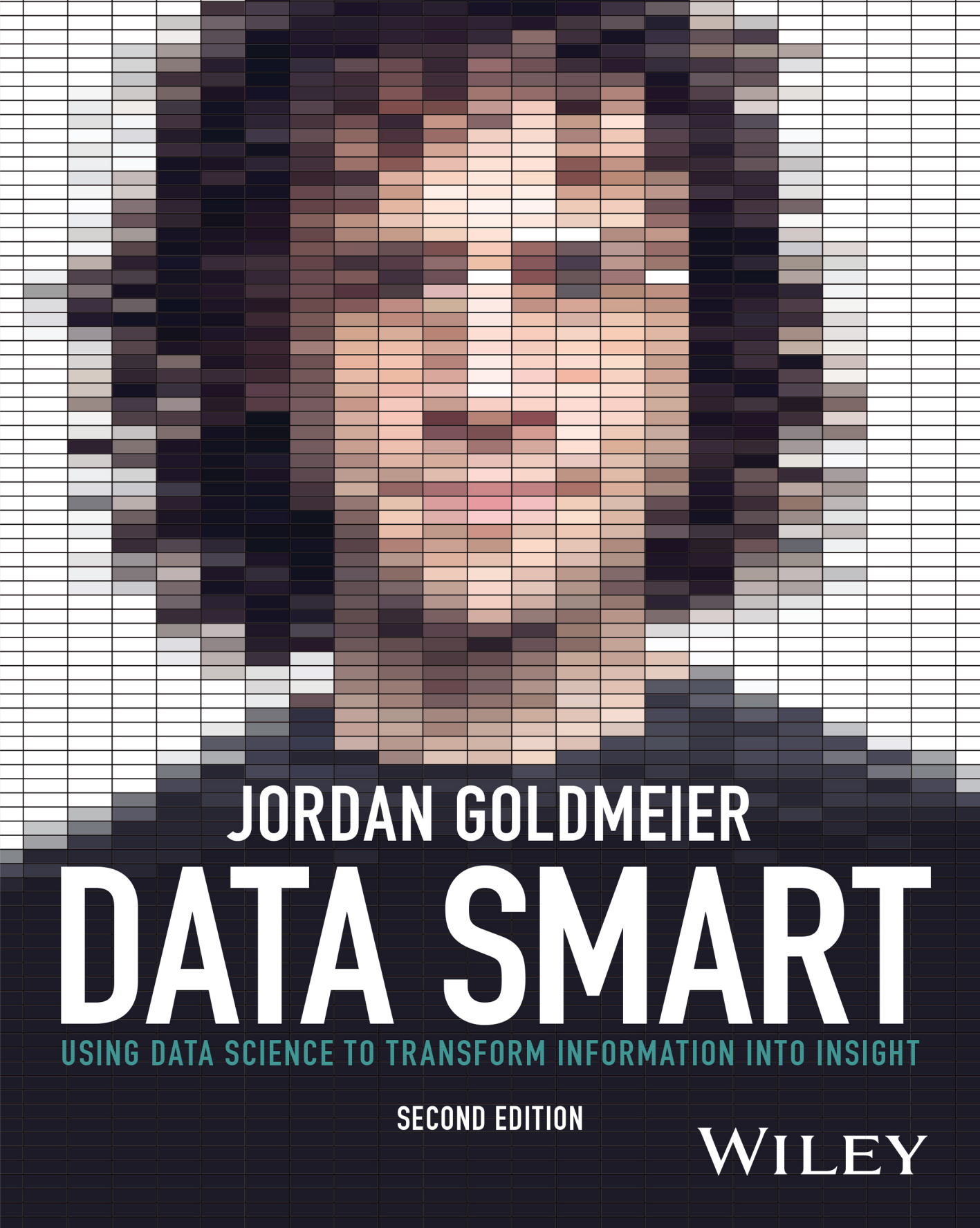
JORDAN GOLDMEIER
DATA SMART
USING DATA SCIENCE TO TRANSFORM INFORMATION INTO INSIGHT
SECOND EDITION
WILEY

Data Smart

Second Edition

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Using Data Science to Transform Information into Insight

Second Edition

Jordan Goldmeier

WILEY

Published by John Wiley & Sons, Inc., Hoboken, New Jersey.
Published simultaneously in Canada and the United Kingdom.

ISBNs: 9781119931386 (Paperback), 9781119931485 (ePDF), 9781119931393 (ePub)

Library of Congress Control Number: 2023940016

Cover image: Courtesy of Greg Jones and Wiley
Cover design: Wiley

Dedicated to David and Terry

About the Author

Jordan Goldmeier is one of the leading global minds on data visualization and data science. His books include *Dashboards for Excel* (Apress), *Advanced Excel Essentials* (Apress), *Becoming a Data Head: How to Think, Speak, and Understand Data Science, Statistics, and Machine Learning* (Wiley). Jordan has received the prestigious Microsoft Most Valuable Professional Award many times over the years. He has consulted and provided training for Fortune 500 companies, NATO, and taught analytics for Wake Forest University. He runs multiple businesses as a digital nomad living in Lisbon, Portugal. You connect with Jordan on LinkedIn and on Instagram (`@jordangoldmeier`).

About the Technical Editors

Alex Gutman is a data scientist, corporate trainer, and Accredited Professional Statistician® who enjoys teaching a wide variety of data science topics to technical and nontechnical audiences. He's a former adjunct professor at the Air Force Institute of Technology and current adjunct at the University of Cincinnati. Alex is also the author of the book *Becoming a Data Head: How to Think, Speak, and Understand Data Science, Statistics, and Machine Learning* (Wiley). He received his BS and MS degrees in mathematics from Wright State University and his PhD in applied mathematics from the Air Force Institute of Technology.

