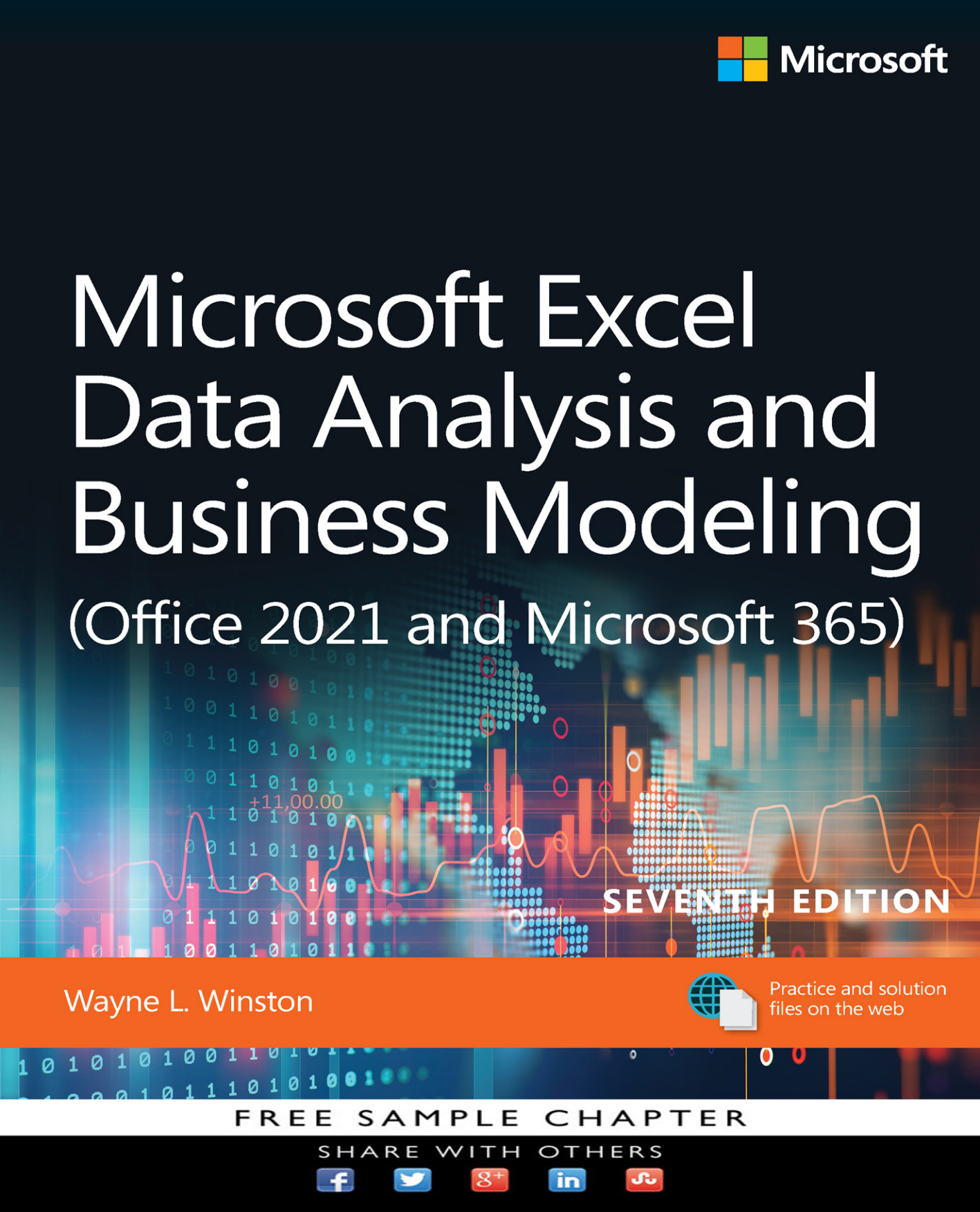
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7th Edition

Wayne Winston

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Dedication

To Vivian, Jen, and Greg. You are all so great, and I love all of you so much!

