	\$10
west	3	2222	12	\$9
west	4	2222	12	\$9
west	1	2222	10	\$9
west	2	2222	9	\$13

FIGURE 137 — Unsorted sales data of a company (top); Data sorted by Division (bottom).

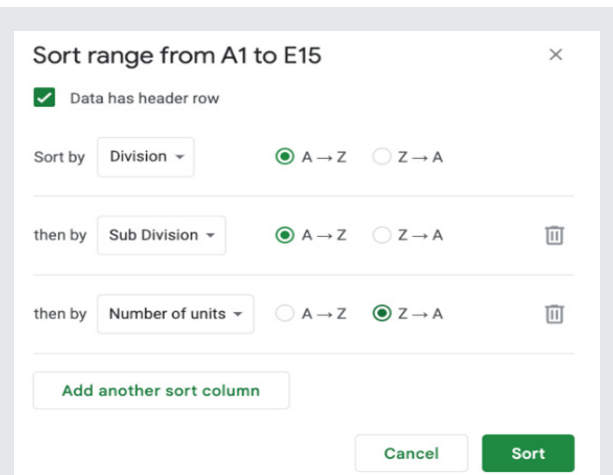


FIGURE 138 — In Google Sheets, users can simultaneously sort multiple columns by utilizing the "Advance range" sorting options.

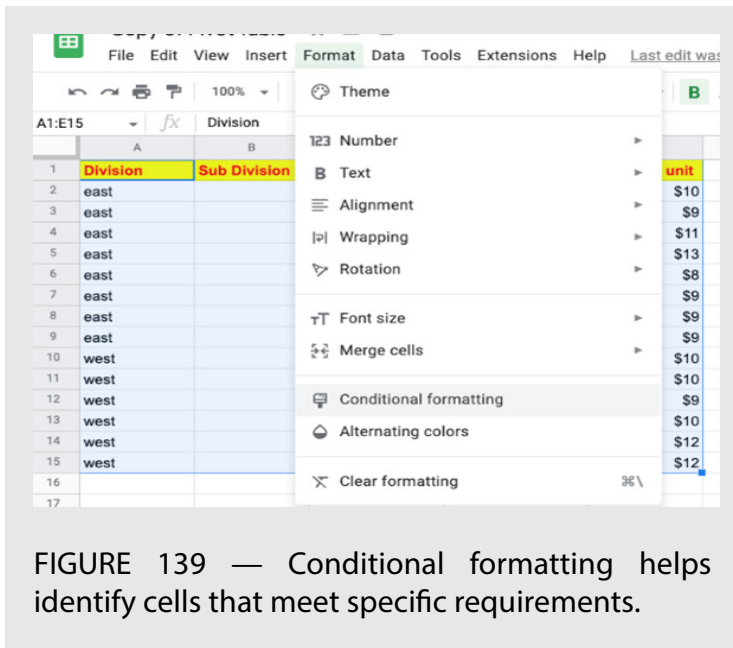


FIGURE 139 — Conditional formatting helps identify cells that meet specific requirements.

### Pivot Tables

A pivot table is a useful tool to quickly summarize and analyze large amounts of data to see patterns and trends. Manually analyzing the data in a spreadsheet with 1000s of rows spread across tens of columns can be a daunting task. If you want to see patterns, compare the impact of different columns, or group data in categories, you may need to put in months of painstaking work. Using pivot tables, you can simply select all your data, transpose it to a pivot table, select columns to categorize on, filters to apply, and choose the summarizations you want. The software will do the calculations and give you a pivot table summary report. If you don't like the outcome or if you want to change your filtering, grouping, or summarization parameters, you can do so and immediately see the outcome.

