Microsoft Excel Data Analysis and Business Modeling
(Office 2021 and Microsoft 365)

SEVENTH EDITION

Wayne L. Winston

FREE SAMPLE CHAPTER
Microsoft Excel Data Analysis and Business Modeling (Office 2021 and Microsoft 365)

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

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>xxiii</td>
<td>About the Author</td>
<td></td>
</tr>
<tr>
<td>xxv</td>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>CHAPTER 1 Basic worksheet modeling</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>CHAPTER 2 Range names</td>
<td>11</td>
</tr>
<tr>
<td>25</td>
<td>CHAPTER 3 Lookup functions</td>
<td>25</td>
</tr>
<tr>
<td>39</td>
<td>CHAPTER 4 The INDEX function</td>
<td>39</td>
</tr>
<tr>
<td>43</td>
<td>CHAPTER 5 The MATCH function</td>
<td>43</td>
</tr>
<tr>
<td>51</td>
<td>CHAPTER 6 Text functions and Flash Fill</td>
<td>51</td>
</tr>
<tr>
<td>73</td>
<td>CHAPTER 7 Dates and date functions</td>
<td>73</td>
</tr>
<tr>
<td>85</td>
<td>CHAPTER 8 The net present value functions: NPV and XNPV</td>
<td>85</td>
</tr>
<tr>
<td>93</td>
<td>CHAPTER 9 The internal rate of return: IRR, XIRR, and MIRR functions</td>
<td>93</td>
</tr>
<tr>
<td>101</td>
<td>CHAPTER 10 More Excel financial functions</td>
<td>101</td>
</tr>
<tr>
<td>117</td>
<td>CHAPTER 11 Circular references</td>
<td>117</td>
</tr>
<tr>
<td>123</td>
<td>CHAPTER 12 IF, IFERROR, IFS, CHOOSE, SWITCH, and the IS functions</td>
<td>123</td>
</tr>
<tr>
<td>149</td>
<td>CHAPTER 13 Time and time functions</td>
<td>149</td>
</tr>
<tr>
<td>157</td>
<td>CHAPTER 14 The Paste Special command</td>
<td>157</td>
</tr>
<tr>
<td>165</td>
<td>CHAPTER 15 Three-dimensional formulas and hyperlinks</td>
<td>165</td>
</tr>
<tr>
<td>171</td>
<td>CHAPTER 16 The auditing tool and the Inquire add-in</td>
<td>171</td>
</tr>
<tr>
<td>183</td>
<td>CHAPTER 17 Sensitivity analysis with data tables</td>
<td>183</td>
</tr>
<tr>
<td>197</td>
<td>CHAPTER 18 The Goal Seek command</td>
<td>197</td>
</tr>
<tr>
<td>203</td>
<td>CHAPTER 19 Using the Scenario Manager for sensitivity analysis</td>
<td>203</td>
</tr>
<tr>
<td>209</td>
<td>CHAPTER 20 The COUNTIF, COUNTIFS, COUNT, COUNTA, and COUNTBLANK functions</td>
<td>209</td>
</tr>
<tr>
<td>217</td>
<td>CHAPTER 21 The SUMIF, AVERAGEIF, SUMIFS, AVERAGEIFS, MAXIFS, and MINIFS functions</td>
<td>217</td>
</tr>
<tr>
<td>225</td>
<td>CHAPTER 22 The OFFSET function</td>
<td>225</td>
</tr>
<tr>
<td>239</td>
<td>CHAPTER 23 The INDIRECT function</td>
<td>239</td>
</tr>
<tr>
<td>251</td>
<td>CHAPTER 24 Conditional formatting</td>
<td>251</td>
</tr>
<tr>
<td>283</td>
<td>CHAPTER 25 Excel tables and table slicers</td>
<td>283</td>
</tr>
</tbody>
</table>
CHAPTER 26  Spin buttons, scrollbars, option buttons, check boxes, combo boxes, and group list boxes  301
CHAPTER 27  Importing data from a text file or document  315
CHAPTER 28  The Power Query Editor  321
CHAPTER 29  Excel’s new data types  343
CHAPTER 30  Summarizing data with histograms and Pareto charts  363
CHAPTER 31  Summarizing data with descriptive statistics  377
CHAPTER 32  Sorting in Excel  397
CHAPTER 33  Filtering data and removing duplicates  411
CHAPTER 34  Summarizing data with database statistical functions  429
CHAPTER 35  Array formulas and functions  441
CHAPTER 36  Excel’s new dynamic array functions  461
CHAPTER 37  Validating data  473
CHAPTER 38  Using PivotTables and slicers to describe data  483
CHAPTER 39  The Data Model  541
CHAPTER 40  Power Pivot  551
CHAPTER 41  Consolidating data  571
CHAPTER 42  Creating subtotals  577
CHAPTER 43  Basic charting  585
CHAPTER 44  Advanced charting  617
CHAPTER 45  Filled and 3D Maps  643
CHAPTER 46  Sparklines  659
CHAPTER 47  Estimating straight-line relationships  665
CHAPTER 48  Modeling exponential growth  675
CHAPTER 49  The power curve  681
CHAPTER 50  Using correlations to summarize relationships  689
CHAPTER 51  Introduction to multiple regression  697
CHAPTER 52  Incorporating qualitative factors into multiple regression  705
CHAPTER 53  Modeling nonlinearities and interactions  719
CHAPTER 54  Analysis of variance: One-way ANOVA  727
CHAPTER 55  Randomized blocks and two-way ANOVA  733
CHAPTER 56  Using moving averages to understand time series  745
| CHAPTER 83 | Using resampling to analyze data | 947 |
| CHAPTER 84 | Pricing stock options | 953 |
| CHAPTER 85 | Determining customer value | 967 |
| CHAPTER 86 | The economic order quantity inventory model | 973 |
| CHAPTER 87 | Inventory modeling with uncertain demand | 979 |
| CHAPTER 88 | Queuing theory: The mathematics of waiting in line | 987 |
| CHAPTER 89 | Estimating a demand curve | 993 |
| CHAPTER 90 | Pricing products by using tie-ins | 999 |
| CHAPTER 91 | Pricing products by using subjectively determined demand | 1005 |
| CHAPTER 92 | Nonlinear pricing | 1011 |
| CHAPTER 93 | Use Analyze Data to find patterns in your data | 1019 |
| CHAPTER 94 | Recording macros | 1031 |
| CHAPTER 95 | The LET and LAMBDA functions and the LAMBDA helper functions | 1049 |
| CHAPTER 96 | Advanced sensitivity analysis | 1063 |
|          | Index | 1067 |
# Contents

*About the Author* ................................................................. xxiii  
*Introduction* ........................................................................ xxv  

## Chapter 1  Basic worksheet modeling  
1  
Answers to this chapter’s questions ........................................ 1  
Problems ................................................................................. 9  

## Chapter 2  Range names  
11  
How can I create named ranges? ........................................... 11  
    Using the Name box to create a range name .................. 12  
    Creating named ranges using the Create from Selection option .. 13  
    Creating range names using the Define Name option ........ 15  
    The Name Manager ......................................................... 16  
Answers to this chapter’s questions ........................................ 17  
Remarks ..................................................................................... 23  
Problems ..................................................................................... 23  

## Chapter 3  Lookup functions  
25  
Syntax of the lookup functions ............................................ 25  
    VLOOKUP syntax ......................................................... 25  
    HLOOKUP syntax ......................................................... 26  
    XLOOKUP syntax ......................................................... 26  
Answers to this chapter’s questions ........................................ 27  
Problems ..................................................................................... 35  

## Chapter 4  The INDEX function  
39  
Syntax of the INDEX function ............................................. 39  
Answers to this chapter’s questions ....................................... 39  
Problems ..................................................................................... 41
### Chapter 5  The MATCH function  43
- Syntax of the MATCH function  ............................................. 43
- Answers to this chapter’s questions  .................................... 45
- Problems  ................................................................. 49

### Chapter 6  Text functions and Flash Fill  51
- Text function syntax  .................................................. 52
- Answers to this chapter’s questions  .......................... 56
- Problems  ................................................................. 69

### Chapter 7  Dates and date functions  73
- Answers to this chapter’s questions  ......................... 74
- Problems  ................................................................. 82

### Chapter 8  The net present value functions: NPV and XNPV  85
- Answers to this chapter’s questions  ......................... 86
- Problems  ................................................................. 90

### Chapter 9  The internal rate of return: IRR, XIRR, and MIRR functions  93
- Answers to this chapter’s questions  ......................... 94
- Problems  ................................................................. 98

### Chapter 10  More Excel financial functions  101
- Answers to this chapter’s questions  ......................... 101
- Problems  ................................................................. 112

### Chapter 11  Circular references  117
- Answers to this chapter’s questions  ......................... 117
- Problems  ................................................................. 120
Chapter 12  IF, IFERROR, IFS, CHOOSE, SWITCH, and the IS functions  123
  Answers to this chapter’s questions  ........................................  124
  Problems  .................................................................  143

Chapter 13  Time and time functions  149
  Answers to this chapter’s questions  ..........................................  150
  Problems  .................................................................  155

Chapter 14  The Paste Special command  157
  Answers to this chapter’s questions  ..........................................  157
  Problems  .................................................................  163

Chapter 15  Three-dimensional formulas and hyperlinks  165
  Answers to this chapter’s questions  ..........................................  165
  Problems  .................................................................  169

Chapter 16  The auditing tool and the Inquire add-in  171
  Excel auditing options  ......................................................  172
  Show Formulas  ..............................................................  172
  Error Checking  ...............................................................  173
  Watch Window  ...............................................................  174
  Trace Precedents, Trace Dependents, and Remove Arrows .......  174
  Answers to this chapter’s questions  ..........................................  175
  Problems  .................................................................  182

Chapter 17  Sensitivity analysis with data tables  183
  Answers to this chapter’s questions  ..........................................  184
  Problems  .................................................................  192

Chapter 18  The Goal Seek command  197
  Answers to this chapter’s questions  ..........................................  198
  Problems  .................................................................  201
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Using the Scenario Manager for sensitivity analysis</td>
<td>203</td>
</tr>
<tr>
<td></td>
<td>Answer to this chapter’s question</td>
<td>203</td>
</tr>
<tr>
<td></td>
<td>Remarks</td>
<td>207</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>207</td>
</tr>
<tr>
<td>20</td>
<td>The COUNTIF, COUNTIFS, COUNT, COUNTA, and COUNTBLANK functions</td>
<td>209</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>211</td>
</tr>
<tr>
<td></td>
<td>Remarks</td>
<td>214</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>214</td>
</tr>
<tr>
<td>21</td>
<td>The SUMIF, AVERAGEIF, SUMIFS, AVERAGEIFS, MAXIFS, and MINIFS functions</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>218</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>222</td>
</tr>
<tr>
<td>22</td>
<td>The OFFSET function</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>226</td>
</tr>
<tr>
<td></td>
<td>Remarks</td>
<td>236</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>236</td>
</tr>
<tr>
<td>23</td>
<td>The INDIRECT function</td>
<td>239</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>248</td>
</tr>
<tr>
<td>24</td>
<td>Conditional formatting</td>
<td>251</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>253</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>278</td>
</tr>
<tr>
<td>25</td>
<td>Excel tables and table slicers</td>
<td>283</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>283</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>298</td>
</tr>
</tbody>
</table>
Chapter 26  Spin buttons, scrollbars, option buttons, check boxes, combo boxes, and group list boxes  301
   Answers to this chapter’s questions .............................................. 302
   Problems ....................................................................................... 313

Chapter 27  Importing data from a text file or document  315
   Answers to this chapter’s question .................................................. 315
   Problems ....................................................................................... 320

Chapter 28  The Power Query Editor  321
   Answers to this chapter’s questions .................................................. 323
   Problems ....................................................................................... 340

Chapter 29  Excel’s new data types  343
   Answers to this chapter’s questions .................................................. 347
   Problems ....................................................................................... 362

Chapter 30  Summarizing data with histograms and Pareto charts  363
   Answers to this chapter’s questions .................................................. 363
   Problems ....................................................................................... 376

Chapter 31  Summarizing data with descriptive statistics  377
   Answers to this chapter’s questions .................................................. 378
   Problems ....................................................................................... 393

Chapter 32  Sorting in Excel  397
   Answers to this chapter’s questions .................................................. 398
   Problems ....................................................................................... 409

Chapter 33  Filtering data and removing duplicates  411
   Answers to this chapter’s questions .................................................. 413
   Problems ....................................................................................... 428
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>Creating subtotals</td>
<td>577</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>577</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>583</td>
</tr>
<tr>
<td>43</td>
<td>Basic charting</td>
<td>585</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>586</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>614</td>
</tr>
<tr>
<td>44</td>
<td>Advanced charting</td>
<td>617</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>618</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>641</td>
</tr>
<tr>
<td>45</td>
<td>Filled and 3D Maps</td>
<td>643</td>
</tr>
<tr>
<td></td>
<td>Questions answered in this chapter</td>
<td>643</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>657</td>
</tr>
<tr>
<td>46</td>
<td>Sparklines</td>
<td>659</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>659</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>664</td>
</tr>
<tr>
<td>47</td>
<td>Estimating straight-line relationships</td>
<td>665</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>667</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>672</td>
</tr>
<tr>
<td>48</td>
<td>Modeling exponential growth</td>
<td>675</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>676</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>680</td>
</tr>
<tr>
<td>49</td>
<td>The power curve</td>
<td>681</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>684</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>687</td>
</tr>
<tr>
<td>Chapter</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>50</td>
<td>Using correlations to summarize relationships</td>
<td>689</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>691</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>695</td>
</tr>
<tr>
<td>51</td>
<td>Introduction to multiple regression</td>
<td>697</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>697</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>703</td>
</tr>
<tr>
<td>52</td>
<td>Incorporating qualitative factors into multiple regression</td>
<td>705</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>705</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>718</td>
</tr>
<tr>
<td>53</td>
<td>Modeling nonlinearities and interactions</td>
<td>719</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>719</td>
</tr>
<tr>
<td></td>
<td>Problems for Chapters 51–53</td>
<td>723</td>
</tr>
<tr>
<td>54</td>
<td>Analysis of variance: One-way ANOVA</td>
<td>727</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>728</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>731</td>
</tr>
<tr>
<td>55</td>
<td>Randomized blocks and two-way ANOVA</td>
<td>733</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>734</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>742</td>
</tr>
<tr>
<td>56</td>
<td>Using moving averages to understand time series</td>
<td>745</td>
</tr>
<tr>
<td></td>
<td>Answer to this chapter’s question</td>
<td>745</td>
</tr>
<tr>
<td></td>
<td>Problem</td>
<td>747</td>
</tr>
<tr>
<td>57</td>
<td>Ratio-to-moving-average forecast method</td>
<td>749</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>749</td>
</tr>
<tr>
<td></td>
<td>Problem</td>
<td>752</td>
</tr>
<tr>
<td>Chapter</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>58</td>
<td>An introduction to probability</td>
<td>753</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>753</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>759</td>
</tr>
<tr>
<td>59</td>
<td>An introduction to random variables</td>
<td>763</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>763</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>767</td>
</tr>
<tr>
<td>60</td>
<td>The binomial, hypergeometric, and negative binomial random variables</td>
<td>769</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>770</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>775</td>
</tr>
<tr>
<td>61</td>
<td>The Poisson and exponential random variable</td>
<td>777</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>777</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>780</td>
</tr>
<tr>
<td>62</td>
<td>The normal random variable and Z-scores</td>
<td>781</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>781</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>789</td>
</tr>
<tr>
<td>63</td>
<td>Making probability statements from forecasts</td>
<td>791</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>792</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>793</td>
</tr>
<tr>
<td>64</td>
<td>Using the lognormal random variable to model stock prices</td>
<td>795</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>795</td>
</tr>
<tr>
<td></td>
<td>Remarks</td>
<td>798</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>798</td>
</tr>
</tbody>
</table>
Chapter 65  Importing past stock prices, exchange rates, and cryptocurrency prices with the STOCKHISTORY function  799

Answers to this chapter’s questions ................................................. 799
Problems ..................................................................................... 806

Chapter 66  An introduction to optimization with Excel Solver  807

Answers to this chapter’s questions ................................................. 807
Problems ..................................................................................... 811

Chapter 67  Using Solver to determine the optimal product mix  813

Answers to this chapter’s questions ................................................. 813
Problems ..................................................................................... 822

Chapter 68  Using Solver to schedule your workforce  825

Answers to this chapter’s question ................................................... 825
Problems ..................................................................................... 827

Chapter 69  Using Solver to solve transportation or distribution problems  831

Answer to this chapter’s question ................................................... 831
Problems ..................................................................................... 834

Chapter 70  Using Solver for capital budgeting  837

Answer to this chapter’s question ................................................... 837
Problems ..................................................................................... 842

Chapter 71  Using Solver for financial planning  845

Answers to this chapter’s questions ................................................... 845
Problems ..................................................................................... 850

Chapter 72  Using Solver to rate sports teams  853

Answer to this chapter’s question ................................................... 854
Problems ..................................................................................... 856
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>73</td>
<td>The Winters method and the Forecast Sheet tool</td>
<td>859</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>859</td>
</tr>
<tr>
<td></td>
<td>Remarks</td>
<td>866</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>867</td>
</tr>
<tr>
<td>74</td>
<td>Forecasting in the presence of special events</td>
<td>869</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>869</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>876</td>
</tr>
<tr>
<td>75</td>
<td>Warehouse location and the GRG Multistart and Evolutionary Solver engines</td>
<td>877</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>877</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>887</td>
</tr>
<tr>
<td>76</td>
<td>Penalties and the Evolutionary Solver</td>
<td>889</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>890</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>893</td>
</tr>
<tr>
<td>77</td>
<td>The traveling salesperson problem</td>
<td>895</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>895</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>898</td>
</tr>
<tr>
<td>78</td>
<td>Weibull and beta distributions: Modeling machine life and duration of a project</td>
<td>901</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>901</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>906</td>
</tr>
<tr>
<td>79</td>
<td>Introduction to Monte Carlo simulation</td>
<td>907</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>908</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>916</td>
</tr>
<tr>
<td>80</td>
<td>Calculating an optimal bid</td>
<td>919</td>
</tr>
<tr>
<td></td>
<td>Answers to this chapter’s questions</td>
<td>919</td>
</tr>
<tr>
<td></td>
<td>Problems</td>
<td>922</td>
</tr>
</tbody>
</table>
Chapter 81  Simulating stock prices and asset-allocation modeling  925
   Answers to this chapter’s questions ........................................... 926
   Problems .................................................................................. 934

Chapter 82  Fun and games: Simulating gambling and sporting-event probabilities  937
   Answers to this chapter’s questions ........................................... 937
   Problems .................................................................................. 945

Chapter 83  Using resampling to analyze data  947
   Answer to this chapter’s question ................................................ 947
   Problems .................................................................................. 950

Chapter 84  Pricing stock options  953
   Answers to this chapter’s questions ........................................... 954
   Problems .................................................................................. 965

Chapter 85  Determining customer value  967
   Answers to this chapter’s questions ........................................... 967
   Problems .................................................................................. 972

Chapter 86  The economic order quantity inventory model  973
   Answers to this chapter’s questions ........................................... 973
   Problems .................................................................................. 977

Chapter 87  Inventory modeling with uncertain demand  979
   Answers to this chapter’s questions ........................................... 980
   Problems .................................................................................. 985

Chapter 88  Queuing theory: The mathematics of waiting in line  987
   Answers to this chapter’s questions ........................................... 987
   Problems .................................................................................. 992
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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 $A$4 (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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If you discover an error that is not already listed, please submit it to us at the same page.