Matthew Bernath is passionate about leveraging data to bolster economies and facilitate strategic dealmaking. Matthew has led the data analytics division of one of Africa's largest investment banks and is currently the head of data ecosystems for Africa's largest retailer. His diverse experience spans from structuring multibillion-rand project financing deals to utilizing data to uplift society, always driven by data-focused decision-making. Recognized as one of the "60 Data Changemakers to Know" by Narrative Science and a finalist for Data Analytics Leader of the Year in 2022, Matthew's achievements extend beyond his professional role. His contribution to community-building initiatives include hosting the Johannesburg Data Science and Financial Modelling meetup groups and the highly regarded *Financial Modelling Podcast*, which was awarded Financial Modelling Resource of the Year 2021. He also formerly hosted the RMB *Data Analytics* podcast. Prior to his investment banking and retail career, Matthew held leadership roles in various advisory and technology firms, bringing his data-driven approach to different industries.

Acknowledgments

Life has a weird way of coming full circle. I read the original *Data Smart* when it first came out in 2013. I had no imagination back then I would write the revised edition. Yet, here I am. If fate brought me to this place, it's because I love Excel. Therefore, it only makes sense to first acknowledge the Excel product team at Microsoft, who've managed to push Excel beyond the tool it was back in 2013.

As a Microsoft MVP, I've met some incredible folks at Microsoft over the years, who've really listened and understood the ways in which my community uses Excel. In particular, I would like to acknowledge David Gainer, Guy Lev, and Joe McDaid for continually expanding the product.

I would also like to acknowledge my peers in the Excel community who pushed the product beyond its limitations for the good of the whole. As it relates to the material in this book, I must mention George Mount, Oz du Soleil, Carlos Barboza, and Roberto Mensa for challenging the norm.

I also have to give major credit to the book's first author, John Foreman. If you weren't in the data space back in 2013, you should know it was a different world. In those days, people were enamored by the idea of "big data." Companies were rushing to implement technologies that could handle large datasets before they even had high-quality data.

But then there was John's book, which showed people how to do (or at the very least, teach) data science without big data technologies—you could just use Excel. John showed people that it wasn't about the technology, but, rather, one had to really think through the problem. And he did it without being boring. John's book served as major motivation and inspiration for my last book, *Becoming a Data Head*. It's a great honor to be working on this material.

I also have to acknowledge my technical editors, Alex Gutman and Mathew Bernath. Both are incredibly intelligent and esteemed in their fields. Alex and I wrote *Data Head* together, and it's amazing to once again have him on another project. Alex is thorough, humble, and deeply affable. He's often the smartest person in the room, but you would never know, as there's not an arrogant bone in his body. Alex's contributions are indelibly fused into the text of this book.

Mathew is perhaps the coolest data (and coffee) nerd I know. He knows his craft well and channels that knowledge into community building, bringing ideas and minds together to push the field forward. His technical advice on this book challenged many of the things I took for granted. This book is much better off for it, and I'm very grateful for his support.

I also want to acknowledge the team at Wiley. In particular, I would like to mention Jim Minatel who believed strongly in this project and really pushed to make it happen. I also want to thank John Sleeva, my development editor. John has my favorite working style—no news is good news. He's always calm, thorough, and dependable. This is my second book with Wiley and Jim and John—and I couldn't have asked for a better team.

I also have to mention Archana Pragash who worked tirelessly on proofing this book to my specifications. I often wondered when she slept. She always responded quickly—nights, weekends, etc. For a big project like this, Archana was a dependable pillar. The layout of this book is to her credit.

Finally, I would like to thank you, the reader. It's your interest that makes this book happen. I hope you enjoy it.

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Introduction

What Am I Doing Here?

If you're reading this book, it's because on some level you understand the importance of both data and data science in your business and career.

The original *Data Smart* was written more than a decade ago. John Foreman, the first book's author, exposed a new generation of readers to the supposed magic behind the curtain of data science. John proved that data science didn't have to be so mysterious. You could both understand and do data science in something as humble as the spreadsheet.

John's words severed as a prescient warning for what would come. He noted the "buzz about data science," and the pressure it created on businesses to take on data science projects and hire data scientists without even fully understanding why.

> *The truth is most people are going about data science all wrong. They're starting with buying the tools and hiring the consultants. They're spending all their money before they even know what they want, because a purchase order seems to pass for actual progress in many companies these days.*

John's words still ring true today. Ten years after the first wave of interest in data science, the data science machine is still working in full force, churning out ideas faster than we can articulate the opportunities and challenges they present to business and society. In my last book, *Becoming a Data Head: How to Think, Speak and Understand Data Science, Statistics and Machine Learning (Wiley, New York, NY, 2021)*, my coauthor and I called this the *data science industrial complex*.

To put it bluntly, despite the extensive interest in data and data science, projects still fail sometimes at alarming rates, even as data is supposed to be fact driven. In truth, as much as 87 percent data science projects won't make it into production.[1]

What is and isn't a "data disaster" is perhaps up from some considerable debate. But it's fair to say the recent past is filled with examples in which technology, data, and the like were hailed as something magical before they ultimately came up short. Here are just a few examples worth considering:

[1]"Why do 87% of data science projects never make it into production?" `https://designingforanalytics.com/resources/failure-rates-for-analytics-bi-iot-and-big-data-projects-85-yikes`

- An attorney used a generative AI chatbot for legal research, submitting a brief to the court with cases that did not exist, but perhaps sounded plausible.[2]
- The COVID-19 pandemic exposed major issues in forecasting across the board, from supply chain issues to understanding the spread of the virus.[3]
- When the original *Data Smart* came out, accurately predicting the outcome of the US presidential election seemed like an easy feat. In 2016, however, model after model inaccurately predicted a win for Hillary Clinton, despite increased money, time, and effort into the subject.[4]

Most data science projects and outcomes don't fail so spectacularly. Instead, data science projects die slow deaths, while management pours money and resources into chasing elusive numbers they don't entirely understand.