Contents at a Glance

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About the Author

Wayne L. Winston is Professor Emeritus of Decision Sciences at the Indiana University School of Business. He has also taught at the University of Houston and Wake Forest. He has won more than 40 teaching awards and taught Excel modeling and analytics at many Fortune 500 companies, accounting firms, the U.S. Army, and the U.S. Navy. He is a two-time *Jeopardy*! champion, and also is a co-developer of a player tracking system utilized by Mark Cuban and the Dallas Mavericks.

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Introduction

Whether you work for a Fortune 500 corporation, a small company, a government agency, or a not-for-profit organization, if you're reading this introduction, the chances are you use Microsoft Excel in your daily work. Your job probably involves summarizing, reporting, and analyzing data. It might also involve building analytic models to help your employer increase profits, reduce costs, or manage operations more efficiently.

Since 1999, I've taught thousands of analysts at organizations such as Abbott Labs, Booz Allen Hamilton consulting, Bristol-Myers Squibb, Broadcom, Cisco Systems, Deloitte Consulting, Drugstore.com, eBay, Eli Lilly, Ford, General Electric, General Motors, Intel, Microsoft, MGM Hotels, Morgan Stanley, NCR, Owens Corning, Pfizer, Proctor & Gamble, PWC, Sabre, Schlumberger, Tellabs, 3M, the U.S. Army, the U.S. Department of Defense, the U.S. Navy, and Verizon how to use Excel more efficiently and productively in their jobs. Students have often told me that the tools and methods I teach in my classes have saved them hours of time each week and provided them with new and improved approaches for analyzing important business problems.

I've used the techniques described in this book in my own consulting practice to solve many business problems. For example, I have used Excel to help the Dallas Mavericks and New York Knickerbockers NBA basketball teams evaluate referees, players, and lineups. During the last 20 years, I have also taught Excel business modeling and data analysis classes to MBA students at Indiana University's Kelley School of Business, the University of Houston's Bauer College of Business, and the Wake Forest Professional MBA Program. (As proof of my teaching excellence, I have won more than 45 teaching awards and have won the school's overall MBA teaching award six times.) Also, I would like to note that 95 percent of MBA students at Indiana University took my spreadsheet modeling class even though it was an elective.

The book you have in your hands is an attempt to make these successful classes available to everyone. Here is why I think the book will help you learn how to use Excel more effectively:

- The materials have been tested while teaching thousands of analysts working for Fortune 500 corporations and government agencies.
- The book has also been used to teach thousands of MBA's at Indiana University, Wake Forest, and the University of Houston.
- Material from the book has been used to teach thousands of accountants Excel and analytics through Becker's continuing education for accountants.

- I've written the book as though I am talking to the reader. I hope this approach transfers the spirit of a successful classroom environment to the written page.
- I teach by example, which makes concepts easier to master. These examples are constructed to have a real-world feel. Many of the examples are based on questions sent to me by employees of Fortune 500 corporations.

For the most part, I lead you through the approaches I take in Excel to set up and answer a wide range of data analysis and business questions. You can follow along with my explanations by referring to the sample worksheets that accompany each example. However, I have also included template files for the book's examples on the companion website, *MicrosoftPressStore.com/Excel365data7e/downloads*. If you want to, you can use these templates to work directly with Excel and complete each example on your own.

Generally, the chapters in this book are short and organized around a single concept. You should be able to master the content of most chapters with at most two hours of study. By looking at the questions that begin each chapter, you'll gain an idea about the types of problems you'll be able to solve after mastering a chapter's topics.

In addition to learning about Excel formulas, you will learn some important math in a painless fashion. For example, you'll learn about statistics, forecasting, optimization models, Monte Carlo simulation, inventory modeling, and the mathematics of waiting in line. You will also learn about some recent developments in business thinking, such as real options, customer value, and mathematical pricing models.