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http://twitter.com/MicrosoftPress
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.
CHAPTER 4  The INDEX function

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.)

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
& (ampersand), 54, 212
* (asterisk), 31, 212, 443
{ } (brackets), 25
^ (caret), 87, 685
: (colon), 150
} (curly braces), 76, 451
$ (dollar sign), 4–5
“ (double quotation marks), 211, 451
= (equal sign), 58, 211
>= (greater-than-or-equal-to) operator, 212
< (less-than sign), 782
<= (less-than-or-equal-to) operator, 782
- (minus) sign, 207
<> (not equal to) operator, 212
. (period), 23
| (pipe character), 61
+ (plus sign), 58, 303
? (question mark), 31, 213
; (semicolon), 79, 154
/ (slash), 803
~ (tilde), 31
_ (underscore), 23
2D Chart button, 654
2D charts, summarizing 3D maps as, 654
2D filled maps
creating, 643–647
labeling, 645–646
3D Map button, 648, 656
3D maps
animating data in, 651–653
creating, 647–649
customizing, 650–651
map tours, 649–650
navigating, 649
New York City’s Fourth Avenue subway line example, 655–656
pie charts with labels in, 654
problems for, 657
summarizing with 2D chart, 654
80–20 rule, 374
95 percent confidence interval, for mean profit, 914
95 percent service level, 982–985
A
A Date Occurring dialog box, 257
a posteriori probability, 758
abandonment options, 964–965
absolute addressing, 4–5
Access Web Content dialog box, 323
accounting costs, returning, 121
Accountsums.xlsx file, 280
accuracy of predictions, 671, 872–876
Across worksheet, 407
Adagency.xlsx file, 299
Add Chart Element button, 598, 600, 609, 623, 646, 669
Add Constraint dialog box, 816–817, 827, 839, 862, 896, 897, 933
Add Data Labels button, 590
Add Filter command, 650
Add option (Paste Special), 162
Add This Data to Data Model option (PivotTables), 546
Add Trendline command, 668, 677, 684, 746, 1006
Add Watch option, 174
Add-Ins dialog box, 721, 809, 847, 862, 872, 889, 902
Analysis ToolPak, 364, 378, 692, 698, 728, 735
Solver Add-In. See Microsoft Excel Solver
addition, with Paste Special command, 162
additive rule, for computing probabilities, 755
Addresses.xlsx file, 145
addressing, absolute, 4–5
adjustable-rate mortgage (ARM), 113
Advancedfilter.xlsx file, 436
advertising, sales as function of, 682
age/gender travel expenditure, PivotTables for, 505–509
Ageofmachine.xlsx file, 69
AGGREGATE function, 135–136
Agingdata.xlsx file, 236
airline flight, probability of overbooking, 772
Airlinemilestemp.xlsx file, 864
alerts, error, 474–475
algebra problems, Goal Seek for, 199–200
AllDifferent constraint, 896
alpha, 902, 904
alternative hypothesis, ANOVA, 727
Amazon.com, upward trend in revenues in, 745–747
Amazon.xlsx file, 279, 281
American cash flows, option pricing and, 955
ampersand (&), 54, 212
analysis of variance (ANOVA), 728
for multiple-regression analysis, 710
one-way, 727–732
alternative hypothesis, 727
book sales case study, 728–731
definition of, 727
forecasting with, 731
null hypothesis, 727
problems for, 731–732
single factor, 728
Two-Factor With Replication, 735
Two-Factor Without Replication, 735
two-way, 733–743
forecasting with, 736–737, 740–742
overview of, 733–734
problems for, 742–743
with replication, 737–742
without replication, 734–736
Analysis ToolPak, 364, 378, 692, 721, 728, 735
Analyse Data, 1019–1029
BOM (bill of materials) reports, 1019
overview of, 1019
stock market prices, 1022–1024
Analyze Data button, 1019, 1021, 1022–1024, 1025, 1027
Analyze group (Data tab), 1000
AnalyzeSurveydata.xlsx file, 539
animals, in Excel formulas, 353–354
Animals data type, 354–355
animating 3D maps, 651–653
annuities, 101–103
Another Summary worksheet, 245
ANOVA. See analysis of variance (ANOVA)
antidepressant, determining 99th percentile of demand for, 785–786
Append dialog box, 338–339
appending tables, 338–340
Applenames.xlsx file, 20
area charts, 603–606
ARM (adjustable-rate mortgage), 113
Arrange Windows dialog box, 572
arrays
array formulas and functions
array constants in, 451–452
averaging numbers with, 447–448
calculating median size of transaction with, 452–453
calculating standard deviation with, 453–454
computing hourly wages with, 442–444
editing, 452
emulating counts, sums, and averages with, 454–457
matching names with, 446
monthly stock return updates with, 444–445
overview of, 442
summarizing data with 2D chart, 448–451
summing second digit of list of integers with, 444–445
transposing rows/columns with, 444
Boolean, 450
constants, 451–452
of numbers
computing tax rates with, 27–29
definition of, 25
looking up prices from product ID codes with, 29–30
mismatches between text and numbers in, 34
problems for, 35–37
syntax of, 25–27
wildcard characters with, 31
Arrays.xlsx file
Average Those > Median worksheet, 447
Creating Powers worksheet, 451
Matching Names worksheet, 446
Total Wages worksheet, 442
Transpose worksheet, 444
ASCIIcharacters.xlsx file, 54
Asiansales.xlsx file, 228
Ask a Question About Your Data, 1021
assets
asset-allocation modeling, 929–934
depreciation of, 109–110
Assign Macro dialog box, 1036
assigning employees to workgroups, 890–893
Assign.xlsx file, 35, 890
Assumption cells (Scenario Manager), 207
asterisk (*), 31, 212, 443
Asterisks.xlsx file, 31
astronomical objects, in Excel formulas, 351
At Each Change In menu commands
  Location, 578
  Name, 580
athletes, salaries of, 542–543
auditing options, 171–182
Error Checking, 173–174
Inquire add-in, 179–182
analyzing precedents/dependents with, 182
analyzing workbook structure with, 181
analyzing worksheet/workbook relationships with, 181
cleaning excess cell formatting with, 182
comparing workbooks with, 180
installing, 179–180
for multiple worksheets, 178–179
problems for, 182
Remove Arrows, 175, 177
Show Formulas, 172
Trace Dependents, 174–177
Trace Precedents, 174–175, 177–178
viewing, 172
Watch Window, 174
Auditwosheets.xlsx file, 178, 181
auto sales
  quarterly predictions for, 705–710
  sensitivity analysis of, 203–208
AutoComplete, 18, 1053
AutoComplete feature, 481
Automatic data type, 356–357
Automatic Except for Data Tables option, 187–188
Automatic option (Map Projection menu), 645
AutoSum function, 3
AVERAGE function, 2, 18, 212, 751, 789, 855, 861, 862, 871–872, 901, 902, 905, 913, 922, 939, 950
average inventory level, 973–975
AVERAGEIFS function, 751
  examples of, 220–221
  syntax of, 218
averages, moving, 745–747
  four-period moving average, 745–746
  moving-average graphs, 745–746
  ratio-to-moving-average forecasting method for, 749–752
axes, chart
  modifying, 612–613
  secondary, 593–594
axioms, for event probabilities, 754
Axis option (Sparkline Tools Design), 661–662

B
bakery case study, cost paid to supplier in, 2–5
Bakery1temp.xlsx file, 2–3
Bakery2temp.xlsx file, 4
balloon mortgages, 113
band charts, 920–923
Bandchart.xlsx file, 620
Bank24.xlsx file, 825
banks
  daily customer counts, 659–660
  workforce scheduling problem, 825–827
bar charts, 590–591
bar graphs, 60–61
Barcharts.xlsx file, 590
base, of series, 859
baseball, 923
  lookup functions with, 31–34
  salary information, 46–47
Baseball96.xlsx file, 724
Baseballproblem7.xlsx file, 49
Baseball.xlsx file, 46–47
Basic Model worksheet, 837
basketball
  NCAA Final Four, probability of team win in, 942–944
  salaries, data-validation example, 473–476
Bayes’ theorem, 758–759
bear spread, 144
Best Fit worksheet, 686
beta, 902
  beta variable, 901, 904–906
  random variable
determining probabilities with, 904–905
problems for, 906
of stocks, 671, 951
Betadatad.xlsx file, 672
BETA.DIST function, 901
Betaresampling.xlsx, 951
Beta.xlsx file, 904
bias, in forecasts, 792–793
bids, calculating optimal, 919–923
  bidding simulation model, 920–922
binomial random variables, 919–922
normal random variables, 920
problems for, 922
bill of materials (BOM) reports, 1019
binary and integer programming problems for, 841–842
binary changing cells, 838
BINOM.DIST function

BINOM.DIST function
examples of, 771–772
overview of, 770
BINOM.DIST.RANGE function
examples of, 771–772
overview of, 770
binomial probabilities, 770–773
Coke/Pepsi preference example, 771
defective elevator rails example, 771–772
overbooked flight example, 772
Village Deli example, 773
binomial random variables, 775–776
BINOM.DIST function
examples of, 771–772
overview of, 770
BINOM.DIST.RANGE function
examples of, 771–772
overview of, 770
BINOM.INV function, 773
computing probabilities for, 770–773
Coke/Pepsi preference example, 771
defective elevator rails example, 771–772
overbooked flight example, 772
Village Deli example, 773
definition of, 770
negative, 774–775
simulating, 919–920
Binomialexamples.xlsx file, 770
Binomialsim.xlsx file, 919
BINOM.INV function, 773, 919, 922
Bitcoin prices
Bitcoin worksheet, 802
importing, 802
PivotTables for, 533–535
Black, Fischer, 953. See also Black-Scholes option-pricing formula
Black Swan, The (Taleb), 798
Blackjack worksheet, 139
Black-Scholes option-pricing formula, 798. See also option pricing
estimating stock volatility with, 959–961
implementation of, 957–958
blank cells in ranges, counting, 214
blank rows, adding to PivotTables, 501–502
Blink (Gladwell), 1028
BMI (body mass index), 9
BOM (bill of materials) reports, 1019
BOM.xlsx file, 1021
book sales, one-way analysis of variance (ANOVA) of, 728–731
Bitcoin worksheet, 802
importing, 802
PivotTables for, 533–535
Black, Fischer, 953. See also Black-Scholes option-pricing formula
Black Swan, The (Taleb), 798
Blackjack worksheet, 139
Black-Scholes option-pricing formula, 798. See also option pricing
estimating stock volatility with, 959–961
implementation of, 957–958
blank cells in ranges, counting, 214
blank rows, adding to PivotTables, 501–502
Blink (Gladwell), 1028
BMI (body mass index), 9
BOM (bill of materials) reports, 1019
BOM.xlsx file, 1021
book sales, one-way analysis of variance (ANOVA) of, 728–731
Boolean arrays, 450
bootstrapping, 925–935
asset-allocation modeling, 929–934
problems for, 934–935
stock price simulation, 926–929
Boxplotmultiple.xlsx file, 392
boxplots, 389–393
Boxplottemp.xlsx file, 389
braces ([ ]), 76
brackets ( [ ] ), 25
break-even analysis
with Goal Seek command, 198–199
sensitivity analysis of, 189–191
Brent Crude Oil prices, 804
Bristol-Myers Squibb, Monte Carlo simulation used by, 907
Bstempprotected.xlsx file, 961
Bstemp.xlsx file, 958, 961
Bubble button, 654
bubble charts, creating, 608–609
Bubbledata.xlsx file, 614
budgeting, capital, 837–844
additional constraints in, 840–841
binary and integer programming problems for, 841–842
problems for, 842–844
software project selection problem, 837–840
bull spread, 144
bundling, price, 1012–1014
business expenses, data validation for, 475–477
business modeling
cost paid to supplier, 2–5
customer estimation, 5–6
demand curve, 7–8
employee weekly wages, 1–2
business variables, 846
correlations between, 689–695
CORREL function, 692
Correlation dialog box, 692–693
correlation matrix, 693
definition of, 689
between monthly stock returns during 1990s, 691–694
overview of, 689–691
problems for, 695
regression toward the mean and, 694–695
R-squared value and, 694
estimating relationships between, 643–652
accuracy of predictions, 671
dependent variables, 665–666
Format Trendline options, 666–667
independent variables, 665–666
intercept of, 672
monthly production and monthly operating costs, 667–670
monthly variation in plant-operating costs, 670–671
problems for, 672–673
R-squared value, 671
scatter charts of data points, 666–667
slope of, 672
trend curve, 665
profit-maximizing price analysis, 184–188
Buslist.xlsx file, 49
butterfly spread, 144
buttons, assigning macros to, 1036
buy-and-hold strategy, 127–130
By Changing Variable Cells (Solver Parameters dialog box), 816, 820, 821, 839
BYCOL helper function, 1057
BYROW helper function, 1056–1057
CAGR (compound annual growth rate), 677–678
Cakes.xlsx file, 614
Calccolumns1.xlsx file, 565
Calccolumns2.xlsx file, 568
Calccolumns3.xlsx file, 568
Calcitemdata.xlsx, 538
CALCULATE function, 567–570
calculated fields, 515–517
calculated items, 519–522
calculated measures, 567–570
Calculateditem.xlsx file, 519
calculations
    Enable Iterative Calculation, 118–120
    moving results of, 157–159
calendar worksheets, 146
call options, 953, 955–956, 958–959
Candybardata.xlsx file, 482
Capbudget.xlsx file
    Basic Model worksheet, 837
    If 3 Then 4 worksheet, 840–841
capital budgeting, 87, 837–844
    additional constraints in, 840–841
    binary and integer programming problems for, 841–842
    problems for, 842–844
    software project selection problem, 837–840
Capitalizefirstletter.xlsx file, 69
card counting, 139
Cardata.xlsx file, 724
caret symbol (^), 87, 685
Carsumdata.xlsx file, 237
Carville, James, 710
case of data
    named ranges, 12
    sorting on, 408–409
Case worksheet, 408
Casesensitive.xlsx file, 237
cash flows, 96
    IRR (internal rate of return), 93–99
    calculating with IRR function, 94
    definition of, 93–94
    for irregularly spaced cash flows, 96
    lack of, 94–95
    multiple, 94–95
    problems for, 98–99
    scale of project and, 95–96
    unique, 95
    NPV (net present value), computing
        for cash flows received at beginning of year, 88
        for cash flows received at irregular intervals, 88–90
        for cash flows received at middle of year, 88
        problems for, 90–91
        option pricing and, 954–955
    category chart labels, 597–598
    Categorylabels.xlsx file, 597
    Catsanddogs.xlsx file, 146
    in-cell In-Cell Dropdown check box (Data Validation dialog box), 477, 479
    CELL function, 247
    Cell Reference box (Add Constraint dialog box), 827, 839
    Cell Relationship button (Inquire add-in), 182
    Cellphonedata.xlsx file, 656
cells
    changing with INDIRECT, 240–241
    color, sorting on, 401–402
    counting, 209–215
    COUNT function, 210, 214
    COUNTA function, 210, 214
    COUNTBLANK function, 210, 214
    COUNTIF function, 209–210, 211–213
    COUNTIFS function, 210, 213
    DISTINCT COUNT function, 214, 547–549
    problems for, 214–215
cells