Yet, some of the greatest data achievements did not come from any particular technology. Rather, they came from human ingenuity. For instance, I used to lead projects for a nonprofit called DataKind, which leverages "data science and AI in service of Humanity."

DataKind uses teams of volunteer data scientists to help mission-driven organizations design solutions to tough social problems in an ethical and socially responsible way. When I was there, we worked with major organizations like the United Nations and Habitat for Humanity.

Volunteers built all sorts of models and tools, from forecasting water demand in California to using satellite imagery to identify villages in need with machine learning. The work we did had impact, so it's not all doom and gloom. When you're done with this book, you might consider giving back in your own way.[5] Remember: Humans solve problems not machines.

What Is Data Science?

In my last book, *Becoming a Data Head,* Alex Gutman (my coauthor) and I actually don't define data science. One reason is that the space is too hard to pin down. And we didn't want folks to get caught up in trying to justify whether or not they were data scientists. In the original *Data Smart*, John Foreman offers this working definition:

> *Data science* is the transformation of data using mathematics and statistics into valuable insights, decisions, and products.

[2]"8 famous analytics and AI disasters." www.cio.com/article/190888/5-famous-analytics-and-ai-disasters.html
[3]"Forecasting for COVID-19 has failed." www.ncbi.nlm.nih.gov/pmc/articles/PMC7447267
[4]"The Real Story Of 2016." https://fivethirtyeight.com/features/the-real-story-of-2016
[5]To see the impact DataKind has had, take a look at their case studies - www.datakind.org/what-we-do

John takes a broad, business-centric view. He's quick to note it's a "catchall buzzword for [everything] analytics today." Ten years later, I and the rest of the industry are still struggling to define exactly what data science is and isn't. So rather than proffer a definition as if that will get us closer to the truth, I'd rather describe what a data scientist does.

- *Data scientists identify relevant questions that can be solved with data*. This may sound obvious, but many questions can't be solved with data and technology. A good data scientist can tease out the problems in which algorithms and analyses make the most sense.
- *Data scientists extract meaningful patterns and insights from data*. Anyone can eyeball a set of numbers and draw their own conclusions. On the other hand, data scientists focus on what can be said statistically and verifiably. They separate speculation from science, focusing instead on what the data says.
- Finally, *data scientists convey results using data visualization and clear communication*. In many cases, a data scientist will have to explain how an algorithm works and what it does. Historically, this has been a challenge for many in the field. But a recent crop of books (like this one) aims at giving data scientists a way to explain how they came to their results without being too stuck into the weeds.

Incredibly, some of the techniques mentioned in the following pages are as old as World War II. They were invented at the dawn of the modern computer, long before you could easily spin up a new instance of R. The hype machine won't tell you these "new" algorithms were first developed on punch cards.

And some of the techniques in this book were invented recently, taking advantage of the wealth of data, self-service analytics, cloud computers, and new graphical processing units developed in the last 10 years.

Again, we're reminded that human ingenuity is what drives this field forward.

Age has no bearing on difficulty or usefulness. All these techniques whether or not they're currently the rage are equally useful in the right business context. It's up to you to use them correctly. That's why you need to understand how they work, how to choose the right technique for the right problem, and how to prototype with them.

Do Data Scientists Actually Use Excel?

Many (but not all) veteran data scientists will tell you they loathe spreadsheets and Excel in particular. They will say that Excel isn't the best place to create a data science model. To some extent, they're right.

But before you throw this book away, let's understand why they say this. You see, there was a time before R and before Python. It was a time when MATLAB and SPSS reigned supreme. The latter tools were expensive and often required a computer with some major

horsepower to run a model. Moreover, the files that these tools generated were not easily distributable. And, in a secure corporate or institutional environment, sending files with code in them over email would trip the unsafe-email alarms.

As a result, many in the industry began building their work in Excel. This was particularly true of models that helped support executive decision-making. Excel was the secret way around these email systems. It was a way to build a mini data application without having to get approval from the security team.

Many executive teams relied on Excel. Unfortunately, this also created a myopic view among executives who didn't really understand data science. For them, Excel was the only place to do this type of work. It was where they were most comfortable.

They knew the product. They could see what the analyst created. And the analyst could walk them through each step. In fact, that's why we're using Excel in this book.

But Excel (at the time) was limited. Limited by how much it could process at any moment. Limited by the amount of data it could store. The macro language behind Excel, Visual Basic for Applications (VBA), is still hailed by many executives as an advanced feature. But VBA is based on Visual Basic 6.0, which was deprecated in 1999. The Excel version of this language has received only the barest of updates. When today's data scientists point out that VBA can't do what R or Python can, it's hard to disagree.

On the flipside, however, Microsoft has paid attention over the last few years. The Excel product team has come to understand how data scientists use their tool. They've poured more research into some very specific use cases. For instance, we'll talk about an entirely new data wrangling tool in Excel called Power Query. Power Query can do the same data wrangling tasks as in Python and R, often more quickly. And we'll talk about new Excel functions that make data science in Excel a whole lot easier. Today, there is renewed interest in using Excel for data science problems beyond what was possible only a few years ago.

But if there's a place where Excel shines, it's in explaining and understanding data science concepts. Before getting a "yes" to your new data science project, you'll need to get buy-in from management. You can fire up an advanced algorithm in R, pull out lines of code, and explain what each function does step-by-step. Or you can walk management through the algorithm in Excel and even give them the ability to filter results and ask questions of the data.

In fact, Excel is great for prototyping. You're not running a production AI model for your online retail business out of Excel, but that doesn't mean you can't look at purchase data, experiment with features that predict product interest, and prototype a targeting model.