At the end of each chapter, I've provided a group of practice problems (more than 900 in total) that you can work through on your own. Many of these problems are based on actual situations faced by business analysts at Fortune 500 companies. These problems will help you fully understand the information in each chapter. Answers to all problems are included in files you can download from the book's companion website.

Most of all, learning should be fun. If you read this book, you will learn how to predict U.S. presidential elections, how to set football point spreads, how to determine the probability of winning at craps, and how to determine the probability of a specific team winning an NCAA tournament. These examples are interesting and fun, and they also teach you a lot about solving business problems with Excel.

Note To follow along with all chapters, you must have Office 365. For most of the book, Excel 2016, 2019, or 2021 should suffice. Previous versions of this book can be used with Excel 2003, 2007, 2010, and 2013.

What you should know before reading this book

To follow the examples in this book, you do not need to be an Excel guru. Basically, the two key actions you should know how to do are the following:

- **Enter a formula** You should know that formulas must begin with an equals sign (=). You should also know the basic mathematical operators. For example, you should know that an asterisk (*) is used for multiplication, a forward slash (/) is used for division, and the caret key (^) is used to raise a quantity to a power.
- **Work with cell references** You should know that when you copy a formula that contains a cell reference such as A4 (an absolute cell reference, which is created by including the dollar signs), the formula still refers to cell A4 in the cells you copy it to. When you copy a formula that contains a cell reference such as $A4 (a mixed cell address), the column remains fixed, but the row changes. Finally, when you copy a formula that contains a cell reference such as A4 (a relative cell reference), both the row and the column of the cells referenced in the formula change.

These ideas are thoroughly described in Chapter 1.

How to use this book

As you read along with the examples in this book, you can take one of two approaches:

- You can open the template file that corresponds to the example you are studying and complete each step of the example as you read the book. You will be surprised how easy this process is and amazed with how much you learn and retain. This is the approach I use in my corporate classes.
- Instead of working in the template files, you can follow my explanations as you look at the final version of each sample file.

What's New in this Edition

This edition contains more new material than any previous edition. New material includes

- Chapter 3 contains discussion of the new **XLOOKUP** function as well a discussion of approximate lookups and issues that arise when lookup formulas get confused about whether cell entries are text or numbers.

- Chapter 6 contains a discussion of how Excel deals with special formats such as phone numbers and leading zeroes.
- Chapter 7 contains a discussion of the **EOMONTH** and **EDATE** functions.
- Chapter 25 contains a discussion of issues that arise when you copy formulas involving table references.
- A completely new Chapter 28 contains an extensive discussion of Power Query.
- A completely new Chapter 29 provides complete coverage of Office 365's new data types.
- Chapter 32 contains a discussion of sorting across columns and sorting based on the case (lower or upper) of the first character in a cell.
- Chapter 33 contains a discussion of sorting based on a selected cell.
- Chapter 35 on arrays has been updated to recognize the obsolescence of the dreaded **Ctrl+Shift+Enter** keystroke combination which was previously required to enter array functions and formulas.
- A brand new Chapter 36 covers Office 365's brand new dynamic array **UNIQUE, SORT, SORTBY, FILTER**, and **SEQUENCE** functions.
- Chapter 37 uses dynamic array formulas to create nested dropdown boxes.
- Chapter 38 uses dynamic arrays to emulate a PivotTable.
- Chapter 42 discusses the use of **SUBTOTAL** functions.
- A completely new Chapter 43 contains a comprehensive introduction to Excel's most widely used charts. Chapter 44 covers more advanced charting techniques.
- A new Chapter 65 discusses Office 365's amazing **STOCKHISTORY** function.
- Chapter 79 discusses Office 365's new **RANDARRAY** function and shows how to use **RANDARRAY** to generate a random sample from a data set.
- Chapter 93 adds several more examples of recording macros.
- A brand new Chapter 94 discusses Office 365's **Analyze Data** feature, which with a single click gives you insights and ideas about your data.
- A brand new Chapter 95 contains a brief introduction to custom functions and Office 365's **LET, LAMBDA**, and **LAMBDA** helper functions.