dependents
  analyzing with Inquire add-in, 182
  definition of, 175
  tracing, 174–177
formatting, cleaning excess, 182
named ranges
  applying to existing formulas, 20
  AutoComplete capabilities for, 18
  AVERAGE function, 18
  case insensitivity of, 12
  creating, 11–16
  deleting, 16–17
  editing, 16–17
  for entire column, 18
  errors in, 22
  examples of, 17–18
  for last year’s revenues, 21–22
  naming conventions for, 23
  noncontiguous, 13
  numbers in, 23
  pasting list of, 21
  problems for, 23
  symbols in, 23
  for total salary per day, 22
  for total sales, 17–18
  underscore (_) in, 23
  workbook/worksheet scope for, 18–19
precedents
  analyzing with Inquire add-in, 182
  definition of, 174
  tracing, 174–175
result, 203, 206
  values, pasting to different part of worksheet, 157–159
centered moving averages, 751
Central Limit worksheet, 786
Ch2lp1.xlsx file, 236
Ch50data.xlsx file, 695
Ch55.xlsx file, 742
Ch56data.xlsx file, 747
Ch78data.xlsx file, 906
Change Chart Type dialog box, 592, 593–594
Change Colors button, 590
Change Constraint dialog box, 820
Changeabsolutetemp.xlsx file, 1041–1044
changing cells, in optimization models
  bank workforce scheduling problem, 826
  optimization problems for, 808–809
  product-mix problem, 815
  software project selection problem, 838
  transportation problem, 831
  Changing Cells option (Solver Parameters), 896
  ChangingAxes.xlsx file, 612–613
  Chapter 58 Solutions.docx file, 759
  Chapter1customers.xlsx file, 5
  Chapter29 problems for.xlsx file, 362
  Chapter32Problem5data.xlsx file, 409
  Chapter32Problem6data.xlsx file, 409
  Chapter35data.xlsx file, 458
  Chapter95data.xlsx file, 1060
  CHAR function, 54, 61
  Chart Design tab, 609
  Chart Elements list, 610, 637
  Chart Filters button, 611
  Chart Layouts section (Chart Design tab), 646
  Chart Styles group, 375, 629
  Chartdynamicrange.xlsx file, 234
charts
  band, 620–621, 923
  bar, 590–591
  based on sorted data, 627–628
  bubble, 608–609
  category labels, 597–598
  column
    adding images to, 588–589
    creating, 586–587
    combination, 591–593
    conditional colors in, 628–629
    controlling which series are charted
      with check boxes, 624
      with list boxes, 625
    creating from data tables, 191–192
    data labels, 598–600
    data tables in, 598–600
    deleting points from, 610–611
    dynamic dashboards for, 628–629
    dynamic labels for, 620–621, 923
    elements in, 609–610
    funnel, 638–639
    Gantt, 626
    hidden data in, 596–597
    inserting vertical lines into, 628–629
    line, 603–606
    missing data in, 595–596
    modifying axes in, 612–613
    Pareto
      creating, 374–375
      design options for, 375
      pie, 600–603, 654

1072
Companydata.xlsx file

PivotCharts, 498–499, 529–531
problems for, 614–615, 641–642
radar, 607–608
sales-force performance over time, 920–923
scatter, 606–607, 666–667, 676
  Scatter with Smooth Lines, 191, 623, 626, 631, 632
  Scatter with Smooth Lines and Markers, 746
  Scatter with Straight Lines, 995
secondary axis, 593–594
stacked area, 603–606
for stocks, 639–641
sunburst, 635–638
switching rows/columns in, 611–612
thermometer, 620–621, 923
treemap (mosaic), 635–638
waterfall, 633–635
Charts section (Insert tab), 191, 586, 593, 603, 604, 608, 644
Check Box form control, 307
Checkbox.xlsx file, 307
chemical compounds and elements, in Excel formulas, 351–352
Chemistry data type, 351–352
CHOOSE function, 139–140
Choosefinal.xlsx file, 139
CigaretteData.xlsx file, 538
circular references, 117–121
  example of, 117–118
  pattern of, 117
  problems for, 120–121
  resolving, 118–120
CircularTempt.xlsx file, 117
Cisco, histogram for, 373–374
Ciscoexpo.xlsx file, 676–678
cities
  returning distance between, 39–40
  sorting on, 405–407
Cities data type, 347–348
Citydata.xlsx file, 36
Citydistances.xlsx file, 194
Clean Excel Cell Formatting button (Inquire add-in), 182
CLEAN function, 55, 61
Cleaneexample.xlsx file, 61
Clear Rules, 253
clearing data validation, 481
CLT (central limit theorem), 786–787, 796
Clustered Column chart option, 586, 591, 628, 629
Clustered Column - Line chart option, 592, 593
cohorts, 968
Coke/Pepsi preference example, 771
collapsing PivotTable fields, 492–493
Collegedata.xlsx file, 538
colon (:) 150
color
  in charts, 628–629
  color coding
    of basketball players' abilities, 274–275
    of monthly stock returns, 266–269
    of quarterly corporate revenues, 269–272
    of weekend dates, 272–273
  filtering by, 421
  sorting on, 401–402
Color Scales, 253, 261–263, 643
Coltsdata.xlsx file, 394
column charts
  adding images to, 588–589
  creating, 586–587
Column Data Format list (Import Wizard), 319
Column Input Cell (Data Table dialog box), 939, 950, 969, 1016
Column option (Sparkline Tools Design), 661
Column Sparkline worksheet, 662
Column worksheet, 586
column_index argument (VLOOKUP function), 25
Columncharts.xlsx file
  Column worksheet, 586
  One Book worksheet, 588
columns
  delimited, 315
  fixed-width, 315, 317–319
  named ranges for, 18
  sorting across, 407–408
  switching with rows, 611–612
  transposing with rows, 159–160
Columns option (Series dialog box), 913
COM Add-Ins dialog box, 179, 552
combination charts, creating, 591–593
CombinationTempt.xlsx file, 591
Combo Box form control, 313
Combobox.xlsx file, 312
commands. See individual commands
comments
  creating, 944
  editing, 944
  hiding, 944
Commodities.xlsx file, 804
commodity prices, importing past data on, 804–805
Companydata.xlsx file, 215
complements, law of

complements, law of, 754
compound annual growth rate (CAGR), 677–678
Compound Interest.xlsx, 111–112
CONCATENATE function, 54, 57
Conditional Formatting
New Rule, 873
Top/Bottom Rules, 1016
conditional formatting, 251–281
checking or customizing, 257–258
Clear Rules, 253
color coding, 266–275
of basketball players’ abilities, 274–275
of monthly stock returns, 266–269
of quarterly corporate revenues, 269–272
of weekend dates, 272–273
Color Scales, 253, 261–263
Conditional Formatting Rules Manager, 257–258
Data Bars feature, 253
creating and customizing, 259–260
negative, 261
Format Painter feature, 277
highlighting employee ratings with, 892–893
Highlights Cells feature, 252, 255–257
Icon Sets, 253, 263–266
Manage Rules, 253
monthly stock returns, 266–269
New Rule, 253
for outliers, 383–384
overview of, 251–253
in PivotTables, 502–504
problems for, 278–281
Stop If True option, 275–277
of table data, 295–298
toggling on/off, 307–312
Top/Bottom Rules, 252, 253–255
Conditional Formatting button, 892–893
Conditional Formatting Rules Manager, 257–258, 259–260
conditional maximums and minimums, 218, 221–222
conditional probability, 756–757
configuration
data validation criteria
AutoComplete feature, 481
clearing data validation, 481
custom, 476–477
dates, 475–476
error alerts, 474–475
Go To Special dialog box, 481
length of text in cell, 481
minimum/maximum, 473–475
nested/dependent drop-down menus, 478–480
nonnumeric values, 476–478
numeric values, 476–477
problems for, 481–482
state abbreviations, 477–478
time of day, 481
in versions prior to Excel 2010, 481
multiple-worksheet workbooks, 167–169
hyperlinks, 167–169
number of worksheets, 166
setting up, 165–167
Consolidate command, 571–575
Consolidate dialog box, 573–574
consolidating data, 571–575
with Consolidate command, 571–575
need for, 571
problems for, 575
constants, array, 451–452
constraints
adding, 896
AllDifferent, 896
in project selection problem, 837–840
consulting costs, 121
customer surplus, 1012
contingency tables, 757
continuous compounding, 111–112
continuous random variables, 765
Contoso.xlsx file, 536
Contrateeq.xlsx file, 976, 977
controls, form
Check Box, 307
Combo Box, 313
Format Control dialog box, 304–306, 313
Option Button, 307
overview of, 302
problems for, 313–314
Scrollbar, 307
Spin Button, 302–307
Controls.xlsx file, 301
Convert Text to Columns Wizard, 59–60
Convert to Range button, 543
converting text strings to times, 152
copper, annual volatility for, 966
Copy command (File menu), 2, 910
Copyingtableformulas.xlsx, 297
corporations, in Excel formulas, 349–350
CORREL function, 692
Correlation dialog box, 692–693
Correlationexamples.xlsx, 689
correlations, 689–695
    CORREL function, 692
    Correlation dialog box, 692–693
    correlation matrix, 693
definition of, 689
between monthly stock returns during 1990s, 691–694
overview of, 689–691
problems for, 695
regression toward the mean and, 694–695
R-squared value and, 694
Costestimate.xlsx file, 667
costs
capital budgeting, 87, 837–844
    additional constraints in, 840–841
    binary and integer programming problems for, 841–842
    problems for, 842–844
    software project selection problem, 837–840
monthly operating, 697–701
paid to supplier, 2–5
reciprocal cost allocation, 121
COUNT function, 574
    examples of, 214
syntax of, 210
COUNTA function
    examples of, 214
overview of, 210
COUNTBLANK function
    examples of, 214
overview of, 210
COUNTIF function, 482, 891, 909, 928, 941, 943
    examples of, 211–213
    syntax of, 209–210
COUNTIFS function, 449
    examples of, 213
    syntax of, 210
counting cells in ranges, 209–215
    COUNT function, 210, 214
    COUNTA function, 210, 214
    COUNTBLANK function, 210, 214
    COUNTIF function, 209–210, 211–213
    COUNTIFS function, 210, 213
    DISTINCT COUNT function, 214, 547–549
Countryregion.xlsx file, 724
Coupontdata.xlsx file, 743
COVIdcases.xlsx file, 614
craps, modeling, 130, 937–939
Craps worksheet, 130
Craps.xlsx file, 938
Create Custom Combo Chart button, 593
Create Data Type dialog box, 360
Create Forecast Worksheet dialog box, 864
Create from Selection option, 13–15, 20
Create PivotTable dialog box, 486, 543, 546, 549, 557, 564
Create Relationship dialog box, 543–544
Create Sparklines dialog box, 660, 663
Create Table dialog box, 284, 290
CreateTabletemp.xlsx file, 328–329
Createtable.xlsx file, 328–329
Creating Powers worksheet, 451
credit score, interest rates and, 115
Creditunion.xlsx file, 869, 874
Crimedata.xlsx file, 642
CRITBINOM function, 773
CUMPRINC function, 107
cumulative interest payments (CUMIPMT), 107
cumulative principal (CUMPRINC), 107
cumulative probability, 770
cumulative units produced, production time and, 683
curly braces ({}), 76, 451
Currencies data type, 350
currency exchange rates, 803
currency ISO codes, 803
Currency worksheet, 803
current date, displaying, 76
current time, displaying, 151
Custom AutoFilter, 427–428
Custom Column dialog box, 336
custom data-validation, 476–477
custom functions, creating with LAMBDA, 1051–1055
Custom Lists dialog box, 404
customer traffic
daily customer counts, sparklines for, 659–660
    forecasting in presence of special events, 869–876
    factors influencing customer traffic, 869–872
    forecast accuracy, 872–876
    overview of, 869
    problems for, 876
    random errors in, 876
    worksheet model for, 5–6
customer value, determining, 967–972
    cell phone customer case study, 969–971
    credit-card customer case study, 967–969
    NPV function, 968–969
    problems for, 969–971
    willingness to pay, 997
Customers.xlsx file, 1065
Customize Data Card dialog box

Customize Data Card dialog box, 651
Customize Ribbon option (Excel Options dialog box), 1031
customizing 3D maps, 650–651

daily customer counts, sparklines for, 659–660
daily suggested prices, importing and transforming, 336–337
Dailydow.xlsx files, 673
Dallas Mavericks basketball statistics, 163, 315–320
dashboards, dynamic, 628–629

data
consolidating, 571–575
with Consolidate command, 571–575
need for, 571
problems for, 575
problems for for, 575
in Data Model, 542–543
adding, 546
removing, 543
filtering. See filtering
realigning from column to row, 159–160
sorting. See sorting
validating, 473–482
AutoComplete feature, 481
clearing data validation, 481
custom, 476–477
dates, 475–476
error alerts, 474–475
Go To Special dialog box, 481
length of text in cell, 481
minimum/maximum criteria, 473–475
nested/dependent drop-down menus, 476–480
nonnumeric values, 476–478
numeric values, 476–477
problems for, 481–482
state abbreviations, 477–478
time of day, 481
in versions prior to Excel 2010, 481
Data Analysis, 692, 721. See also analysis of variance (ANOVA)
correlations, 689–695
CORREL function, 692
Correlation dialog box, 692–693
correlation matrix, 693
definition of, 689
between monthly stock returns during 1990s, 691–694
overview of, 689–691
problems for, 695
regression toward the mean and, 694–695
R-squared value and, 694
installing/activating, 728
Data Analysis dialog box, 377, 378, 692, 698. See also analysis of variance (ANOVA)
Data Analysis Expressions (DAX), 560–562
Data Bars, 253
creating and customizing, 259–260
negative, 261
data import
combining data into summary worksheet, 338–340
combining into single file, 331–333
daily suggested prices, 336–337
Excel tables
appending, 338–340
creating from flat files, 328–329
flattening, 327–328
Get & Transform Data options, 321–322
hardware store data, 331–333
NBA player data, 329–331
Power Query Editor, 322
US city population data, 323–327
Data Label Range dialog box, 604, 607, 609
Data Model, 541–550
creating PivotTables with, 542–543, 544–546
data
adding, 542–543, 546
removing, 543
sample, 541–542
DISTINCT COUNT function, 214, 547–549
problems for, 550
relationships
creating, 543–544
managing, 546–547
worksheets in, 541
Data Selector pane, 345
data sets
boxplots, 389–393
comparing, 384–385
finding patterns in, 1019–1029
BOM (bill of materials) reports, 1019
daycare late pickups, 1027–1028
heights of fathers/sons, 1025–1027
hospital data, 1024–1025
overview of, 1019
problems for, 1028–1029
stock market prices, 1022–1024
geometric mean, 388–389
kurtosis, 381
mean and standard deviation, 379, 382–384
mode, 380–381
outliers, conditional formatting for, 383–384
percentile rankings within, 385–386
ranges of cells, 381–382, 388
ranking numbers in, 387
sample standard deviation, 381–382
sample variance, 381–382
second-largest or second-smallest number in, 386–387
skewness measure, 381
trimmed mean, 387–388
typical value for, 378–381

Data tab
Analyze group, 1000
Get & Transform Data group, 321, 323
Data Table dialog box, 913, 922, 928, 939, 941
Column Input Cell, 950, 969, 1016
Row Input Cell, 969, 991
data tables, sensitivity analysis with, 183–195, 598–600
advanced sensitivity analysis, 1063–1065
break-even year analysis, 189–191
creating charts from, 191–192
mortgage payment analysis, 188–189
one-way data tables
creating, 185–186
definition of, 184
overview of, 183–184
problems for, 192–195
profit-maximizing price analysis, 184–188
spider plots, 1063–1065
stock price simulation, 928
Data Tools group, 543
Consolidate command, 571–575
Relationships button, 546
data types, 343–362
Animals, 354–355
Automatic, 356–357
Chemistry, 351–352
Cities, 347–348
Currencies, 350
Foods, 352
Geography, 347–348
Locations, 347–348
Movies, 353–354
Music, 353
overview of, 343–346
People, 356
Plants, 354
problems for, 362
Space, 351
Stock, 349–350
Terrain, 347–348
Universities, 351
Yoga, 352–353

Data Validation dialog box
AutoComplete feature, 481
clearing data validation, 481
custom, 476–477
dates, 475–476
error alerts, 474–475
Go To Special dialog box, 481
length of text in cell, 481
minimum/maximum criteria, 473–475
nested/dependent drop-down menus, 478–480
nonnumeric values, 476–478
numeric values, 476–477
problems for, 481–482
state abbreviations, 477–478
time of day, 481
in versions prior to Excel 2010, 481

Data worksheet, 720
Databars.xlsx file, 259
database statistical functions, 429–439
criteria ranges for, 434–435
elements of, 431–437
overview of, 429–431
problems for, 438–439
Datamodeltemp.xlsx file, 541
Datasources.xlsx file, 344
Data.xlsx file, 12
Date Format worksheet, 76, 77, 78
DATE function, 78
date functions, 73–83
DATE, 78
DATEDIF, 79
DATEVALUE, 76
MOD, 78–80
NETWORKDAYS, 78
NETWORKDAYS.INTL, 78
TEXT, 80
TODAY, 76, 79
WEEKDAY, 78
WEEKNUM, 80
WORKDAY, 76–77
WORKDAY.INTL, 77
DATEDIF function, 79
Datedif.xlsx file