At the end of this book, I'll show you how to implement what we've built in Excel in R. In fact, this follows my own path in building data science tools for companies. First, I would lay out my ideas in Excel. Use the spreadsheet as a way to validate my ideas and make sure I understand exactly what the algorithms do. Then, usually, when I'm ready, I move it to R or Python.

But sometimes I don't. Because in some instances Excel just gets the job done, and the problem doesn't need more complication. As you will see, knowing how to do these techniques in Excel will give you a major advantage, whether or not you end up implementing them in something more powerful.

Conventions

To help you get the most from the text and keep track of what's happening, I've used a number of conventions throughout the book.

Frequently in this text I'll reference little snippets of Excel code like this:

```
=IF(A1 = 1, "I love Excel", "I REALLY love Excel")
```

SIDEBARS

Sidebars touch upon some side issue related to the text in detail.

WARNING

Warnings hold important, not-to-be-forgotten information that is directly relevant to the surrounding text.

NOTE

Notes cover tips, hints, tricks, or asides to the current discussion.

- We bold technical objects, when introducing them for the first time, or when it makes sense to set them off. We also use the bold font to refer to specific fields and buttons.
- We *italicize* new concepts and important words when we introduce them.
- We show filenames, URLs, and formulas within the text like so: `www.linkedin.com/in/jordangoldmeier`

Let's Get Going

A new generation of data scientists is learning how to implement work that was only theoretical when I first started. The industry is undergoing a serious reflection on what's

important. Businesses are starting to realize their most important assets aren't data, algorithms, or technology—it's people. People just like you.

As you go along your data journey, you will likely encounter more than your fair share of bad decision-making, a lack of critical thinking, ignorant management, and even some imposter syndrome. Sadly, as with many of the data successes, these are part of the legacy. But with the knowledge contained herein, you'll be set up for success. You'll understand the algorithms. You'll know how and what they do. And, you won't be fooled by buzzwords. When it comes to doing real data science work, you'll already know how to identify the data science opportunities within your own organization.

By reading this book, you're going have a leg up on the next generation of data problems. Whether you're a veteran of the field or a student in school, by reading this book, you will become a better data scientist.

In Chapter 1, "Everything You Ever Needed to Know About Spreadsheets but Were Too Afraid to Ask," I'm going to fill in a few holes in your Excel knowledge. And, in Chapter 2, "Set & Forget it! An introduction to Power Query." I'm going to show you Power Query. After that, you'll move right into use cases. By the end of this book, you'll have experience implementing from scratch the following techniques:

- Optimization using linear and integer programming.
- Working with time-series data, detecting trends, and seasonal patterns, and forecasting with exponential smoothing.
- Using Monte Carlo simulation in optimization and forecasting scenarios to quantify and address risk.
- Applying Artificial intelligence using the general linear model, logistic link functions, ensemble methods, and naïve Bayes.
- Measuring distances between customers using cosine similarity, creating kNN graphs, calculating modularity, and clustering customers.
- Detecting outliers in a single dimension with Tukey fences or in multiple dimensions with local outlier factors.
- Using R packages to implement data science techniques quickly.

It's now time for our journey to begin. I'll see you in the next chapter!

1 Everything You Ever Needed to Know About Spreadsheets but Were Too Afraid to Ask

This book assumes you have some experience working with spreadsheets. You won't need to be a spreadsheet expert, but if this is your first-time opening Excel, you might find this chapter a bit challenging. If that's you, I would recommend pairing this chapter with a *For Dummies* book or a beginner-level online class.

Even so, what follows in this chapter might still surprise the most seasoned, self-professed Excel pros. So, regardless of your Excel experience, this chapter should not be skipped! In the following pages, we'll describe a wide variety of Excel features that we'll use throughout the book.

Before moving forward, let's talk about the different versions of Excel out there and how they might affect you. First, everything in this book will work seamlessly in Excel 365 and Excel 2016 and beyond for Windows.

This book is going to use Excel 365 desktop for Windows. Excel 365 generally represents the latest versions of Excel, to which Microsoft pushes monthly updates. Some institutions still use enterprise versions of Excel such as Excel 2016 and Excel 2019. These versions will work, too. To ensure you are using the latest version of Excel, call the IT department at your school or your office and let them know you'd like to get the latest build. They'll know what you mean.

The story for Mac is a bit different. If you're on a Mac, some of keystrokes will be different. There are different icons and button locations. Power Query, Excel's data wrangling powerhouse, has fewer features in the Mac version as of this writing. Still, you should be able to get by just fine.

This book requires a desktop version of Excel. Though you can work in Excel through their online platform and through SharePoint, neither of these environments is suitable for this book as of this writing. That may change in time, but for now, assume everything from here on out is for Excel on the desktop.

Some Sample Data

> **NOTE**
>
> The Excel workbook used in this chapter, `Concessions.xlsx`, is available for download at the book's website at `www.wiley.com/go/datasmart2e`.

Let's start with some sample data.

You don't know this about me, but I love hot dogs. (Seriously, I have a Chicago-style hot dog tattoo.) A dream of mine is to one day run a hot dog stand. Let's say that dream happens, and I open up a concession stand to serve the sporting events of a local high school. If you've already opened `Concessions.xlsx`, let's start on the first tab, Basketball Game Sales.

At the end of each night, the point-of-sale system spits out the day's takings. It looks like in Figure 1.1.