Downloads

This book features a companion website that makes available to you all the sample files, solution files, and templates you can use in the book's examples (both the final Excel workbooks and the starting templates you can work with on your own). The workbooks and templates are organized in folders named for each chapter. The answers to all chapter-ending problems in the book are also included with the sample files. Each answer file is named so that you can identify it easily. For example, the file containing the answer to Problem 2 in Chapter 10 is named S10_2.xlsx.

To work through the examples in this book, you need to copy the book's sample files to your computer. These practice files can be downloaded from the book's download page, located at

MicrosoftPressStore.com/Excel365data7e/downloads

Display the page in your web browser and follow the instructions for downloading the files.

Acknowledgments

I am eternally grateful to Jennifer Skoog and Norm Tonina, who had faith in me and first hired me to teach Excel classes for Microsoft finance. Jennifer, in particular, was instrumental in helping design the content and style of the classes on which the book is based. Keith Lange of Eli Lilly, Pat Keating and Doug Hoppe of Cisco Systems, and Dennis Fuller of the U.S. Army also helped me refine my thoughts on teaching data analysis and modeling with Excel.

Kate Shoup did an **incredible** job as Development Editor. David Franson did a wonderful job technically editing the book. Charvi Aurori did a great job as Sponsoring Editor. Scout Festa was a thorough copy editor. Senior Production Editor Tracey Croom assisted me with the Pearson template when I was clueless. As always, Executive Editor Loretta Yates did a great job shepherding the project to completion and answered many emails instantly! And finally, the team at codeMantra, lead by Project Manager Vaishnavi Venkatesan, produced the chapters at breakneck speed, ensuring the book made it into the hands of readers as soon as possible.

I am also grateful to my many students at the organizations where I've taught and students at the Indiana University Kelley School of Business, Wake Forest, and the University of Houston Bauer College of Business. Many of them have taught me things I did not know about Excel.

Alex Blanton, formerly of Microsoft Press, championed this project at the start and shared my vision of developing a user-friendly text designed for use by business analysts.

Finally, my lovely and talented wife, Vivian, and my wonderful children, Jennifer and Gregory, put up with my long weekend hours at the keyboard.

Errata, updates, and book support

We've made every effort to ensure the accuracy of this book and its companion content. You can access updates to this book—in the form of a list of submitted errata and their related corrections—at:

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CHAPTER 4

The INDEX function

Questions answered in this chapter:

- I have a list of distances between US cities. How do I write a function that returns the distance between, for example, Seattle and Miami?
- Is there a way I can write a formula that references the entire column containing the distances between each city and Seattle?

Syntax of the INDEX function

The **INDEX** function enables you to return the entry in any row and column within an array of numbers. The most commonly used syntax for the **INDEX** function is the following:

INDEX(*array*,*row_number*,*column_number*)

To illustrate, the formula **=INDEX(A1:D12,2,3)** returns the entry in the second row and third column of the array A1:D12. This entry is the one in cell C2.

Answers to this chapter's questions

I have a list of distances between US cities. How do I write a function that returns the distance between, for example, Seattle and Miami?

The file named INDEX.xlsx (see Figure 4-1) contains the distances between eight US cities. The range C10:J17, which contains the distances, is named *distances*.

	A	B	C	D	E	F	G	H	I	J
1										
2										
3										
4		Boston-Denver	1991			T Dist to Seattle	15221			
5		Seattle- Miami	3389							
6										
7										
8										
9			Boston	Chicago	Dallas	Denver	LA	Miami	Phoenix	Seattle
10	1	Boston	0	983	1815		3036	1539	2664	2612
11	2	Chicago	983	0	1205	1050	2112	1390	1729	2052
12	3	Dallas	1815	1205	0	801	1425	1332	1027	2404
13	4	Denver	1991	1050	801	0	1174	2100	836	1373
14	5	LA	3036	2112	1425	1174	0	2757	398	1909
15	6	Miami	1539	1390	1332	2100	2757	0	2359	3389
16	7	Phoenix	2664	1729	1027	836	398	2359	0	1482
17	8	Seattle	2612	2052	2404	1373	1909	3389	1482	0

FIGURE 4-1 You can use the **INDEX** function to calculate the distance between cities.