Datedif.xlsx file, 79
Datelookup.xlsx file, 30
Datep.xlsx file, 82
dates, 73–83
color coding of, 272–273, 274–275
days off, 77
determining number of days between two dates, 79
displaying current, 76
entering into worksheets, 79
extracting day/month/year from, 78
filtering on, 417–420
holiday dates, excluding, 77
leap years, 74
problems for, 82–83
recovering, 78
returning date of most recent Sunday, 78–80
returning date of next Monday, 81
returning first/last day of month, 81–82
returning week of year for, 80
serial format for, 74–76
validating, 473–475
workdays
determining date that is x workdays after another date, 76–77
determining number of workdays between two dates, 78
Dates worksheet, 403
Dates.xlsx file
Date Format worksheet, 76, 77, 78
Serial Format worksheet, 74
DATEVALUE function, 76
DAX (Data Analysis Expressions), 560–562
day of the week/month
extracting from dates, 78
recovering, 78
returning date of next Monday, 81
returning first/last day of month, 81–82
daycare late pickups, patterns in, 1027–1028
Daycaretemp.xlsx file, 1027
days off, excluding, 77
DDB (double-declining-balance depreciation), 109–110
DDB function, 110
deactivating relationships, 546–547
Decadeincome.xlsx file, 393
Deciles.xlsx file, 439
decision-making process
Monte Carlo simulation for, 911–914. See also Monte Carlo simulation
option pricing in, 963–964
Define Name option, 15–16
Deletetemp.xlsx file, 610
deleting
named ranges, 16–17
relationships, 546–547
delimited columns, 315, 317–319
Delldata.xlsx file, 671
Dellvol.xlsx file, 956
demand constraint, 832–833
demand curve, 993–998. See also profit-maximizing price analysis
customer’s willingness to pay and, 997
definition of, 993
elasticity of demand, 994
estimating, 994–997
linear, 994
percentile of, 785–786
power, 994–997
price bundling and, 1013–1014
problems for, 998, 1006–1008
subjectively determined demand, 1005–1010
equation for, 1005
example of, 1005–1010
tie-ins, pricing products with, 999–1003
uncertain demand, inventory modeling with, 979–985
lost-sales approach, 980–981
overview of, 979–980
service-level approach, 982–985
worksheet model for, 7–8
demand points, 831
Deming, W. Edwards, 376
Deming.xlsx file, 376
Density worksheet, 779
dependent variables, 665–666
Dependentdropdown.xlsx file, 478–480
dependents
analyzing with Inquire add-in, 182
definition of, 175
tracing, 174–177
depreciation functions, 109–110
descriptive statistics, 377–395
boxplots, 389–393
comparing data sets with, 384–385
geometric mean, 388–389
kurtosis, 381
mean, 379
mean and standard deviation, 382–384
mode, 380–381
outliers, conditional formatting for, 383–384
overview of, 377–378
percentile rankings, 385–386
problems for, 393–395
range, 381–382
for ranges of cells, 388
ranking numbers in, 387
sample standard deviation, 381–382
sample variance, 381–382
second-largest or second-smallest numbers, 386–387
skewness measure, 381
trimmed mean, 387–388
typical value for data set, 378–381
Sample Standard Deviation, 381, 382
deseasonalized observations, 860
design, table, 283–287
Developer tab
displaying, 301
Insert button, 1036
Record Macro button, 1032–1033, 1034, 1038, 1041, 1044, 1046, 1047
Stop Recording button, 1033
Use Relative References option, 1039
viewing, 1031
Dget.xlsx file, 435
Diagonal.xlsx function, 237
dialog box, Format Axis, 612–613
dialog boxes, 16–17, 336, 384, 481, 891, 938, 1016, 1035
A Date Occurring dialog box, 257
Access Web Content, 323
Add Constraint, 816–817, 827, 839, 862, 896, 897, 933
Add-ins, 721, 847, 862, 872, 889, 895, 902
Analysis ToolPak, 364, 698, 728
Solver Add-In. See Microsoft Excel Solver
Anova: Single Factor, 728
Append, 338–339
Arrange Windows, 572
Assign Macro, 1036
Change Chart Type, 592, 593–594
Change Constraint, 820
COM Add-Ins, 179, 552
Conditional Formatting Rules Manager, 259–260
Consolidate, 573–574
Correlation, 692–693
Create Data Type, 360
Create Forecast Worksheet, 864
Create PivotTable, 486, 543, 546, 549, 557, 564
Create Relationship, 543–544
Create Sparklines, 660, 663
Create Table, 284, 290
Custom Lists, 404
Customize Data Card, 651
Data Analysis, 377, 378, 692, 698, 728, 735. See also analysis of variance (ANOVA)
Data Label Range, 604, 607, 609
Data Table, 913, 922, 928, 939, 941
Column Input Cell, 950, 969, 1016
Row Input Cell, 969, 991
Data Validation
AutoComplete feature, 481
clearing data validation, 481
custom, 476–477
dates, 475–476
tables, 474–475
Go To Special dialog box, 481
length of text in cell, 481
minimum/maximum criteria, 473–475
nested/dependent drop-down menus, 478–480
nonnumeric values, 476–478
numeric values, 476–477
problems for, 481–482
state abbreviations, 477–478
time of day, 481
in versions prior to Excel 2010, 481
Descriptive Statistics, 377, 378
Edit Default Layout, 530
Edit Name, 16, 21
Edit Rule, 259–260
Edit Scenario, 204
Edit Series, 623
Error Checking, 173
Evaluate Formula, 49, 172, 229–231, 242, 451, 454
Excel Options, 118, 179, 187–188, 847, 862, 889, 895, 902, 983–985
Add-Ins, 815, 1000, 1007
Customize Ribbon, 1031
File Conversion, 316
Format Axis, 369
Format Cells, 67–68, 74, 152, 254, 268, 491, 559, 961, 1034, 1042, 1044
Format Control, 304–306, 307–311, 313, 625
Go To, 179, 962
Goal Seek, 197–202, 960
high-school algebra problems for, 199–200
problems for, 201–202
requirements for, 197
Hidden and Empty Cell Settings, 595, 597
Histogram, 365
Import Data, 338, 339
dialog boxes

Insert Calculated Field, 516, 522
Insert Calculated Item, 521
Insert Chart, 498, 621
Insert Function, 560
Insert Hyperlink, 167
Insert Pictures, 588
Insert Slicers, 500, 516
Macro, 1033
Manage Relationships, 543–544, 546–547
Merge Columns, 325
Modify Button, 1037
Name Manager, 16–17, 19
Navigator, 324
New Formatting Rule, 264–266, 270–272, 296, 503, 873, 892–893
New Name, 15, 234–235, 245, 1052, 1053
Number Format, 492
Open, 317
Page Setup, 944
Paste Name, 12
Paste Special
  Paste Link button, 160
  Transpose option, 159–160, 693
  Values option, 158
Pivot Column, 328–329
Protect Sheet, 962
Record Macro, 1032–1033, 1034, 1038, 1041, 1044, 1046, 1047
Regression, 698–699
  Input X Range, 712, 721
  Input Y Range, 712, 721
Save Chart Template dialog, 621
Scenario Manager, 205
  Merge button, 207
  Summary button, 205
Scenario Summary, 206–207
Scenario Values, 205
Select Data Source, 595, 597, 623
Select Files to Compare, 180
  By Changing Variable Cells, 816, 820, 821, 839
  Evolutionary Solver, 889–890
  Ignore Integer Constraints, 898
  Make Unconstrained Variables Non-Negative, 817, 821, 833
  Select a Solving Method list, 840
  Set Objective, 816, 821, 839, 897
  Solve, 821, 833
  Subject to the Constraints, 821
Sort, 401, 403
Sort Warning, 405
Sparkline Date Range, 662
Split Column by Delimiter, 333
Split Column by Number of Characters, 333
Subtotal, 578–580
Text That Contains, 254
Top 10 Filter, 496–497
Value Field Settings, 506, 508, 514, 559
From Web, 323
Worksheet Analysis Report, 181
Diner.xlsx file, 642
discrete random variables, 763–764, 909–910
Discretesim.xlsx file, 909
Disneyland, price bundling at, 1013
Display Equation on Chart option, 668, 677, 684, 996, 1006
Display R-Squared Value on Chart option, 668, 677, 684
distance between cities, returning, 39–40
DISTINCT COUNT function, 214, 547–549
DISTINCT function, 561
Distinctcounttemp.xlsx file, 547–550
distribution problems for, 831–836
  definition of, 831
  demand constraint, 832–833
  demand points, 831
  drug-distribution example, 831–834
  problems for, 834–836
  specifications for, 831
  supply constraints, 832
  supply points, 831
Divide option (Paste Special), 160–162
Dividebyprice.xlsx file, 145
dividend rate, 955
division, with Paste Special command, 160–162
documents, importing data from, 315–320
  problems for, 320
  Text Import Wizard, 315–320
dollar sign ($), 4–5
double quotation marks ("), 451
double-declining-balance depreciation (DDB), 109–110
Dowdata.xlsx file, 642
down blocks, 662
Dow.xlsx file, 394, 537, 664, 695
Draftlottery.xlsx file, 393
drilling down, 522
drop-down menus, nested, 478–480
EOQ (economic order quantity) inventory model
EOQ (economic order quantity) inventory model

problems for, 977–978
EOQ Protected worksheet, 975
Eoq.xlsx file, 975
equal sign (=), 58, 211
equation solver. See Goal Seek command
Error Alert tab (Data Validation dialog box), 474–475
error alerts, 474–475
Error Checking dialog box, 173–174
errors, 95, 481–482
circular references, 117–121
example of, 117–118
pattern of, 117
problems for, 120–121
resolving, 118–120
data validation, 473–482
clearing data validation, 481
dates, 475–476
error alerts, 474–475
Go To Special dialog box, 481
minimum/maximum criteria, 473–475
nested/dependent drop-down menus, 478–480
numeric values, 476–477
problems for, 481–482
state abbreviations, 477–478
in versions prior to Excel 2010, 481
Error Checking feature, 173–174
in forecasts, 876
#N/A, 26, 28, 134–136, 174
#NUM!98
#SPILL, 22, 349, 464
#VALUE, 61–62
Errortrap.xlsx file, 134, 173
Errortypes.xlsx file, 136
European cash flows, option pricing and, 954–955
European options, 124, 953
Evaluate Formula dialog box, 49, 172, 229–231, 242, 451, 454
evaluating forecasts, 792–793
events
definition of, 754
forecasting in presence of, 869–876
factors influencing customer traffic, 869–872
forecast accuracy, 872–876
overview of, 869
problems for, 876
random errors in, 876
independent, 755–756
mutually exclusive, 754–755
Evolutionary Solver, 810–811, 889–894
assigning employees to workgroups with, 890–892
highlighting employee ratings with, 892–893
options for, 889–890
problems for, 893–894
tips for success, 889–894
Evolutionary Solver engine, 1017
EXACT function, 237
Excel Add-Ins, 692, 847, 933, 1000, 1007
Excel AutoFilter feature
eamples of, 413–428
 clearing, 415
 Color, 421
 Custom AutoFilter, 427–428
 Date, 417–420
 Location, 413–415
 Name, 420
 Numbers, 416–417, 421–422
 Reapply option, 425
 Remove Duplicates, 424
 overview of, 411–413
problems for, 428
Excel Data Analysis feature, 698
Excel Data Model, 541–550
 creating PivotTables with, 542–543, 544–546
data
 adding, 542–543, 546
 removing, 543
 sample, 541–542
DISTINCT COUNT function, 214, 547–549
problems for, 550
relationships
 creating, 543–544
 managing, 546–547
worksheets in, 541
Excel Options dialog box, 118, 179, 187–188, 847, 862, 889, 895, 897, 902, 983–985
Add-Ins, 809, 815, 839, 862, 1000, 1007
Customize Ribbon, 1031
Excelfinfunctions.xlsx file, 102
 FV worksheet, 104
 PMT worksheet, 105
 PV worksheet, 102
Rate worksheet, 108
excess cell formatting, cleaning with Inquire add-in, 182
exchange rates
 in Excel formulas, 350
 importing past data on, 803
exercise date/expiration date, 953
exercise price, 125
EXP function, 679, 723
expanding PivotTable fields, 492–493
experience curve, 683, 684–685
experiments, 753, 763
EXPON.DIST function, 779–780
Explorential command (Format Trendline menu), 666, 675–678
exponential growth, 675–680
CAGR (compound annual growth rate), 675–678
Exponential command, 675–678
GROWTH function, 679–680
modeling, 676–678
overview of, 675
predictions based on, 679–680
problems for, 680
S-curve, 678
trend curve parameters for, 678–679
exponential random variable
computing probabilities for, 779–780
problems for, 780
exponential smoothing, Winters method of
equations for, 860–861
Forecast Sheet tool, 863–866
initialization of, 861
level of series, 860–861
overview of, 859
problems for, 867
seasonal index for current month, 860–861
smoothing constants, estimation of, 862–863
time series characteristics, 859–860
trend of series, 860–861
Exponentialdata.xlsx file, 680
Exponentialdist.xlsx file, 779
extracting hour/minute/second from times, 152
EyeColor.xlsx file, 1028

F
F4 key, 5
Faberu.xlsx file, 550
FACTORIAL function, 1056
Fair, Ray, 710
father/son heights, patterns in, 1025–1027
Fax.xlsx file, 684
FCFs (free cash flows), 130
Feasible Solution worksheet, 813, 820
feasible solutions, 811, 813–819, 820
Febcon.xlsx file, 575
federal aid, determining 99th percentile of demand for, 785–786
Fermat, Pierre de, 776
Fibonacci sequence, 9
fields, PivotTable
calculated, 515–517
collapsing/expanding, 492–493
filtering, 495–498
format of, 491–492
PivotTable Fields pane, 487–488
sorting, 493–494
File Conversion dialog box, 316
File menu commands
Copy, 910
Options, 64, 809
Paste Special Values, 910
files, 41, 49, 249, 634, 672, 676–678, 961
Accountsums.xlsx, 280
Adagency.xlsx, 299
Addresses.xlsx, 145
Advancedfilter.xlsx, 436
Ageofmachine.xlsx, 69
Agingdata.xlsx, 236
Airlinemilestemp.xlsx, 864
Amazon.xlsx, 279, 281
Analyzesurveydata.xlsx, 539
Applynames.xlsx, 20
Arrays.xlsx, 447
Creating Powers worksheet, 451
Matching Names worksheet, 446
Total Wages worksheet, 442
Transpose worksheet, 444
ASCIIcharacters.xlsx, 54
Asiansales.xlsx, 228
Assign.xlsx, 35, 890
Asterisks.xlsx, 31
Audittwosheets.xlsx, 178, 181
Bakery1temp.xlsx, 2–3
Bakery2temp.xlsx, 4
Bandchart.xlsx, 620
Bank24.xlsx, 825
Barcharts.xlsx, 590
Baseball96.xlsx, 724
Baseballproblem7.xlsx, 49
Baseball.xlsx, 46–47
0eataresampling.xlsx, 951
Beta.xlsx, 904
Binomialalexamples.xlsx, 770
Binomialsim.xlsx, 919
files

Duedates.xlsx, 278
DVDsales.xlsx, 237
Dynamiclabelstemp.xlsx, 622
Dynamicrange.xlsx, 232–235
Eastwest.xlsx, 12
East.xlsx, 575
Electiondata.xlsx, 673
Electoralvotes.xlsx, 657
Emailproblem.xlsx, 69
Employees.xlsx, 37
EOMONTHEDATE.xlsx, 81–82
Eoq.xlsx, 975
Errortrap.xlsx, 134, 173
Errortypes.xlsx, 136
Excellinfonctions.xlsx, 102
FV worksheet, 104
PMT worksheet, 105
PV worksheet, 102
Rate worksheet, 108
Exponentialdata.xlsx, 680
Exponentialdist.xlsx, 779
EyeColor.xlsx, 1028
Faberu.xlsx, 550
Fax.xlsx, 684
Febcon.xlsx, 575
Filledmaptemp.xlsx, 643
Finearts.xlsx, 537
Finmathsolver.xlsx, 848
Fizzy.xlsx, 723
Flashfill.xlsx, 62
Flattentabletemp.xlsx, 327–328
Footballdata.xlsx, 146
FootballProblem8.xlsx, 49
FormattingDDAnum.xlsx, 145
Fourthavenuetemp.xlsx, 655
Fractiondefective.xlsx, 279
Galton.xlsx, 614
Gamestop.xlsx, 540
Gasprices507.xlsx, 287
Geommean.xlsx, 388
Globalwarming2011.xlsx, 279, 280
GNP.xlsx, 280
Goals.xlsx, 664
Goldata.xlsx, 237
Grades.xlsx, 36
Grocery.xlsx, 723
Hardware.xlsx, 37
Heighttemp.xlsx, 1025
Hidden.xlsx, 596
Highlightcells.xlsx, 255–257
Historicalinvest2009.xlsx, 376
Historicalinvest.xlsx, 279, 394, 459
Hockey.xlsx, 1028
Hospitaltemp.xlsx, 1024–1025
Hospital.xlsx, 537
House2.xlsx, 861
Housepricedata.xlsx, 438
Hr.xlsx, 35
Hypergeom.dist.xlsx, 773–774
Hyperlinkstemp.xlsx, 167
IDPrice.xlsx, 69
IFSfinal.xlsx, 138
Ifstatement.xlsx, 124, 126, 130
Incomedata.xlsx, 394
Incomefrequency.xlsx, 69
INDEX.xlsx, 39
Index.xlsx, 49
Indirectconsolidate.xlsx, 244
Indirectinsertrow.xlsx, 242
Interactions.xlsx
Data worksheet, 720
Nonlinearity worksheet, 719
IRR.xlsx, 96
MIRR worksheet, 97
XIRR worksheet, 96
ISFORMULA_TEXT.xlsx, 172
Jancon.xlsx, 575
Jordan.xlsx, 394
Kingslineups.docx, 320
Lagged.xlsx, 236
Lambdahelper.xlsx, 1056–1060
Last year.xlsx, 21
LastSunday.xlsx, 80
Latitude.xlsx, 482
Lawdata.xlsx, 951
Lefthandlookup.xlsx, 227
Lemonadegs.xlsx, 198
Lemonade.xlsx, 184
Lenora.xlsx, 56
LETandLAMBDA.xlsx, 1050
Lillydata.xlsx, 459
Lineupdate.xlsx, 69
Lineupsch27temp.docx, 315–320
Lineupsch27.txt, 316
Lognormal.xlsx, 797
Lookupmultiplecolumns.xlsx, 36
Lookupmultiplecolumns.xlsx, 69
Lookup.xlsx, 27, 29
files