	A	B	C	D	E
1	**Item**	**Category**	**Price**	**Profit**	**Actual Profit**
2	Beer	Beverages	$ 4.00	50%	$ 2.00
3	Hamburger	Hot Food	$ 3.00	67%	$ 2.00
4	Popcorn	Hot Food	$ 5.00	80%	$ 4.00
5	Pizza	Hot Food	$ 2.00	25%	$ 0.50
6	Bottled Water	Beverages	$ 3.00	83%	$ 2.50
7	Hot Dog	Hot Food	$ 1.50	67%	$ 1.00
8	Chocolate Dipped Cone	Frozen Treat	$ 3.00	50%	$ 1.50
9	Soda	Beverages	$ 2.50	80%	$ 2.00
10	Chocolate Bar	Candy	$ 2.00	75%	$ 1.50
11	Hamburger	Hot Food	$ 3.00	67%	$ 2.00
12	Beer	Beverages	$ 4.00	50%	$ 2.00
13	Hot Dog	Hot Food	$ 1.50	67%	$ 1.00
14	Licorice Rope	Candy	$ 2.00	50%	$ 1.00
15	Chocolate Dipped Cone	Frozen Treat	$ 3.00	50%	$ 1.50
16	Nachos	Hot Food	$ 3.00	50%	$ 1.50
17	Pizza	Hot Food	$ 2.00	25%	$ 0.50
18	Beer	Beverages	$ 4.00	50%	$ 2.00
19	Soda	Beverages	$ 2.50	80%	$ 2.00
20	Beer	Beverages	$ 4.00	50%	$ 2.00

Figure 1.1: Concession stand sales

This data is laid out in *tabular format*. This is likely something you're very familiar with. In Excel it's made up of *rows*, *columns*, and *cells*.

Some areas of data science may call these by different names. For instance, a row might be called a *record*, *observation*, or *tuple*. A column might be called a *field*, *feature*,

or *dimension*. In truth, it doesn't matter what you call them so long as you use them well. However, you should take note that those around you might use different terms depending upon their field.

Accessing Quick Descriptive Statistics

Excel has the ability to instantly provide summary statistics—such as average, sum, min, and max—in the status bar. However, most of these measures aren't enabled by default. You'll likely want to refer to these continuously along your data journey.

To see what I mean, select cell E2 and then press Ctrl+Shift+Down (⌘+Shift+Down on a Mac). This will automatically highlight the data region of the entire column, spanning from E2:E200.

TIP

If you're the type who loves keyboard shortcuts, my friend, David Bruns, has put together a very handy list of shortcuts for both Mac and PC on his website, Excel Jet. See `https://exceljet.net/shortcuts`.

Look at the lower-right portion of your status bar. It should show an average of $1.79. Right-click the average label in your status bar, and you'll see multiple measures you can select (see Figure 1.2). Go ahead and select Average, Count, Numerical Count, Minimum, Maximum, and Sum. Once complete, you'll see they're now all available in the status bar. You'll appreciate having these measures at a moment's glance.

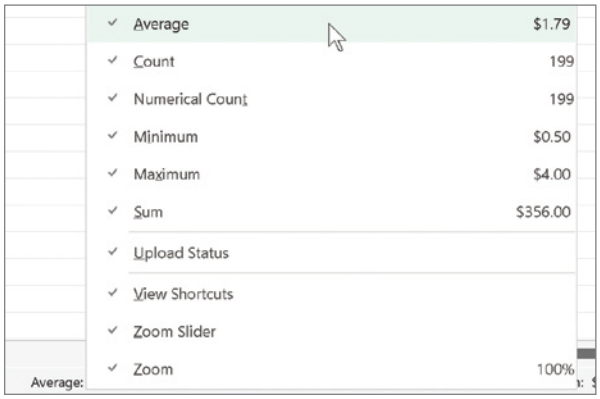


Figure 1.2: When you right-click the status bar, you have the option to have additional descriptive statistics reported to you. Select all of them.

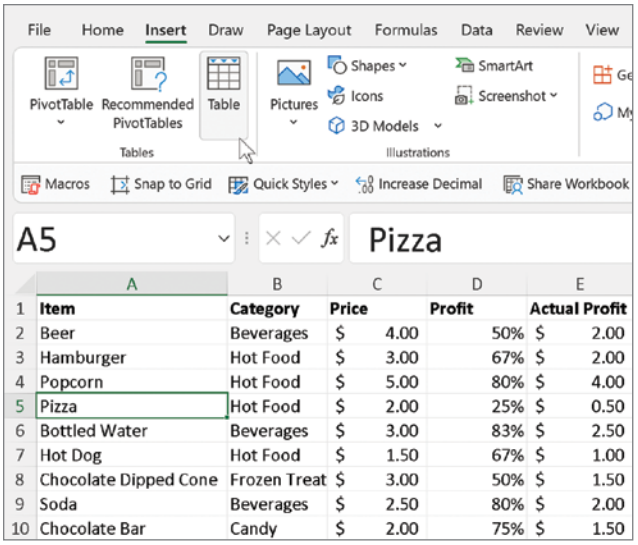
Excel Tables

Perhaps you have experience with Excel formulas. You know, for instance, we could place a formula like `=AVERAGE(E2:E200)` in a blank cell to find the average.

Unfortunately, the cell reference (E2:E200) inside the AVERAGE formula is a bit of problem for the data scientist. What if we want to add 50 records? We would have to remember to update the AVERAGE formula to the new cell address of E2:E250. What if we moved the data from column E to column F? We would *again* have to ensure the AVERAGE formula pulls from F2:F250. And when you think about it, what does E2:E200 or F2:F250 really tell us about the data it represents?

You may have accepted that clunky formulas and misaligned references are just part of Excel. But I'm here to tell you there's a better way. Excel tables were created to meet the challenges described.

To apply an Excel table, place the cursor anywhere inside the data region. On the Insert tab, click Table (see Figure 1.3).