Suppose you want to enter in a cell the distance between Boston and Denver. Because distances from Boston are listed in the first row of the array named *distances*, and distances to Denver are listed in the fourth column of the array, the appropriate formula is **=INDEX(distances,1,4)**. The results show that Boston and Denver are 1,991 miles apart. Similarly, to find the (much longer) distance between Seattle and Miami, you would use the formula **=INDEX(distances,6,8)**. Seattle and Miami are 3,389 miles apart.

Imagine that the Seattle Seahawks NFL team is embarking on a road trip during which they will play games in Phoenix, Los Angeles, Denver, Dallas, and Chicago. At the conclusion of the road trip, the Seahawks will return to Seattle. Can you easily compute how many miles they will travel on the trip? As you can see in Figure 4-2, you simply list the numbers in the spreadsheet that correspond with the cities that the Seahawks will visit (8, 7, 5, 4, 3, 2, 8), one number per row, in the order the cities will be visited, starting and ending in Seattle. Then, copy the formula **INDEX(distances,C21,C22)** from D21 to D26. The formula in D21 computes the distance between Seattle and Phoenix (city number 7), the formula in D22 computes the distance between Phoenix and Los Angeles, and so on. The Seahawks will travel a total of 7,112 miles on their road trip. (Just for fun, I used the **INDEX** function to determine that the Miami Heat travel more miles during the NBA season than any other team.)

	C	D
19	Road Trip!!	
20	City	Distance
21	8	1482
22	7	398
23	5	1174
24	4	801
25	3	1205
26	2	2052
27	8	
28	Total	7112

FIGURE 4-2 Distances for a Seattle Seahawks road trip.

Is there a way I can write a formula that references the entire column containing the distances between each city and Seattle?

The **INDEX** function makes it easy to reference an entire row or column of an array. If you set the row number to **0**, the **INDEX** function references the listed column. If you set the column number to **0**, the **INDEX** function references the listed row in the array. To illustrate, suppose you want to total the distances from each listed city to Seattle. You could enter either of the following formulas:

```
=SUM(INDEX(distances,8,0))

=SUM(INDEX(distances,0,8))
```

The first formula totals the numbers in the eighth row (row 17) of the *distances* array; the second formula totals the numbers in the eighth column (column J) of the *distances* array. In either case, you find that the total distance from Seattle to the other cities is 15,221 miles. (Refer to Figure 4-1.)

Problems

1. Use the **INDEX** function to compute the distance between Los Angeles and Phoenix and the distance between Denver and Miami.
2. Use the **INDEX** function to compute the total distance from Dallas to the seven other cities listed in Figure 4-1.
3. Jerry Jones and the Dallas Cowboys are embarking on a road trip that takes them to Chicago, Denver, Los Angeles, Phoenix, and Seattle. How many miles will they travel on this road trip?
4. The file named Product.xlsx contains monthly sales for six products. Use the **INDEX** function to compute the sales of Product 2 in March. Use the **INDEX** function to compute total sales during April.
5. The file named NBAdistances.xlsx shows the distance between any pair of NBA arenas. Suppose you begin in Atlanta, visit the arenas in the order listed, and then return to Atlanta. How far would you travel?
6. Use the **INDEX** function to solve Problem 10 of Chapter 3, "Lookup functions." Here is the problem again: The file named Employees.xlsx contains the rating (on a 0–10 scale) that each of 35 workers has given to three jobs. The file also gives the job to which each worker is assigned. Use a formula to compute each worker's ranking for the job to which the worker is assigned.

Index

Symbols

A

B

C

D

E

F

G

H

I

J

K

L

M

N

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P

Q

R

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T

U

V

W

X

Y

Z