Statedv.xlsx, 477
Stateincome.xlsx, 657
States.xlsx, 16, 17, 552
Staticdate.xlsx, 79
Station.xlsx, 509
Stdevif.xlsx, 453
Stockcorrel.xlsx, 691
Stockhistoryfinal.xlsx

  Bitcoin worksheet, 802
  Currency worksheet, 803
  Stocks worksheet, 800
Stockpricesx.xlsx, 1022–1024
Stock.xlx, 373, 376, 383, 393
Storesales.txt, 552
Sumifrows.xlsx, 222
Sumindirect.xlsx, 240
Superbowlspreads.xlsx, 787–788
Suppliers.xlsx, 314
Switchfinal.xlsx, 141
Tableexampletemp.xlsx, 283–284
Tableexample.xlsx, 298
Tablemakeuptemp.xlsx, 289, 299
Tablemakeuptotals.xlsx, 291, 292
Tablepie.xlsx, 299
Tablestructure.xlsx, 294
Tablexnvpdata.xlsx, 299
Teachers.xlsx, 1028
Teams.xlsx, 376
Temperature2020.xlsx, 253
Test.xlsx, 278
Textandnumbers.xlsx, 34
Textfunctions.xlsx, 52
Textjjoinfinal.xlsx, 65
Textstylesdata.xlsx, 69
Threetimes.xlsx, 280
Timeseries.xlsx, 603
Time.xlsx, 151
Top5.xlsx, 280
Top20.xlsx, 657
Toysrusformat.xlsx, 278
Toysrus.xlsx, 222
Transactiondata.xlsx, 237
Transport.xlsx, 831–832
Traveldatatemp.xlsx, 505
Treemapbookstoretemp.xlsx, 636
Trendandseasonality.xlsx, 1028
Trimmean.xlsx, 386, 388
Unemployment.xlsx, 376
Unique.xlsx, 462

USC.xlsx, 794
USfilledmapstemp.xlsx, 646
Valentine.xlsx, 911, 914
Varianceanalysis.xlsx, 278
Verizondata.xlsx, 236
Verizon.xlsx, 237
Volatility.xlsx, 965
Wagehistoryfinal.xlsx, 1–2
Walmartdata.xlsx, 752
Walmartrev.xlsx, 136
Waterfallpandlttemp.xlsx, 633
Weekendformatting.xlsx, 278
WEEKNUM.xlsx, 80
Weibullest.xlsx, 901
Weirddata.xlsx, 69
West.xlsx, 571, 575
Worksheetnames.xlsm, 245
Worldball.xlsx, 857
XLOOKUP.xlsx, 31
Yeardate.xlsx, 237

Fill button, 950
filled maps
  creating, 643–647
  labeling, 645–646
Filledmapstemp.xlsx file, 643
FILTER function, 466–468
filtering
  dynamic array functions for, 466–468
  with Excel AutoFilter feature
    examples of, 413–428
    overview of, 411–413
    problems for, 428
  PivotTable fields, 495–498
  with Quick Access toolbar, 425–427
  tables, 289–292
Filters option (Layer pane), 650
Final Four basketball, probability of team win in, 942–944
Finalregression worksheet, 721
financial functions
  CUMIPMT, 107
  CUMPRINC, 107
  DDB, 110
  FV, 103–105, 111–112
  interest rate
    calculating with RATE, 108
    compound interest, 111–112
    cumulative interest payments. See cumulative interest payments (CUMIPMT)
  IPMT, 106–107
IRR, 94
MIRR, 97–98
NPER, 108–109
NPV. See NPV (net present value)
PMT, 101–107
PPMT, 106–107
problems for, 112–115
PV, 101–105
RATE, 108
SLN, 109–110
SYD, 109–110
XIRR, 93–94
XNPV, 88–90
financial planning, with Solver, 845–851
overview of, 845
PMT function, verifying accuracy of, 845
retirement savings, determining, 848–849
Find Errors worksheet, 458
FIND function, 53, 57–58, 59, 61, 482
Finearts.xlsx file, 537
Finmathsolver.xlsx file, 848
first day of month
returning date of next Monday, 81
returning first/last day of month, 81–82
First Point option (Sparkline Tools Design), 661
five-card draw poker, probability of three of a kind in,
939–942
fixed-width columns, 315, 317–319
Fizzy.xlsx file, 723
Flash Fill, 62–64, 65
Flashfill.xlsx file, 62
flat files, creating tables from, 328–329
Flat Map button, 654
flattening Excel tables, 327–328
Flattentabletemp.xlsx file, 327–328
font color, sorting on, 401–402
Foods data type, 352
Footballdata.xlsx file, 146
FootballProblem8.xlsx file, 49
Ford, Gerald, 712
FORECAST function, 866
Forecast Sheet tool, 863–866
FORECAST.ETS function, 866
forecasting. See also multiple regression analysis
bias in, 792–793
evaluating, 792–793
forecasting future values of time series, Winters
method of
equations for, 860–861
problems for, 867
making probability statements from, 791–794
with one-way ANOVA, 731
in presence of special events, 869–876
factors influencing customer traffic, 869–872
forecast accuracy, 872–876
overview of, 869
problems for, 876
random errors in, 876
ratio-to-moving-average forecasting method for,
749–752
seasonal indexes
interpretation of, 749–750
Toys "R" Us example, 715–718
Walmart example, 749–750
with wo-way analysis of variance (ANOVA), 740–742
with two-way ANOVA, 736–737
Winters method of
Forecast Sheet tool, 863–866
initialization of, 861
level of series, 860–861
overview of, 859
seasonal index for current month, 860–861
smoothing constants, estimation of, 862–863
time series characteristics, 859–860
trend of series, 860–861
Foreign column
Create Relationships dialog box, 544
Data Model, 544
form controls
Check Box, 307
Combo Box, 313
Format Control, 304–306, 313
Option Button, 307
overview of, 301
problems for, 313–314
Scrollbar, 307
Spin Button, 302–307
Format Axis dialog box, 369, 612–613
Format Cells dialog box, 67–68, 74, 152, 254, 268, 491,
559, 961, 1034, 1042, 1044
Format Control dialog box, 304–306, 307–311, 313, 625
Format Data Labels pane, 599, 601, 602, 604, 607, 609,
646
Format Data Series pane, 589, 602, 604, 607, 609, 645
Format Data Series pane, 589, 602, 622, 637, 645
Format Painter feature, 277
Format Selection button, 669
Format Trendline pane, 666–667
Exponential command, 675–678
Format Trendline pane

Moving Average option, 746
Number section, 669
Polynomial option, 1006
Power command, 684
Format Values Where This Formula Is True option, 873
formatting
conditional. See conditional formatting
dates, 74–76
excess cell formatting, 182
PivotTable fields, 491–492
times, 150, 151
formatting, conditional. See conditional formatting
FormattingDDAnum.xlsx file, 145
Formula Auditing group, 172
Error Checking, 173–174
multiple worksheets and, 178–179
Remove Arrows, 175, 177
Show Formulas, 172
Trace Dependents, 174–177
Trace Precedents, 174–175, 177–178
Watch Window, 174
formulas
applying named ranges to, 20
cost paid to supplier, 2–5
customer estimation, 5–6
locking/unlocking, 961–963
order of operations in, 6–7
properties and data types in
animals, 353–354
astronomical objects, 351
chemical compounds and elements, 351–352
corporations, 349–350
exchange rates, 350
flowers and trees, 353–354
geographic locations, 347–348
HR data, 359–361
movies and music, 353–354
nutritional characteristics, 352
people, 356
problems for, 362
universities, 351
weather data, 357–359
weekly wages, 1–2
Formulas menu commands
Create from Selection, 20
Defined Names, 20
Enable Iterative Calculation option, 118–120
Evaluate Formula, 49
FORMULATEXT function, 2, 172
four-period moving average, 745–746
Fourthavenuetemp.xlsx file, 655
Fractiondefective.xlsx file, 279
free cash flows (FCFs), 130
Freeze First Column command (Freeze Panes menu), 128
Freeze Top Row command (Freeze Panes menu), 128
FREQUENCY function, 444–445
From Web dialog box, 323
Fuller, Dennis, 1
BETWEEN function, 1053–1054
Function Wizard, 135
functions, 18, 194, 272, 482, 679–680, 687, 1054–1055
& (ampersand), 54
ABVERA, 922
AGGREGATE, 135–136
AutoComplete capabilities for, 18
AutoSum, 3
AVERAGE, 2, 212, 751, 788, 793, 855, 861, 862, 871–872, 901, 902, 905, 913, 939, 950
AVERAGEIF, 751
AVERAGEIFS, 218, 220–221
BETWEEN function, 1053–1054
BINOM.DIST
examples of, 771–772
overview of, 770
BINOM.DIST.RANGE
examples of, 771–772
overview of, 770
BINOM.INV, 773, 922
CALCULATE, 567–570
CELL, 247
CHAR, 54, 61
CHOOSE, 139–140
CLEAN, 55, 61
CONCATENATE, 54, 57
CORREL, 692
COUNT, 574
examples of, 214
syntax of, 210
COUNTA
examples of, 214
overview of, 210
COUNTBLANK
examples of, 214
overview of, 210
COUNTIF, 482, 891, 909, 928, 941, 943
examples of, 211–213
functions

COUNTIFS, 449
examples of, 213
syntax of, 210
CRITBINOM, 773
CUMIPMT, 107
CUMPRINC, 107
custom, creating with LAMBDA, 1051–1055
DATE, 78
DATEDIF, 79
DATEVALUE, 76
DB, 110
DISTINCT, 561
DISTINCT COUNT, 214, 547–549
DSUM, 429–439
criteria ranges for, 434–435
examples of, 431–437
overview of, 429–431
problems for, 438–439
syntax of, 430–431
EDATE, 81
EOMONTH, 81
EXACT, 237
EXP, 679
EXPON.DIST, 779–780
FACTORIAL, 1056
FILTER, 466–468
FIND, 53, 57–58, 59, 61, 482
FORECAST, 866
FORECAST.ETS, 866
FORMULATEXT, 2, 172
FREQUENCY, 444–445
FV, 103–105, 111–112
GEOMMEAN, 389
GETPIVOTDATA, 523–525, 629, 630
GETSTATE, 1054
GROWTH, 679–680, 715–718
HLOOKUP, 891
looking up prices from product ID codes with, 29–30
syntax of, 26
wildcard characters with, 31
HOUR, 152
Housedata.xlsx, 671
HYPEGEO.M.DIST, 773–774
HYPERLINK, 168, 247
IF, 190, 619, 622, 624, 628, 876, 891, 912, 939, 943
craps, modeling, 130
Freeze Panes options and, 127–130
hEDGExEamplewith, 125–126
IFERROR, 134–136
moving-average trading rule, 127–130
pro forma financial statements, 130–134
problems for, 143–147
quantity discounts, 124–125
summarizing annual revenues with, 136–137
IFERROR, 26, 134–136, 622, 631
IFS, 137
INDEX, 39–41, 45, 313, 625, 897
problems for, 41
referencing entire row/column of array with, 41
returning distance between cities with, 39–40
syntax of, 39
INDIRECT, 168, 239–249, 465–466, 480, 482
changing cell references in formulas with, 240–241
creating summary of product sales with, 244–245
creating table of contents with, 247–248
listing monthly sales of product with, 241–242
listing worksheets in workbook with, 245–247
problems for, 248–249
referencing range names within formulas with, 243–244
simple example of, 239–240
totaling values in range with, 242–243
INTERCEPT, 672, 679, 751
IPMT, 106–107
IRR, 94
IS, 141
ISBLANK, 141
ISERR, 141
ISERROR, 141
ISEVEN, 147
ISFORMULA, 141, 172
ISNA, 141
ISNONTEXT, 141
ISTEXT, 141, 482
LAMBDA, 1051–1060
creating custom functions with, 1051–1055
helper functions, 1056–1060
problems for, 1060–1061
recursive, 1055–1056
LARGE, 47, 386
lastyear, 22
LEFT, 53, 56, 57–58, 59
LEN, 53, 56, 59, 482
LET, 1050–1051, 1060
LINEST, 702–703
functions

LOGEST, 715–718
LOGNORM.DIST, 797–798
LOGNORM.INV, 798
lookup, 25–37
computing tax rates with, 27–29
definition of, 25
looking up prices from product ID codes with,
29–30
mismatches between text and numbers in, 34
problems for, 35–37
syntax of, 25–27
wildcard characters with, 31
LOWER, 54
MATCH, 43–50
investment payback period, returning, 47–48
MLB player salaries, returning, 46–47
nonlinear pricing plan, 1014, 1015
problems for, 49–50
product sales per month, returning, 45–46
syntax of, 43–45
two-way lookups, 46
wildcard characters with, 44
MAX, 445
Max, 574
MAXIFS
example of, 221–222
syntax of, 218
MID, 53, 57, 59
MIN, 445, 912
MINUTE, 152
MINVERSE, 459
MIRR, 97–98
MOD, 78–80
MODE.MULT, 380
NEGBINOM.DIST, 774–775
nesting, 137
NETWORKDAYS, 78
NETWORKDAYS.INTL, 78
nonsmooth functions, 810–811
NORM.DIST, 784–785, 793
NORM.INV, 785–786, 787, 910–911, 942, 943
NORM.S.DIST, 957
NOW, 151
NPER, 108–109
NPV, 87–90, 968–969
for cash flows received at beginning of year, 88
for cash flows received at middle of year, 88
how to use, 87
problems for, 90–91
syntax of, 87
OFFSET, 225–237
computing development costs with, 228–229
dynamic ranges, 232–235
Evaluate Formula feature, 229–231
last number in column, finding, 232
left-hand lookup with, 227–228
movie example, 229–231
problems for, 236–237
revenue tracking with, 228
simple example of, 226–227
syntax of, 226
PDF (probability density function), 765–766, 903, 920
PERCENTILE, 385–386
PERCENTILE.EXC, 385–386
PERCENTILE.INC, 385–386
PERCENTRANK, 385–386
PERCENTRANK.EXC, 385–386
PERCENTRANK.INC, 385–386
PMT, 105–107, 188–189, 199
retirement savings, determining, 848–849
verifying accuracy of, 845–848
POISSON.DIST, 778
PPMT, 106–107
probability mass, 770
Problem39data.xlsx, 147
PROPER, 54
PV, 101–103
RAND, 908–909, 912, 923, 940, 943
RANDARRAY, 914–915, 916, 923, 950
RANDBETWEEN, 923, 926–927, 930, 938, 947
RANK, 387, 619, 625
RANK.AVG, 387
RANK.EQ, 298, 387, 940
RATE, 108
RELATED, 562–567
REPLACE, 54
REPT, 54, 61, 62–64
RIGHT, 53, 59, 482
ROW, 137
RSQ, 672
SEARCH, 53–54
SECOND, 152
SEQUENCE, 469–470, 950
SHEET, 246
SKEW, 381
SLN, 109–110
SLOPE, 672, 679, 687, 751, 752
SMALL, 47, 386
SORT, 464–466, 479, 480
SORTBY, 464–466, 916
SQR, 956–957
STDEV, 382, 454, 788
STDEV.S, 382, 793, 901, 902, 905, 913, 915, 956–957
STDEVS, 873
STOCKHISTORY, 799–806
arguments of, 800
importing past Bitcoin prices with, 802
importing past data on commodity prices with, 804–805
importing past data on currency exchange rates with, 803
importing past data on index or mutual funds with, 804
importing past trading data on stock with, 799–801
problems for, 806
SUBSTITUTE, 55, 61
SUBTOTAL, 582–583
SUM, 3, 137, 573, 578, 871, 891, 897
SUMIF, 218
copying across columns, 297
examples of, 218–221
syntax of, 218
SUMIFS, 449, 480
SUMPRODUCT, 443, 454–457, 814–815, 826, 832
SWITCH, 140–141
SYD, 109–110
TEXT, 54, 80, 81, 622–623
TEXTJOIN, 54, 61–65
time, 152
TIMEVALUE, 152
today, 76, 79, 151
TRANSPOSE, 444
TREND, 714–715
TRIM, 53, 56, 57
TRIMMEAN, 388
UNICHAR, 62–64, 65
UNICODE, 61, 65
UNIQUE, 461–464
UPPER, 54
VALUE, 54, 57, 61
VARS, 382
VLOOKUP, 134, 244, 312, 313, 751, 871, 927, 941, 943, 949
avoiding use of, 542
computing tax rates with, 27–29
nonlinear pricing plan, 1014
syntax of, 25–26
wildcard characters with, 31
WEEKDAY, 78
WEEKNUM, 80
WEIBULL.DIST, 901–904
WEIBULLDIST, 904
WORKDAY, 76–77
WORKDAY.INTL, 77
XIRR, 93–94
XLOOKUP
examples of, 31–34
syntax of, 26–27
two-way lookups, 48–49
wildcard characters with, 31
XNPV, 88–90
funnel charts, 638–639
Funnel.xlsx file, 638
future investment value, returning, 103–105
future payments, returning value of, 101–105
FV function, 103–105, 111–112
FV worksheet, 104
G
Galton.xlsx file, 614
gambling and sporting-event probabilities, 937–946
craps, 937–939
five-card draw poker, 939–942
NCAA men’s basketball Final Four, 942–944
problems for, 945
GameStop stock, 801
Gamestop.xlsx file, 540
Gantt charts, 626
Gasprices507.xlsx file, 287
Gauss-Seidel method, 119
GE stock, price simulation of, 926–929
General Motors (GM)
histogram for, 373–374
Monte Carlo simulation used by, 907
geographic locations, in Excel formulas, 347–348
Geography data type, 347–348
geometric mean, 388–389
GEOMMEAN function, 389
Geommean.xlsx file, 388
Get & Transform Data group, 321, 323
appending tables, 338–340
combining data into summary worksheet, 338–340
combining files into single file, 331–333
daily suggested prices, 336–337
Get & Transform Data options