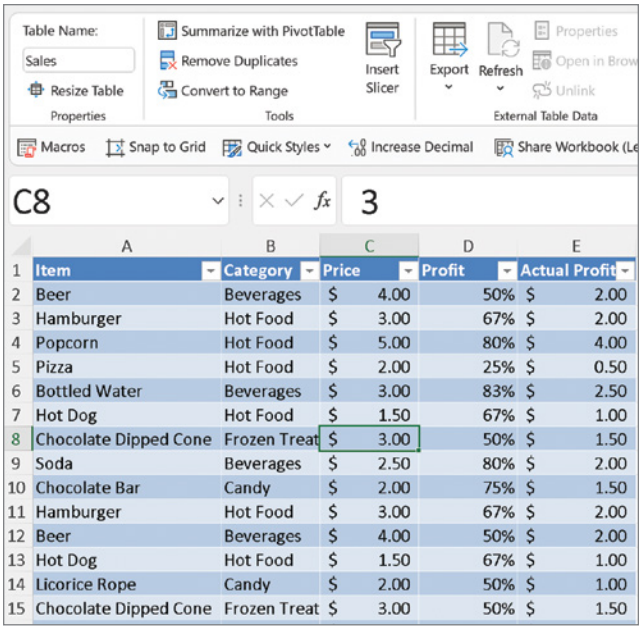


	A	B	C	D	E
1	**Item**	**Category**	**Price**	**Profit**	**Actual Profit**
2	Beer	Beverages	$ 4.00	50%	$ 2.00
3	Hamburger	Hot Food	$ 3.00	67%	$ 2.00
4	Popcorn	Hot Food	$ 5.00	80%	$ 4.00
5	Pizza	Hot Food	$ 2.00	25%	$ 0.50
6	Bottled Water	Beverages	$ 3.00	83%	$ 2.50
7	Hot Dog	Hot Food	$ 1.50	67%	$ 1.00
8	Chocolate Dipped Cone	Frozen Treat	$ 3.00	50%	$ 1.50
9	Soda	Beverages	$ 2.50	80%	$ 2.00
10	Chocolate Bar	Candy	$ 2.00	75%	$ 1.50

Figure 1.3: To insert an Excel table, place your cursor anywhere in the table region. Then, on the Insert tab, click the Table button.

In the Create Table dialog box, ensure that My Table Has Headers is selected, and then click OK.

You have now applied an Excel table. Your screen should look like in Figure 1.4.



	A	B	C	D	E
1	Item	Category	Price	Profit	Actual Profit
2	Beer	Beverages	$ 4.00	50%	$ 2.00
3	Hamburger	Hot Food	$ 3.00	67%	$ 2.00
4	Popcorn	Hot Food	$ 5.00	80%	$ 4.00
5	Pizza	Hot Food	$ 2.00	25%	$ 0.50
6	Bottled Water	Beverages	$ 3.00	83%	$ 2.50
7	Hot Dog	Hot Food	$ 1.50	67%	$ 1.00
8	Chocolate Dipped Cone	Frozen Treat	$ 3.00	50%	$ 1.50
9	Soda	Beverages	$ 2.50	80%	$ 2.00
10	Chocolate Bar	Candy	$ 2.00	75%	$ 1.50
11	Hamburger	Hot Food	$ 3.00	67%	$ 2.00
12	Beer	Beverages	$ 4.00	50%	$ 2.00
13	Hot Dog	Hot Food	$ 1.50	67%	$ 1.00
14	Licorice Rope	Candy	$ 2.00	50%	$ 1.00
15	Chocolate Dipped Cone	Frozen Treat	$ 3.00	50%	$ 1.50

Figure 1.4: Concession stand data with an Excel table applied

Whenever you create a new table, the Table Design ribbon tab appears, allowing you to interact with the table. As a first step for working with Excel tables, give the table a good name.

Excel will attempt to name the table for you with names like Table1, Table2, and mysteriously, Table1_2. You should never accept these default names (it's tacky!), but instead set a proper name reflecting the underlying dataset.

In the upper-left corner of the Table Design tab you can set the table's name. In Figure 1.4, I've set it to **Sales**. You'll quickly see why this is important.

Tables provide tons of features, akin to the data frames of Python and R that make doing data science in Excel that much easier. For one, as you scroll down an Excel table, the normal alphabetical column headers are replaced with the table's fields. This allows you to work with a table and know which column you're working with without freezing the top row. Take a look at Figure 1.5.

Filtering and Sorting

Tables have filtering and sorting already baked in (no need to apply the filtering feature on the Home or Data tab). For instance, if I want to simply look at the sales of hot dogs, I can filter the Item column by clicking the drop-down button in the header and selecting the item of interest (see Figure 1.6).

	Item	Category	Price	Profit	Actual Profit
2	Beer	Beverages	$ 4.00	50%	$ 2.00
3	Hamburger	Hot Food	$ 3.00	67%	$ 2.00
4	Popcorn	Hot Food	$ 5.00	80%	$ 4.00
5	Pizza	Hot Food	$ 2.00	25%	$ 0.50
6	Bottled Water	Beverages	$ 3.00	83%	$ 2.50
7	Hot Dog	Hot Food	$ 1.50	67%	$ 1.00
8	Chocolate Dipped Cone	Frozen Treat	$ 3.00	50%	$ 1.50
9	Soda	Beverages	$ 2.50	80%	$ 2.00
10	Chocolate Bar	Candy	$ 2.00	75%	$ 1.50
11	Hamburger	Hot Food	$ 3.00	67%	$ 2.00
12	Beer	Beverages	$ 4.00	50%	$ 2.00
13	Hot Dog	Hot Food	$ 1.50	67%	$ 1.00
14	Licorice Rope	Candy	$ 2.00	50%	$ 1.00
15	Chocolate Dipped Cone	Frozen Treat	$ 3.00	50%	$ 1.50

Figure 1.5: Tables will replace the column headers with the column names. This means you can work with the table without having to freeze the header row.