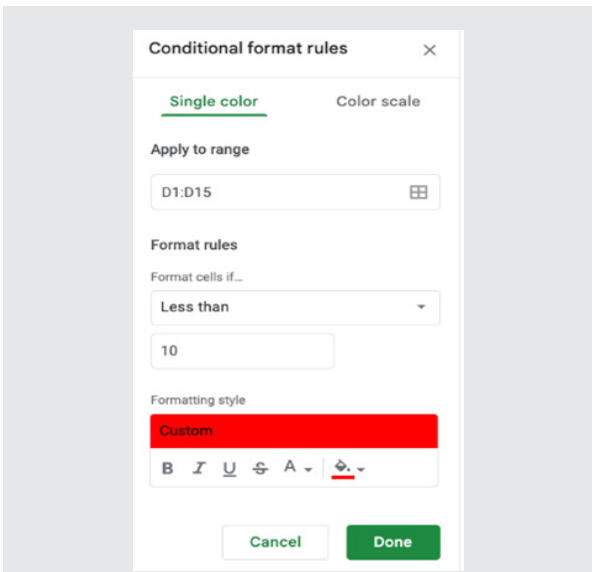
### Additional Resources

Spreadsheets have a wide range of capabilities for a wide array of applications. To become proficient at using spreadsheets, consider using them anytime you are working with numbers. Like any skill, practice will improve your ability to leverage this highly valuable technology.

Several influencers share valuable Excel tips on social media sites, including Twitter. Some threads the authors can recommend are below:

15 Excel tips: <https://twitter.com/FluentInFinance/status/1611807041399705600>

Search by hashtag for Excel: <https://twitter.com/hashtag/excel>.



Division	Sub Division	Product Number	Number of units	Price per unit	
west		2	1111	21	\$9
west		3	1111	18	\$12
west		3	2222	16	\$12
west		2	2222	15	\$10
west		1	2222	12	\$10
west		1	1111	11	\$10
east		1	1111	140	\$10
east		3	1111	16	\$8
east		2	2222	15	\$11
east		3	2222	12	\$9
east		4	2222	12	\$9
east		4	1111	11	\$9
east		1	2222	10	\$9
east		2	2222	9	\$13

FIGURE 140 — Users can specify colors to represent cells that meet specific criteria.



## Chapter Terms and Definitions

**Cell:** A cell is a single element in the worksheet that has a value, some text, or a formula

**Chart:** A type of visualization shaped like a pie and used to analyze data in an intuitive and user-friendly way

**Column:** Represents categories of data and the cells are named by alphabet vertically

**Conditional Formatting:** A spreadsheet feature that allows you to apply formatting options, such as cell shading and text color, to cells based on conditions

**Data:** Information used for reasoning, discussion, or calculation

**Filter:** A spreadsheet feature designed to narrow a set of data based on specific criteria so that you can choose which rows are visible and which ones are hidden

**Formula:** A feature that performs specific calculations or other actions on the data in the spreadsheet

**Function:** A set piece of code built into a spreadsheet that performs certain predefined actions; examples include SUM, AVERAGE, COUNT, MIN, and MAX

**Pivot Table:** A useful tool to quickly summarize and analyze large amounts of data to see patterns and trends

**Row:** Represents a record of data and the cells are numbered horizontally

**Sorting:** A spreadsheet feature that organizes data in an ascending or descending order and facilitates searching for specific data

**Spreadsheet:** A computer program that represents information in rows and columns, and makes it easy to perform calculations with the data





## Chapter Case

### Sports Tracking Spreadsheet

Kenny needed to take on a volunteer project to help with his future chances of getting a college scholarship. Most of the college scholarships he was interested in applying for required that he have a minimum number of documented volunteer hours. Thankfully, a local non-profit youth sports management organization needed to create a spreadsheet that would help track students who sign up for various youth sports.

Kenny offered to help the organization create the spreadsheet in exchange for documented volunteer hours. The manager of the organization agreed to the project and Kenny was ready to apply his spreadsheet skills.

The spreadsheet required the tracking of the following data:

- Student First Name
- Student Last Name
- Student Age
- Student Grade
- Student School
- Telephone Number
- Sport (Volleyball, Basketball, Softball, Baseball, Soccer, or Football)

.....

**Question 1:** Considering the data required in the list above, create a spreadsheet in a spreadsheet application you have access to. Add at least 10 rows of data to your spreadsheet. Once you add all the data to the spreadsheet, what is the average age for all the students? What formula did you use to calculate the average age?

**Question 2:** Add a chart to the spreadsheet that illustrates the total number of students for each sport. Which sport has the highest number of students? What formula did you use to count the total number of students for each sport?