Excel tables
  creating from flat files, 328–329
  flattening, 327–328
hardware store data, 331–333
NBA player data, 329–331
Pivot Column command, 328–329
Unpivot Columns command, 327
US city population data, importing into Excel, 323–327
Get & Transform Data options, 321–322
Get External Data menu (PowerPivot), 554
GETPIVOTDATA function, 523–525, 629, 630
GETSTATE function, 1054
GET.WORKBOOK macro, 245
Gini index, 9
Gladwell, Malcolm, 1028
Globalwarming2011.xlsx file, 279, 280
GNP.xlsx file, 280
Go To dialog box, 179, 962
Go To Special dialog box, 481
Goal Seek, 197–202, 971
  break-even analysis with, 198–199
  high-school algebra problems for, 199–200
  mortgage payment analysis, 199
  problems for, 201–202
  requirements for, 197
Goal Seek command, 960, 965, 970
Goals.xlsx file, 664
Golfdata.xlsx file, 237
Gompertz curve. See S-curves
Grades.xlsx file, 36
graphics
  charts
    band, 620–621, 923
    bar, 590–591
    based on sorted data, 627–628
    bubble, 608–609
    category labels, 597–598
    column, 586–589
    combination, 591–593
    conditional colors in, 628–629
    controlling which series are charted, 624–626
    creating from data tables, 191–192
    data labels, 598–600
    data tables in, 598–600
    deleting points from, 610–611
    dynamic dashboards for, 628–629
    dynamic labels for, 620–621, 923
    elements in, 609–610
    funnel, 638–639
    Gantt, 626
    hidden data in, 596–597
    inserting vertical lines into, 628–629
    line, 603–606
    missing data in, 595–596
    modifying axes in, 612–613
    pie, 600–603, 654
    problems for, 614–615, 641–642
    radar, 607–608
    sales-force performance over time, 920–923
    scatter, 606–607, 666–667
    secondary axis, 593–594
    stacked area, 603–606
    for stocks, 639–641
    storing as templates, 620–621, 923
    sunburst, 635–638
    switching rows/columns in, 611–612
    thermometer, 923, 620–621, 923
    treemap (mosaic), 635–638
    waterfall, 633–635
histograms
  comparing, 373–374
  creating, 363–371
  multiple-peak, 372–373
  overview of, 363
  problems for, 376
  skewed left (negatively skewed), 372
  skewed right (positively skewed), 371–372
  symmetric, 371
maps
  2D filled, 643–647
  3D, 647–649
Pareto charts
  creating, 374–375
  design options for, 375
sparklines, 659–664
  automatically updating, 663–664
  daily customer counts, 659–660
  modifying, 661–662
  overview of, 659
  problems for, 664
  win/loss, 662–663
graphics, adding to charts, 588–589
graphs
  definition of, 895
  index funds, importing past data on, 804
  line, 287–289
moving-average, 745–746
greater than or equal to (>=) operator, 212
greeting cards, Monte Carlo simulation of, 911–914
GRG Nonlinear engine, 810
Grocery.xlsx file, 723
grouping PivotTable items, 518–519
growth, exponential, 675–680
  CAGR (compound annual growth rate), 675–678
equation for, 675
  Exponential command, 675–678
  GROWTH function, 679–680
  modeling, 676–678
  overview of, 675
  predictions based on, 679–680
  problems for, 680
  S-curve, 678
  trend curve parameters for, 678–679
GROWTH function, 679–680, 715–718
H
Hall, Monty, 759
hardware store data
  combining into single file, 334–336
  importing and formatting, 331–334
Hardware.xlsx file, 37
Harris, F.973
health club case study, 5–6
heat maps, 643. See also filled maps
hedging, with IF function, 125–126
Hedging worksheet, 126
heights of fathers/sons, finding patterns in, 1025–1027
Heighttemp.xlsx file, 1025
Help On This Error option (Error Checking dialog box), 173
helper functions, LAMBDA, 1056–1060
  BYCOL, 1057
  BYROW, 1056–1057
  ISOMITTED, 1060
  MAKEARRAY, 1059–1060
  MAP, 1057–1058
  problems for, 1060–1061
  REDUCE, 1058
  SCAN, 1059–1060
Hidden and Empty Cell Settings dialog box, 595, 597
hidden data, in charts, 596–597
Hidden.xlsx file, 596
  Hide Columns command, 189
  Hide Rows command, 189
hiding
  Assumption cells (Scenario Manager), 207
  comments, 944
High Low worksheet, 661
High Point option (Sparkline Tools Design), 661
Highlightcells.xlsx file, 255–257
Highlights Cells conditional formatting, 252, 255–257
High-Low-Close chart option, 640
high-school algebra problems for, Goal Seek command for, 199–200
Histogram dialog box, 365
histograms
  of annual stock returns, 1024
  comparing, 373–374
  creating, 363–371
  of father/son heights, 1025–1026
  multiple-peak, 372–373
  overview of, 363
  problems for, 376
  skewed left (negatively skewed), 372
  skewed right (positively skewed), 371–372
  symmetric, 371
historical volatility of stock, 956–957
Historicalinvest2009.xlsx file, 376
Historicalinvest.xlsx file, 279, 394, 459
HLOOKUP function, 891
  looking up prices from product ID codes with, 29–30
  syntax of, 26
  wildcard characters with, 31
Hockey.xlsx file, 1028
holiday dates, excluding, 77
Holt, Charles, 859
hospital data, patterns in, 1024–1025
Hospitaltemp.xlsx file, 1024–1025
Hospital.xlsx file, 537
hour, extracting from time, 152
HOUR function, 152
hourly wages, computing, 442–444
House2.xlsx file, 861
Housedata.xlsx file, 671
Housepricedata.xlsx file, 438
HR data, in Excel formulas, 359–361
Hr.xlsx file, 35
HYPGEOM.DIST function, 773–774
Hypergeom.dist.xlsx file, 773–774
hypergeometric random variables
  binomial, 775–776
  definition of, 773–774
HYPERLINK function, 168, 247
hyperlinks

hyperlinks, 167–169, 181
Hyperlinkstemp.xlsx file, 167

Icon Sets, 253, 263–266, 402–403
IDprice.xlsx file, 69
If 3 Then 4 worksheet, 840–841
IF function, 190, 619, 624, 628, 876, 891, 912, 939, 943
  craps, modeling, 130
  Freeze Panes options and, 127–130
  hedging example with, 125–126
  IFERROR, 134–136
  moving-average trading rule, 127–130
  nesting, 137
  overview of, 123–124
  pro forma financial statements, 130–134
  problems for, 143–147
  quantity discounts, 124–125
  summarizing annual revenues with, 136–137
if_not_found argument (XLOOKUP function), 26
IFERROR function, 26, 134–136, 194, 622, 631
IFS function, 137
IFSfinal.xlsx file, 138
Ifstatement.xlsx file, 130
  Hedging worksheet, 126
  Quantity Discount worksheet, 124
Ignore Blank check box (Data Validation dialog box), 474, 475, 480
Ignore Error option (Error Checking dialog box), 173
Ignore Integer Constraints option (Solver), 898
implied volatility, 796, 960
Import Data dialog box, 338, 339
importing data
  appending tables, 338–340
  Bitcoin prices, 802
  combining data into summary worksheet, 338–340
  combining into single file, 331–333
  daily suggested prices, 336–337
  Excel tables
    creating from flat files, 328–329
    flattening, 327–328
  Get & Transform Data options, 321–322
  hardware store data, 331–333
  NBA player data, 329–331
  past data
    on commodity prices, 804–805
    on currency exchange rates, 803
    on index or mutual funds, 804
  on stock, 799–801
Power Query Editor, 322
  from text files, 315–320
  problems for, 320
Text Import Wizard, 315–320
US city population data, 323–327
Include This Many Sheets option, 166
income, computing tax rates based on, 27–29
Incomedata.xlsx file, 394
Incomefrequency.xlsx file, 69
independent events, 755–756
independent random variables, 766
independent variables, 665–666
INDEX function, 39–41, 45, 313, 625, 897
  problems for, 41
  referencing entire row/column of array with, 41
  returning distance between cities with, 39–40
  syntax of, 39
indexes, seasonal
  in forecasting of future product sales, 750–752
  interpretation of, 749–750
  Toys “R” Us example, 715–718
  Walmart example, 749–750
INDEX.xlsx file, 39, 49
Indiana Pacers, minutes played by lineup, 1045–1046
INDIRECT function, 168, 239–249, 465–466, 480, 482
  changing cell references in formulas with, 240–241
  creating summary of product sales with, 244–245
  creating table of contents with, 247–248
  listing monthly sales of product with, 241–242
  listing worksheets in workbook with, 245–247
  problems for, 248–249
  referencing range names within formulas with, 243–244
  simple example of, 239–240
  totaling values in range with, 242–243
Indirectconsolidate.xlsx file, 244
Indirectinsertrow.xlsx file, 242
inferences, resampling, 947–951
initialization, of Winters method, 861
Input Message tab (Data Validation dialog box), 475
Input Y Range (Regression dialog box), 712
Inquire add-in, 179–182
  analyzing precedents/dependents with, 182
  analyzing workbook structure with, 181
  analyzing worksheet/workbook relationships with, 181
  cleaning excess cell formatting with, 182
  comparing workbooks with, 180
  installing, 179–180
IRR function

development of, 973
economic order batch (EOB) size, 976–977
electronics store case study, 973–975
equations for, 973–975
problems for, 977–978
with uncertain demand, 979–985
lost-sales approach, 980–981
overview of, 979–980
service-level approach, 982–985
investment returns, uncertainty in, 925–935
asset-allocation modeling, 929–934
problems for, 934–935
stock price simulation, 926–929
Investment Science (Luenberger), 953, 958, 963
investments
beta, 951
hedging example, 127–130
option pricing, 953–966
abandonment options, 964–965
American cash flows, 955
American options, 953
Black-Scholes formula, 798, 957–958, 959–961
call/put options, 953, 955–956, 958–959
in decision-making process, 963–964
European cash flows, 954–955
European options, 953
exercise date/expiration date, 953
historical volatility, 956–957
parameters for, 955
problems for, 965–966
real options, 963–964
volatility of stock, estimating, 956–957
worksheet protection, 961–963
payback period, 47–48
returning future value of, 103–105
IPMT (interest payment) function, 106–107
IQs
calculating probabilities for, 784–785
PDF (probability density function) for, 782–784
IRR (internal rate of return), 93–99
calculating with IRR function, 94
definition of, 93–94
for irregularly spaced cash flows, 96
lack of, 94–95
modified internal rate of return, 97–98
multiple, 94–95
problems for, 98–99
scale of project and, 95–96
IRR function, 94

Insert Calculated Field dialog box, 516, 522
Insert Calculated Item dialog box, 521
Insert Chart dialog box, 498, 621
Insert Column or Bar Chart button, 586, 587, 588, 591, 620, 621, 628, 629
Insert Combo Chart button, 593
Insert Function dialog box, 560
Insert Hyperlink dialog box, 167
Insert Line or Area Chart button, 603, 605
Insert Pictures dialog box, 588
Insert Pie or Doughnut Chart button, 601, 602
Insert PivotTable button, 1021
Insert Scatter (X,Y) or Bubble Chart button, 191, 606, 608, 623, 626, 631, 632, 667, 746, 995, 1006
Insert Slicers dialog box, 500, 516
Insert tab
Charts, 644
Charts section, 191, 586, 593, 603, 604, 608
Insert Waterfall, Funnel, Stock, Surface, or Radar Chart button, 608, 639
Insig worksheet, 730
installing, Microsoft Excel Solver, 809
insurance, portfolio, 126
integer constraint, 827
Integer Optimality settings, 842
integer programming problems for, 841–842
interactions, 719–726
definition of, 719–720
problems for, 720–723
testing for presence of, 720–723
Interactions.xlsx file
Data worksheet, 720
Nonlinearity worksheet, 719
interarrival time, 988
intercept
of straight-line relationship predictions, 672
of trendlines, 751
INTERCEPT function, 671, 672, 679, 687, 751
interdependence of returns, 931
interest rate
calculating with RATE, 108
compound, 111–112
computing with IPMT function, 106–107
cumulative. See cumulative interest payments (CUMIPMT)
internal rate of return. See IRR (internal rate of return)
inventory modeling
EOQ (economic order quantity) model, 973–978
computer-manufacturing plant case study, 976–977
irregularly spaced cash flows

irregularly spaced cash flows
IRR (internal rate of return), 96
NPV (net present value), 88–90
IRR.xlsx file, 96
MIRR worksheet, 97
XIRR worksheet, 96
IS functions, 141
ISBLANK function, 141
ISERR function, 141
ISERROR function, 141
ISEVEN function, 147
ISFORMULA function, 141
ISNA function, 141
ISNONTEXT function, 141
ISNUMBER function, 141
ISEMITTED helper function, 1060
ISTEXT function, 141
items, PivotTable
   calculated, 519–522
   grouping, 518–519
IVolatility.com, 796

J
Jancon.xlsx file, 575
JDS Uniphase stock, 965
Jelen, Bill, 1031
Jordan.xlsx file, 394

K
Keep Solver Solution option, 819
keystroke combinations
   Copy command, 2
   New Sheet, 166
   Paste command, 2
   static dates, 79
   worksheet navigation, 168
Kingslineups.docx, 320
kurtosis, 381, 920