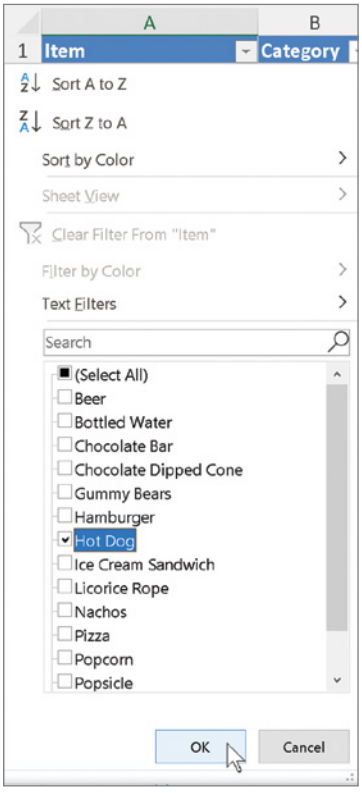


Figure 1.6: Tables already have filters bulit-in. To filter a specific column, press the gray drop-down button next to the column header.

To clear the filter, again, simply click the drop-down in the header of Items and select Clear Filter From Item.

Before moving on, take a look at the different options available in the drop-downs. Note that there are many ways to sort and filter your data.

Table Formatting

Excel's default formatting of tables is hideous. (Sorry, that's just how I feel.) I can't abide by the tacky overcolored defaults. For ease of reading the data in your tables, my recommendation is to use the Table style menu and select a table style from the Light category that does not include banded rows (see Figure 1.7).

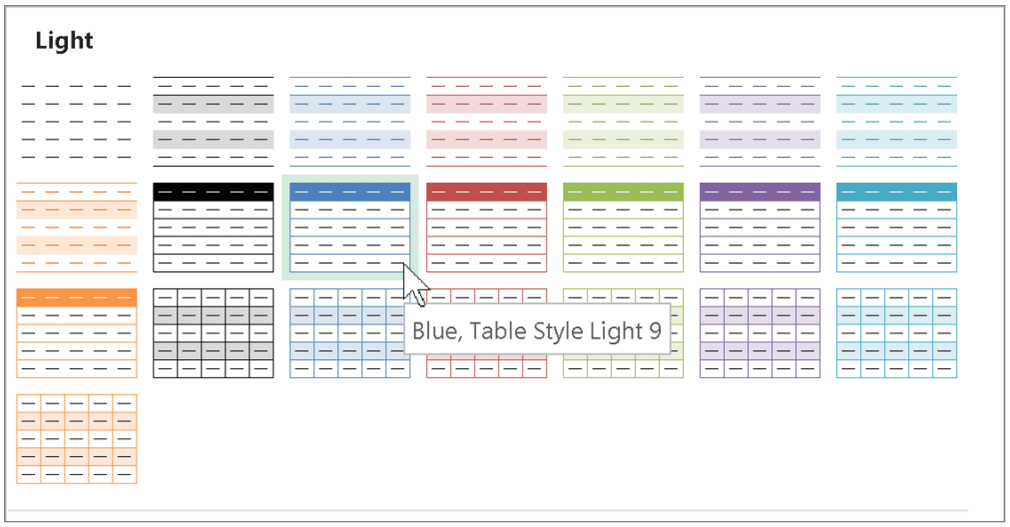


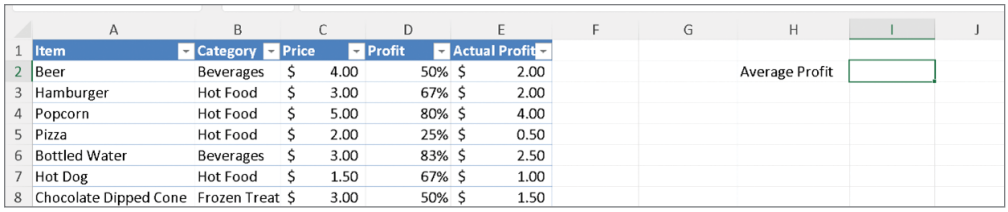
Figure 1.7: The default table formatting is overly colorful and distracting. However, the lighter styles will make your data easy to read and comprehend.

Going forward, I will always adjust the table style to one of the easier-to-read options even when I haven't directed you to do so.

Structured References

Structured references are the single most important feature of Excel tables. Remember, at the start of the chapter, we focused on the issues of using cell references in formulas. Let's see how Excel tables switch things up.

In cell H2 on the Basketball Game Sales tab, I've created a label called Average Profit. To the right of it, in cell I2, I'll write my Average formula. You can set this up like in Figure 1.8.



	Item	Category	Price	Profit	Actual Profit		
2	Beer	Beverages	$ 4.00	50%	$ 2.00	Average Profit	
3	Hamburger	Hot Food	$ 3.00	67%	$ 2.00		
4	Popcorn	Hot Food	$ 5.00	80%	$ 4.00		
5	Pizza	Hot Food	$ 2.00	25%	$ 0.50		
6	Bottled Water	Beverages	$ 3.00	83%	$ 2.50		
7	Hot Dog	Hot Food	$ 1.50	67%	$ 1.00		
8	Chocolate Dipped Cone	Frozen Treat	$ 3.00	50%	$ 1.50		

Figure 1.8: The label "Average Profit" has been added to H2. The cell I2 is where we'll add our formula.

In cell I2, start typing `=AVERAGE` to begin your Average formula. Instead of using a cell reference, we'll use a reference to our table, which I have named Sales.

Note that as you begin to type **Sales**, the name Sales appears in the IntelliSense prompt with a table icon next to it. Once you have completed typing Sales (or selected it from the IntelliSense drop-down), the entire table is highlighted, reflecting that you are now referring to the table. You can see this in Figure 1.9.