L
labels, chart, 598–600
   2D filled maps, 645–646
   category labels, 597–598
   creating, 620–621, 923
   data labels, 598–600
dynamic labels for, 620–621, 923
   pie charts, 654
trendlines, 669
   for two-way analysis of variance (ANOVA), 738
labor. See employees
lagged independent variables, 708
Lagged.xlsx file, 236
LAMBDA functions, 1051–1060
   creating custom functions with, 1051–1055
   helper functions, 1056–1060
      BYCOL, 1057
      BYROW, 1056–1057
      ISOMITTED, 1060
      MAKEARRAY, 1059–1060
      MAP, 1057–1058
      problems for, 1060–1061
      REDUCE, 1058
      SCAN, 1059
      problems for, 1060–1061
      recursive, 1055–1056
Lambdahelper.xlsx file, 1056–1060
LARGE function, 47, 386
last day of month
   returning date of next Monday, 81
   returning first/last day of month, 81–82
last number in column, finding, 232
Last Point option (Sparkline Tools Design), 661
last year’s revenues, named ranges for, 21–22
Last year.xlsx file, 21
LastSunday.xlsx file, 80
lastyear function, 22
Latitude.xlsx file, 482
law of complements, 754
law of total probability, 757
Lawdata.xlsx file, 951
layouts, PivotTable, 489–490
leap years, 74
learning curve, 683, 684–685
least-squares line, 669–670
LEFT function, 53, 56, 57–58, 59
left-hand lookup, 227–228
Lefthandlookup.xlsx file, 227
lemonade store case study
   break-even analysis, 198–199
   profit-maximizing price analysis, 184–188
Lemonadegs.xlsx file, 198
Lemonade.xlsx file, 184
LEN function, 53, 56, 59, 482
lookup functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HLOOKUP</td>
<td>Looking up prices from product ID codes with wildcard characters with, 29–30</td>
</tr>
<tr>
<td>VLOOKUP</td>
<td>Computing tax rates with, 27–29, syntax of, 25–26</td>
</tr>
<tr>
<td>XLOOKUP</td>
<td>Examples of, 31–34</td>
</tr>
</tbody>
</table>

length of time worked by employees, calculating, 152–153, 312–313
Lenora.xlsx file, 56
less-than sign (<), 782
less-than-or-equal-to sign (<=), 782
LET function, 1050–1051, 1060
LETandLAMBDA.xlsx file, 1050
Let's Make a Deal problem, 759
Lewent, Judy, 963
lifetime of machine, modeling problems for, 906
Weibull random variable, 901–904
WEIBULL.DIST function, 901–904
Lillydata.xlsx file, 459
line, waiting in. See queueing theory
line charts, 603–606
line graphs, creating from tables, 287–289
Line option (Sparkline Tools Design), 661
Linear command (Format Trendline menu), 666
linear demand curve, 994
linear models, 818
linear pricing, 1011
linear relationships, 643–652
accuracy of predictions, 671
dependent variables, 665–666
Format Trendline options, 666–667
independent variables, 665–666
intercept of, 672
between monthly production and monthly operating costs, 667–670
monthly variation in plant-operating costs, 670–671
problems for, 672–673
scatter charts of data points, 666–667
slope of, 672
trend curve, 665
LINEST function, 702–703
Lineupdata.xlsx file, 69
Lineupsch27 temp.docx, 315–320
Lineupsch27.txt file, 316
lipstick-pricing model, 1005–1010
loans
computing, 105–107
dependence on credit score, 115
future payments, returning value of, 101–103
interest rate, 108
calculating with RATE, 108
compound, 111–112
computing with IPMT function, 106–107
cumulative. See cumulative interest payments (CUMIPMT)
number of periods, determining, 108–109
periodic payments, computing, 105–107
principal payment, 106–107
location
filtering by, 413–415
sorting data by, 580
Location option (At Each Change In menu), 578
Locations data type, 347–348
Locked option, 962
locking formulas, 961–963
rows, 4–5
Logarithmic command (Format Trendline menu), 666
Logarithmic Polynomial (Format Trendline menu), 666
LOGEST function, 715–718
logistic curve. See S-curves
lognormal random variables, 795–798, 956
definition of, 795
LOGNORM.DIST function, 797–798
LOGNORM.INV function, 798
mean, 795
modeling future prices of stock as, 796–797
problems for, 798
standard deviation, 795
stock prices following, 796
Lognormal.xlsx file, 797
LOGNORM.DIST function, 797–798
LOGNORM.INV function, 798
lookup functions, 25–37
computing day/date with, 83
computing tax rates with, 27–29
definition of, 25
HLOOKUP
looking up prices from product ID codes with, 29–30
syntax of, 26
wildcard characters with, 31
VLOOKUP
computing tax rates with, 27–29
syntax of, 25–26
wildcard characters with, 31
XLOOKUP
wildcard characters with, 31
examples of, 31–34
lookup functions

syntax of, 26–27
two-way lookups, 48–49
wildcard characters with, 31
lookup range argument (MATCH function), 43
lookup value argument (MATCH function), 43
lookup_array argument (XLOOKUP function), 26
lookup_value argument
VLOOKUP function, 25
XLOOKUP function, 26
Lookupmultiplecolumns.xlsx file, 36
lookups, left-hand, 227–228
Lookuptwocolumns.xlsx file, 69
Lookup.xlsx file, 27, 29
loops, circular references, 117–121
every of, 117–118
pattern of, 117
problems for, 120–121
resolving, 118–120
lost-sales approach to reorder points, 980–981
Low Point option (Sparkline Tools Design), 661
LOWER function, 54
lowercase, sorting on, 408–409
Luenberger, David G.953, 958, 963

M
machine life, modeling
problems for, 906
Weibull random variable, 901–904
WEIBULL.DIST function, 901–904
Machinedates.xlsx file, 83
machinery, depreciation of, 109–110
Macro dialog box, 1035
macros
assigning to buttons, 1036
editing, 1033
GET.WORKBOOK, 245
Namedaterelative, 1040
placing on Quick Access Toolbar, 1037
recording, 1031–1048
macros to format a selected range of cells, 1031–1048
minutes played by lineup, 1045–1046
overview of, 1031–1048
problems for, 1047–1048
Record Macro dialog box, 1032–1033
relative references, 1037–1040
step-by-step process for, 1032–1033
Top 10 Filter (Customer), 1047
weekly changes in sales, 1041–1044
running, 1035–1037
Major League Baseball, 923
lookup functions with, 31–34
salary information, 46–47
Make Unconstrained Variables Non-Negative option, 817, 821, 827, 833, 849, 855
MAKEARRAY helper function, 1059–1060
Makeup worksheet, 401
Makeup2007.xlsx file, 218, 222, 223
Makeuparray.xlsx file, 448
Makeupdb.xlsx file, 435, 438, 459, 537
Makeupfiltertemp.xlsx file, 412, 428
Makeupsortfont.xlsx file, 409
Makeupsorttemp.xlsx file
Across worksheet, 407
Case worksheet, 408
Dates worksheet, 403
Makeup worksheet, 401
Makeupsubtotals.xlsx file, 577, 583
Makeuptimeline.xlsx file, 525
Manage Relationships dialog box, 543–544, 546–547
Manage Rules, 253
managing relationships, 546–547
manufacturing, predicted monthly operating costs, 697–701
Map Area menu, 645
MAP helper function, 1057–1058
Map Labels button, 645, 654, 656
Map Projection menu, 645
map tours, 649–650
MAPE (mean absolute percentage error), 863
Mapping Confidence report, 655
maps
2D filled
creating, 643–647
labeling, 645–646
3D
animating data in, 651–653
creating, 647–649
customizing, 650–651
map tours, 649–650
navigating, 649
New York City’s Fourth Avenue subway line
example, 655–656
pie charts with labels in, 654
summarizing data with 2D chart, 654
heat maps, 643
problems for, 657
Maps button, 644
Marker Color option (Sparkline Tools Design), 661
Markers option (Sparkline Tools Design), 661
Marketbasketdata.xlsx file, 249
Marketing Analytics (Winston), 678, 747, 993
master workbooks, consolidating data into, 571–575
MATCH function, 43–50
  investment payback period, returning, 47–48
  MLB player salaries, returning, 46–47
  nonlinear pricing plan, 1014, 1015
  problems for, 49–50
  product sales per month, returning, 43–45
  syntax of, 43–45
  two-way lookups, 46
  wildcard characters with, 44
match type argument (MATCH function), 44
match_mode argument (XLOOKUP function), 27
Matchex.xlsx file, 44
Matching Names worksheet, 446
Matchlist.xlsx file, 146
Matchthemax.xlsx file, 49
Matchthesecond.xlsx file, 215
Matchtype1.xlsx, 49
materials, bill of. See BOM (bill of materials) reports
mathematical functions, 147
  AVERAGEIFS
    examples of, 220–221
    syntax of, 218
  COUNT, 574
    examples of, 214
    syntax of, 210
  COUNTA
    examples of, 214
    overview of, 210
  COUNTBLANK
    examples of, 214
    overview of, 210
  COUNTIF, 482, 891, 909, 928, 941, 943
    examples of, 211–213
    syntax of, 209–210
  COUNTIFS
    examples of, 213
    syntax of, 210
  MAXIFS
    example of, 221–222
    syntax of, 218
  OFFSET, 225–237
    computing development costs with, 228–229
    dynamic ranges, 232–235
Evaluate Formula feature, 229–231
  last number in column, finding, 232
  left-hand lookup with, 227–228
  movie example, 229–231
  problems for, 236–237
  revenue tracking with, 228
  simple example of, 226–227
  syntax of, 226
  order of operations in, 6–7
  with Paste Special command, 160–162
  SUMIF, 218
    examples of, 218–221
    syntax of, 218
Matradingrule.xlsx files, 127, 128, 236
matrices, correlations, 693
matrix multiplication, 459
Mavscores.xlsx file, 615
Mavs.xlsx file, 163
MAX function, 445, 574
MAXIFS function
  example of, 221–222
  syntax of, 218
Maxifsmiifs.xlsx file, 221
Maximum Change setting (Goal Seek), 199
Maximum Time Without Improvement option (Solver), 889
maximum values
  conditional, 218, 221–222
  validating, 473–475
Mcdonalds.xlsx file, 537
mean, 382–384, 764–765, 910–911
  95 percent confidence interval for, 914
  definition of, 379
  geometric, 388–389
  lognormal random variables, 795
  MAPE (mean absolute percentage error), 863
  normal random variables, 786
  regression toward, 694–695
  of service times, 988
  trimmed, 387–388
Meanvariance.xlsx file, 764
Medians.xlsx file, 452
Mercator, Gerardus, 645
Mercator option (Map Projection menu), 645
Merck, 963, 966
Merge button (Scenario Manager dialog box), 207
Merge Columns dialog box, 325
Merton, Robert, 953. See also Black-Scholes option-pricing formula
messages
messages
“Set values do not converge”, 820–821
“Solver could not find a feasible solution”, 820–821
microchip data, PivotTables for, 512–515
Microsoft Excel 2019 VBA and Macros (Jelen and Syrstad), 1031
Microsoft Excel Solver, 1007
capital budgeting, 837–844
  additional constraints in, 840–841
  binary and integer programming problems for, 841–842
  problems for, 842–844
  software project selection problem, 837–840
determining optimal product mix with, 813–823
  feasible solutions, 813–820
  infeasible solutions, 820
  problems for, 822–823
  “Set values do not converge” message, 821–822
  “Solver could not find a feasible solution” message, 820–821
Evolutionary Solver, 889–894
assigning employees to workgroups with, 890–892
highlighting employee ratings with, 892–893
options for, 889–890
problems for, 893–894
tips for success, 889–894
financial planning with, 845–851
  overview of, 845
  PMT function, verifying accuracy of, 845–848
  problems for, 848–850
forecasting in presence of special events, 869–876
  factors influencing customer traffic, 869–872
  forecast accuracy, 872–876
  overview of, 869
  problems for, 876
  random errors in, 876
how it works, 811
installing/activating, 809, 815, 839, 862, 889, 902, 933, 983, 1000, 1007–1008
Integer Optimality settings, 842
optimization with, 807–811
optimization models, 808–809
  sample optimization problems for, 807–808
  problems for, 811, 827
profit-maximizing nonlinear pricing plan, finding, 1014–1018
rating sports teams with, 853–857
  NFL point spreads, setting, 854–856
  nonlinear nature of, 856
overview of, 853–854
problems for, 856–857
reorder points, determining, 983–985
retirement savings, determining, 848–850
running, 809–810, 872
scheduling workforce with, 825–829
solution engines, 810–811
terminology for, 811
tie-ins, pricing products with, 999–1003
transportation or distribution problems for, 831–836
  definition of, 831
  demand constraint, 832–833
  demand points, 831
  drug-distribution example, 831–834
  problems for, 834–836
  specifications for, 831
  supply constraints, 832
  supply points, 831
Winters method
equations for, 860–861
Forecast Sheet tool, 863–866
initialization of, 861
level of series, 860–861
overview of, 859
problems for, 867
seasonal index for current month, 860–861
smoothing constants, estimation of, 862–863
time series characteristics, 859–860
trend of series, 860–861
Microsoft stock, modeling future price of, 796–797
Microsoft Word documents, importing data from, 315–320
  problems for, 320
Text Import Wizard, 315–320
MID function, 53, 57, 59
Miller option (Map Projection menu), 645
MIN function, 445, 912
minimum values
  conditional, 218, 221–222
  validating, 473–475
minus (-) sign, in Scenario Manager dialog box, 207
MINUTE function, 152
minutes
  extracting from times, 152
  played by lineup, macro for, 1045–1046
MINVERSE function, 459
MIRR function, 97–98
MIRR.xlsx file, 97–98
missing data, in charts, 595–596
MLB player salaries, returning, 46–47
MOVIE data type, 78–80
mode

definition of, 380
MODE.SNGL function, 380
Modefunctions.xlsx file, 380
Model worksheet, 684, 989
modeling
exponential growth, 675–680
CAGR (compound annual growth rate), 675–678
equation for, 675
example of, 676–678
Exponential command, 675–678
GROWTH function, 679–680
overview of, 675
predictions based on, 679–680
problems for, 680
S-curve, 678
trend curve parameters for, 678–679
inventory. See inventory modeling
machine life
problems for, 906
Weibull random variable, 901–904
WEIBULL.DIST function, 901–904
nonlinearities and interactions, 719–726
definitions of, 719–720
problems for, 720–723
testing for presence of, 720–723
optimization models, 808–809
changing cells, 808–809, 815, 826, 831, 838
problem constraints, 809, 815, 826, 831, 838
target cells, 808, 815, 826, 831, 838
stock prices with lognormal random variables, 795–798
definition of, 795
LOGNORM.DIST function, 797–798
LOGNORM.INV function, 798
modeling future prices of stock as, 796–797
problems for, 798
stock prices following, 796
MODE.MULT function, 380
modified internal rate of return (MIRR), 97–98
Modify Button dialog box, 1037
modifying sparklines, 661–662
Monday.xlsx file, 81
Monte Carlo simulation, 907–917
95 percent confidence interval for mean profit, 914
corporate use of, 907–908
as decision-making tool, 911–914
discrete random variables, 909–910
gambling and sporting-event probabilities, 937–946
craps, 937–939
five-card draw poker, 939–942
NCAA men's basketball Final Four, 942–944
problems for, 945
greeting-card case study, 911–914
history of, 907
normal random variables, 910–911
problems for, 916–917
RAND function, 908–909
RANDARRAY function, 914–915
random sample generation, 916
sensitivity analysis and, 207
month, sales by
last day of, returning, 81–82
returning date of next Monday, 81
summarizing with PivotTables, 528–529
MONTH function, 78
month of year
extracting from dates, 78
recovering, 78
monthly product sales, 45–46
monthly production
accuracy of predictions, 671
intercept of, 672
monthly operating costs, predicting, 697–701
monthly payments, worksheet model for, 199
monthly variation in plant-operating costs, 667–670
relationship with monthly operating costs, 667–670
R-squared value, 671
slope of, 672
monthly stock returns
color coding of, 266–269
correlations between, 691–694
Monthsales.xlsx file, 615
months, sorting in chronological order, 403–404
Monthtomonth.xlsx file, 526, 528
Moore’s Law, 680
Moore.xlsx file, 680
More Data Table Options button, 600
mortgage payment analysis
with Goal Seek command, 199
sensitivity analysis of, 188–189
mosaic charts, 635–638
most-likely scenarios, for automobile sale, 203–208
Mostrecent.xlsx file, 232
Moviedata.xlsx file, 69
Movienumbers.xlsx file, 69
movies, in Excel formulas, 353–354
Movies data type, 353–354
Movies.xlsx file

Movies.xlsx file, 229–231
Moving Average command (Format Trendline menu), 666, 746
moving averages, 745–747
  four-period moving average, 745–746
  moving-average graphs, 745–746
  moving-average trading rule, 127–130
ratio-to-moving-average forecasting method for, 749–752
Mrcostest.xlsx file, 697–698
Multiple Consolidation Ranges option, 575
multiple IRRs (internal rates of return), 94–95
multiple regression analysis
  with GROWTH function, 715–718
  with LOGEST function, 715–718
nonlinearities and interactions, 719–726
  definition of, 719–720
  problems for, 720–723
  testing for presence of, 720–723
problems for, 718
qualitative factors, 705–714
quantitative independent variables in, 705
with TREND function, 714–715
multiple worksheets, auditing options for, 178–179
multiple-peak histograms, 372–373
multiple-worksheet workbooks
  hyperlinks in, 167–169
  navigating between, 167–169
  number of worksheets in, 166
  problems for, 169
  setting up, 165–167
Multipleworksheetstemp.xlsx file, 169
multiplication, with Paste Special command, 162
Multiply option (Paste Special), 162
Multistart engine, 903
Multistart option, GRG Nonlinear engine, 810
music, in Excel formulas, 353–354
Music data type, 353
Mutation Rate options (Solver), 889, 897
Mutation Rate setting, 1017–1018
mutual funds, importing past data on, 804
mutually exclusive events, 754–755
My Table Has Headers check box, 284
Myexample.xlsx file, 562

N

#N/A error, 26, 28, 134–136, 174, 381
Name box, defining range names with, 12–13
Name columns, sorting data by, 580
Name command (At Each Change In menu), 580
Name Manager, 16–17, 19
named ranges
  applying to existing formulas, 19, 20
  AutoComplete capabilities for, 18
  AVERAGE function, 18
  case insensitivity of, 12
  creating, 11–16
    with Create from Selection option, 13–15
    with Define Name option, 15–16
    with Name box, 12–13
deleting, 16–17
editing, 16–17
  for entire column, 18
  errors in, 22
  examples of, 17–18
  for last year’s revenues, 21–22
  Name Manager, 16–17, 19
  naming conventions for, 13, 23
  noncontiguous, 13
  numbers in, 23
  pasting list of, 21
  problems for, 23
  referencing within formulas, 243–244
  symbols in, 23
  for total salary per day, 22
  for total sales, 17–18
  underscore (_) in, 23
  workbook scope for, 18–19
  workbook/worksheet scope for, 18–19
  worksheet scope for, 18–19
Namedaterelative() macro, 1040
names
  extracting, 62–64
  filtering by, 420
Names.xlsx file, 278
naming conventions, for named ranges, 23
Nancybonds.xlsx file, 145
navigating
  3D maps, 649
  between worksheets, 167–169
Navigator dialog box, 324
Navy, BOM (bill of materials) reports for, 1019
NBA player statistics
  Copyingtableformulas.xlsx, 297
  data-validation example, 473–476
  filling and loading into separate rows, 329–331
Nba01_02.xlsx file, 857
NPV (net present value)