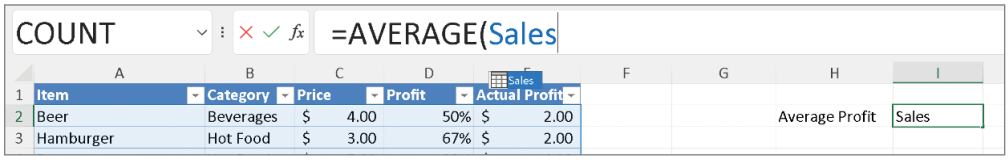


Figure 1.9: The Excel table was named Sales. As you type **Sales** into the formula bar, Excel recognizes that it's an Excel table and provides you with a direct, named reference.

Now that you have access to the table, you'll want to access a specific field. After the table name is entered, press the left square bracket ([) on your keyboard. This opens the table to allow you to select the field of choice (see Figure 1.10). Let's select Actual Profit. You can either type this field (make sure to add a right square bracket] at the end) or select it from the IntelliSense drop-down. Once complete, Excel will highlight the column accordingly, like in Figure 1.11.

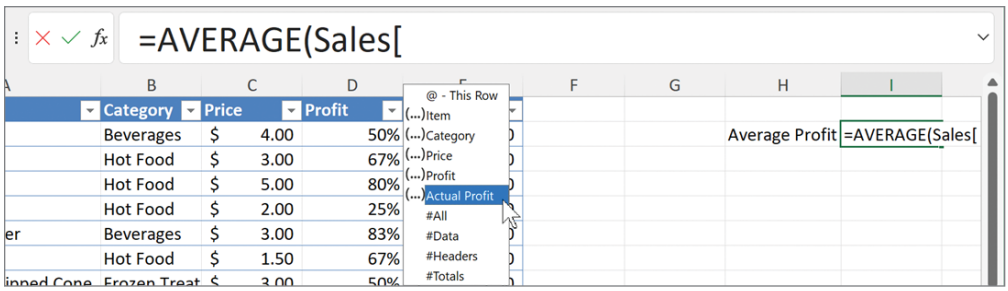
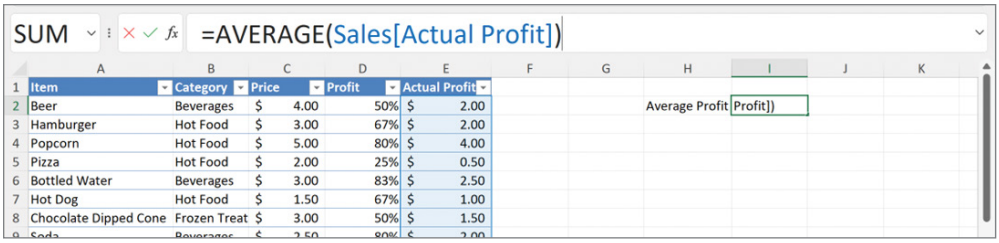


Figure 1.10: Once you've typed in the table name and added a left square bracket, you will have access to every field and additional table properties.



	Item	Category	Price	Profit	Actual Profit
2	Beer	Beverages	$ 4.00	50%	$ 2.00
3	Hamburger	Hot Food	$ 3.00	67%	$ 2.00
4	Popcorn	Hot Food	$ 5.00	80%	$ 4.00
5	Pizza	Hot Food	$ 2.00	25%	$ 0.50
6	Bottled Water	Beverages	$ 3.00	83%	$ 2.50
7	Hot Dog	Hot Food	$ 1.50	67%	$ 1.00
8	Chocolate Dipped Cone	Frozen Treat	$ 3.00	50%	$ 1.50

Figure 1.11: When referring to a table's column field in Excel, you will see the selected column highlighted like a cell reference.

Once you're happy with the formula, press Enter. The average profit spend is 1.79ish. To format this cell to a dollar amount, you can click the dollar sign icon ($) on the Home ribbon tab in the Number group to turn it into a two-decimal dollar amount.

Now, I want to draw your attention to the magic of tables and structured references. Structured references can grow and shrink based on how much data is contained in the table without having to adjust the formulas that use them. Let's see this in action.

Scroll all the way down to the bottom of the table and place your cell in the leftmost cell at the bottom of the table. In this case, that's cell A201 (see Figure 1.12).

	A	B	C	D	E
199	Bottled Water	Beverages	$ 3.00	83%	$ 2.50
200	Popsicle	Frozen Treat	$ 3.00	83%	$ 2.50
201					

Figure 1.12: To automatically add information to an Excel table, place your cursor in the cells directly under the last record and add your new data.

Let's add a new record in cell A201 by typing **Popsicle**. Then, press Enter. Note that the table has now grown to consume this new record. In the Profit field, add a large dollar amount like $2000. Your table should now look like in Figure 1.13.

	Item	Category	Price	Profit	Actual Profit
190	Popsicle	Frozen Treat	$ 3.00	83%	$ 2.50
191	Gummy Bears	Candy	$ 2.00	50%	$ 1.00
192	Pizza	Hot Food	$ 2.00	25%	$ 0.50
193	Bottled Water	Beverages	$ 3.00	83%	$ 2.50
194	Popcorn	Hot Food	$ 5.00	80%	$ 4.00
195	Beer	Beverages	$ 4.00	50%	$ 2.00
196	Pizza	Hot Food	$ 2.00	25%	$ 0.50
197	Popsicle	Frozen Treat	$ 3.00	83%	$ 2.50
198	Chocolate Bar	Candy	$ 2.00	75%	$ 1.50
199	Bottled Water	Beverages	$ 3.00	83%	$ 2.50
200	Popsicle	Frozen Treat	$ 3.00	83%	$ 2.50
201	Popsicle				$2,000

Figure 1.13: When you add new data to the bottom of a table, it will automatically grow to consume the new information. However, you won't need to change any of the formulas that refer to it.