Nba02_03.xlsx file, 857
Nbadvl.xlsx file, 474
NBAfinal.xlsx file, 329–331
Nbamiles.xlsx file, 279
Nbaplayers.xlsx file, 37
Nbasalaries.xlsx file, 279
NBAtemp.xlsx file, 329–331
NBA.xlsx file, 215, 222
NCAA men’s basketball Final Four, probability of team win in, 942–944
negative binomial random variables, 774–776
negative Data Bars, 261
Negative Points option (Sparkline Tools Design), 661
negatively skewed histograms, 372
NEGBINOM.DIST function, 774–775
Negbinom.dist.xlsx file, 774–775
nested drop-down menus, validating, 478–480
nesting
   IF function, 137
   subtotals, 580–581
net present value. See NPV (net present value)
NETWORKDAYS function, 78
NETWORKDAYS.INTL function, 78
New Comment button, 944
New Formatting Rule dialog box, 264–266, 270–272, 296, 384, 503, 873, 892–893
New Name dialog box, 15, 234–235, 245, 1052, 1053
New Rule command (Conditional Formatting menu), 253, 873
New Scene button, 650
New Sheet icon, 166
New Worksheet Ply option, 721
New York City’s Fourth Avenue subway line, 3D map of, 655–656
Next option (Error Checking dialog box), 174
NFL point spreads, setting, 854–856
NFL team wins/losses, sparklines for, 662–663
NFL2012data.xlsx file, 856
NFL2012data.xlsx file, 857
NFLinfo.xlsx, 725
NFLpoints.xlsx file, 376
NFLwinslosses.xlsx file, 662
Nflinfo.xlsx, 725
Np.xlsx file
   Nonlinear Pricing Examples worksheet, 1011–1012
   OnePrice worksheet, 1013
   Two-Part Tariff worksheet, 1014
No Feasible Solution worksheet, 820–821
nonblank cells in ranges, counting, 214
Noncontigtemp.xlsx file, 13
noncontiguous named ranges, 13
nonlinear pricing, 1011–1018
   definition of, 1011
   price bundling, 1012–1014
   profit-maximizing, 1014–1018
   quantity discounts, 1011
   two-part tariff, 1012
Nonlinear Pricing Examples worksheet, 1011–1012
nonlinearities, 719–726
   definition of, 719–720
   problems for, 720–723
   testing for presence of, 720–723
Nonlinearity worksheet, 719
nonsmooth functions, 810–811
normal random variables, 781–790, 920
   CLT (central limit theorem), 786–787, 796
   computing probabilities for, 784–785
   finding percentiles for, 785–786
   mean, 786
   Monte Carlo simulation of, 910–911
   NORM.DIST function, 784–785
   NORM.INV function, 785–786, 787, 910–911
   PDF (probability density function), 782–784
   problems for, 789–790
   properties of, 781–784
   standard deviation, 786
   variance, 786
   Z-scores, 787–788
Normalexamples.xlsx file, 783, 786
NORM.DIST function, 784–785
NORM.INV function, 785–786
NORM.S.DIST function, 957
North sales, extracting from total US sales, 58–60
not equal to operator (<>), 212
NOW function, 151
NPER function, 108–109
NPV (net present value), 85–91, 201, 837, 966, 1063–1064
   computing with NPV function, 87–90
   for cash flows received at beginning of year, 88
   for cash flows received at middle of year, 88
   how to use, 87
   problems for, 90–91
   syntax of, 87
   computing with XNPV function, 88–90
   cost of capital, 87
customer value, determining, 967–972
   cell phone customer case study, 969–971
   credit-card customer case study, 967–969
NPV (net present value)

NPV function, 968–969
problems for, 969–971
definition of, 86–87
sensitivity analysis related to, 203–208
tracing dependents for, 175–177
NPV function, 87–90, 968–969
for cash flows received at beginning of year, 88
for cash flows received at middle of year, 88
how to use, 87
problems for, 90–91
syntax of, 87
NPVauditscenario.xlsx file, 203
NPVspinnerstemp.xlsx file, 303
null hypothesis, 727
#NUM! error, 90, 95, 98
Number Filters, Excel AutoFilter feature, 416–417, 421–422
Number Format dialog box, 492
number of periods (NPER) function, 108–109
Number section, Format Trendline pane, 669
Numberdv.xlsx file, 476
numbers
arrays of numbers, returning entries in computing tax rates with, 27–29
definition of, 25
looking up prices from product ID codes with, 29–30
mismatches between text and numbers in, 34
problems for, 35–37
syntax of, 25–27
wildcard characters with, 31
matching with MATCH function, 43–50
investment payback period, 47–48
MLB player salaries, returning, 46–47
problems for, 49–50
product sales per month, 45–46
syntax of, 43–45
two-way lookups, 46
wildcard characters with, 44
in named ranges, 23
ranking in data sets, 387
Numbers.xlsx file, 215, 223
numeric values, validating, 476–477
Nursejackiedata.xlsx file, 894
nutritional characteristics, in Excel formulas, 352

OFFSET function, 225–237
computing development costs with, 228–229
dynamic ranges, 232–234
Evaluate Formula feature, 229–231
left-hand lookup with, 227–228
movie example, 229–231
problems for, 236–237
revenue tracking with, 228
simple example of, 226–227
syntax of, 226
Offsetcost.xlsx file, 228–229
Offsetexample.xlsx file, 226–227
Oldfaithful.xlsx file, 673
on-base percentage (OPS), 724
One Book worksheet, 588
OnePrice worksheet, 1013
one-way analysis of variance (ANOVA), 727–732
alternative hypothesis, 727
book sales case study, 728–731
definition of, 727
forecasting with, 731
null hypothesis, 727
problems for, 731–732
one-way data tables
creating, 185–186
definition of, 184
Onewayanovatemp.xlsx file, 728, 730
Only Regions with Data option (Map Projection menu), 645
Open 3D Maps command, 648, 656
Open dialog box, 317
Open-High-Low-Close chart option, 640
opening new workbooks, 166
operating costs
monthly variation in, 670–671
predicting, 697–701
relationship with production, 667–670
operations, order of, 6–7
Operations area, Paste Special dialog box, 160–162
Operations Research (Winston), 975, 992
operators
<= (less-than-or-equal-to), 782
<> (not equal to), 212
= (equal to), 211
>= (greater than or equal to), 212
OPS (on-base percentage), 724
optimal bids, calculating, 919–923
bidding simulation model, 920–922
binomial random variables, 919–920
normal random variables, 920
problems for, 922
optimal product mix, determining with Solver, 813–823  
feasible solutions, 813–820  
infeasible solutions, 820  
problems for, 822–823  
“Set values do not converge” message, 821–822  
“Solver could not find a feasible solution” message, 820–821  
optimal solutions, 811, 819–820  
optimization, 808–809  
changing cells  
bank workforce scheduling problem, 826  
opimization problems for, 808–809  
product-mix problem, 815  
software project selection problem, 838  
transportation problem, 831  
with Evolutionary Solver, 889–894  
assigning employees to workgroups with, 890–892  
highlighting employee ratings with, 892–893  
options for, 889–890  
problems for, 893–894  
tips for success, 889–894  
with Microsoft Excel Solver, 807–811  
opimization models, 808–809  
sample optimization problems for, 807–808  
problem constraints, 809  
bank workforce scheduling problem, 826  
opimization problems for, 808  
product-mix problem, 815  
software project selection problem, 838  
transportation problem, 831  
target cells  
bank workforce scheduling problem, 826  
opimization problems for, 808  
product-mix problem, 815  
software project selection problem, 838  
transportation problem, 831  
Option Button form control, 307  
option pricing, 953–966  
abandonment options, 964–965  
American cash flows, 955  
Black-Scholes formula, 798, 957–958, 959–961  
call/put options, 953, 955–956, 958–959  
in decision-making process, 963–964  
European cash flows, 954–955  
European options, 953  
historical volatility, 956–957  
parameters for, 955  
real options, 963–964  
volutility of stock, estimating, 956–957  
worksheet protection, 961–963  
Optionbuttons.xlsx file, 311  
Options command (File menu), 64, 809  
Options dialog box, 179  
Or Select a Place in This Document option (Insert Hyperlink dialog box), 167  
order of operations, 6–7  
Original Model worksheet, 303  
outliers, 383–384, 671  
Outline group, Subtotal command, 577–581  
Output Range option, 735, 739  
overbooked flight case study, 772  
P  
p values, 700, 730  
P23_2.xlsx file, 248  
P23_3.xlsx file, 249  
Page Setup dialog box, 944  
parent/child relationships, 633  
Pareto, Vilfredo, 374  
Pareto charts  
creating, 374–375  
design options for, 375  
Paretotemp.xlsx file, 374  
Pascal, Blaise, 776  
Paste Link button, 160  
Paste List button, 21  
Paste Name dialog box, 12  
Paste Special command, 157–163, 187  
operations in, 160–162  
overview of, 157  
Paste Link button, 160  
problems for, 163  
transposing rows/columns with, 159–160  
vvalues of cells, pasting to different part of worksheet, 157–159  
Paste Special dialog box  
Paste Link button, 160  
Transpose option, 159–160, 693  
Values option, 158  
Paste Special Divide Before worksheet, 160–161  
Paste Special Transpose worksheet, 159  
Paste Special Value worksheet, 157  
Paste Special Values command (File menu), 910  
Pastespecial.xlsx file, 157  
Paste Special Divide Before worksheet, 160–161  
Paste Special Transpose worksheet, 159  
Paste Special Value worksheet, 157
pattern-recognition technology, Flash Fill

- pattern-recognition technology, Flash Fill, 62–64
- patterns, finding with Analyze Data, 1019–1029
- BOM (bill of materials) reports, 1019
- daycare late pickups, 1027–1028
- heights of fathers/sons, 1025–1027
- hospital data, 1024–1025
- overview of, 1019
- problems for, 1028–1029
- stock market prices, 1022–1024
- payback period, returning, 47–48
- Payback.xlsx file, 47
- Payments.xlsx file, 199
- payments, future, 101–105
- payroll, weekly, worksheet model for, 1–2
- PDF (probability density function), 765–766, 782–784, 903, 920
- PEMDAS order of operations, 6–7
- People data type, 356
- Pepsi/Coke preference example, 771
- PERCENTILE function, 385–386
- percentile rankings, 385–386
- PERCENTILE.EXC function, 385–386
- PERCENTILE.INC function, 385–386
- percentiles, for normal random variables, 785–786
- PERCENTRANK function, 385–386
- PERCENTRANK.EXC function, 385–386
- PERCENTRANK.INC function, 385–386
- period (.), in named ranges, 23
- periodic payments, computing, 105–107
- perpetuity, 112
- Personal Macro Workbook, 1033
- Pfizer, Monte Carlo simulation used by, 907
- pharmaceuticals, probability statements from forecasts, 792–793
- phone numbers, formats for, 65–69
- Phonestroyalty.xlsx file, 969
- pie charts, 600–603, 654
- Pinevalley.xlsx file, 36
- pipe character (|), 61
- Pivot Column dialog box, 328–329
- PivotCharts, 498–499, 529–531
- PivotTable and PivotChart Wizard, 529–531
- problems for, 536–540
- Pivotwithslicers.xlsx file, 559
- Place In This Document option (Insert Hyperlink dialog box), 167
- plants, in Excel formulas, 353–354
- Plants data type, 354
- Play Tour button, 649
- player statistics, filling and loading into separate rows, 329–331
- conditional formatting in, 502–504
- creating, 542–543
- based on existing PivotTable, 531–532
- from data in different locations, 529–531
- with Data Model, 544–546
- multiple, 532–533
- with PowerPivot, 557–559
- daycare late pickups, 1027
- default settings for, 533
- design options for, 491
- drilling down, 522
- dynamic array functions compared to, 535–536
- editing, 509
- fields
  - calculated, 515–517
  - collapsing/expanding, 492–493
  - filtering, 495–498
  - format of, 491–492
  - PivotTable Fields pane, 487–488
  - sorting, 493–494
- GETPIVOTDATA function, 523–525
- grouping items in, 518–519
- hiding subtotals in, 501–502
- inserting, 1021–1022
- layouts, 489–490
- modifying empty cells in, 501–502
- origins of name, 491
- overview of, 483–485
- PivotCharts, 498–499
- PivotTable and PivotChart Wizard, 529–531
- problems for, 536–540
- Reports Filter, 499–500, 532–533
- slicers, 500–501
- station wagon ownership by family size and salary, 509–512
- summarizing Bitcoin prices and returns with, 533–535
- summarizing grocery sales with, 485–489
- summarizing sales by month with, 528–529
- summarizing total sales to date with, 526–527
- Timeline feature, 525–526
- updating calculations in, 504
- Pivotwithslicers.xlsx file, 559
prices and pricing

“Please excuse my dear Aunt Sally” (PEMDAS), 6–7
plus sign (+), 58, 303
PMT function, 101–107, 188–189, 199
mortgage payments, determining, 845
retirement savings, determining, 845
verifying accuracy of, 845
point spreads, setting with Solver, 853–857
example of, 854–856
nonlinear nature of, 856
overview of, 853–854
problems for, 856–857
points, 937–946
  deleting from charts, 610–611
  problem of, 776
Poisson random variable, 777–778
  computing probabilities for, 778
  definition of, 777
POISSON.DIST function, 778
problems for, 777
POISSON.DIST function, 778
Poisson.xlsx file, 778
poker, five-card draw, probability of three of a kind in, 939–942
Poker.xlsx file, 939
policy, reorder-point
  lost-sales approach, 980–981
  overview of, 979–980
  problems for, 985
  service-level approach, 982–985
Polynomial option (Format Trendline pane), 1006
population data, importing into Excel, 323–327
portfolio insurance, 126
positively skewed histograms, 371–372
posterior probability, 758
Power command (Format Trendline menu), 666, 684
power curve, 681–688, 994–997
  equation for, 681
  learning curve and, 684–685
  problems for, 687–688
  properties of, 683
  relationships modeled by, 681–683
  SSE (sum of squared errors), 685
  trend curve parameters for, 686–687
Power Query Editor, 322, 340–341
  daily suggested prices, importing and transforming, 336–337
Excel tables
  creating from flat files, 328–329
  flattening, 327–328
hardware store data
  combining into single file, 334–336
  importing and formatting, 331–334
NBA player statistics, filling and loading into separate rows, 329–331
overview of, 321–322
queries, editing, 334
tables, appending, 338–340
Unpivot Columns command, 327
US city population data, importing into Excel, 323–327
Power Pivot, 551–570
  CALCULATE function, 567–570
  calculated measures, 567–570
  creating PivotTables with, 557–559
  DAX (Data Analysis Expressions), 560–562
  importing data into, 552–557
  installing/activating, 552
  problems for, 570
  RELATED function, 562–567
  slicers with, 559–560
Powerpivoteexample1.xlsx file, 561
PQappendtemp.xlsx file, 336
PQappend.xlsx file, 339
PQdatatypetemp.xlsx file, 359
PQPROMBLEM5DATA.XLSX file, 340
PQPROMBLEM6DATA.XLSX file, 341
PQPROMBLEM7DATA.XLSX file, 341
PQPROMBLM4DATA.XLSX file, 340
  pre- and post-merger performance, separating in charts, 628–629
precedents
  analyzing with Inquire add-in, 182
  definition of, 174
  tracing, 174–175
predictions
  accuracy of, 671, 872–876
  auto sales, 705–710
  based on exponential growth, 679–680
  of presidential elections, 710–714
  straight-line relationship, 672
presidential elections, predictions for, 710–714
Previous option (Error Checking dialog box), 174
Priceads.xlsx file, 724
prices and pricing
  Bitcoin prices, importing, 802
  demand curve, 993–998
prices and pricing

- customer’s willingness to pay and, 997
- definition of, 993
- elasticity of demand, 994
- estimating, 993–998
- linear, 994
- problems for, 998
- subjectively determined demand, 1005–1010
- tie-ins, pricing products with, 999–1003
- worksheet model for, 7–8
- effect on profits, 7–8
- extracting dollar and cents amounts from, 62–64
- extracting from text strings, 56–58
- linear, 1011
- looking up from product ID codes, 29–30
- nonlinear, 1011–1018
- definition of, 1011
- profit-maximizing, 1014–1018
- quantity discounts, 1011
- two-part tariff, 1012
- option buttons for, 311–312
- option pricing, 953–966
- abandonment options, 964–965
  - American cash flows, 955
  - American options, 953
- Black-Scholes formula, 798, 957–958, 959–961
- call/put options, 953, 955–956, 958–959
- in decision-making process, 963–964
- European cash flows, 954–955
- European options, 953
- exercise date/expiration date, 953
- historical volatility, 956–957
- parameters for, 955
- problems for, 965–966
  - real options, 963–964
  - volatility of stock, estimating, 956–957
  - worksheet protection, 961–963
- price bundling, 1012–1014
- profit-maximizing price analysis, 184–188, 993–994
- stock prices
  - lognormal random variables, 795–798
  - simulation, 926–929
- tie-ins, pricing products with, 999–1003
- principal
  - cumulative, 107
  - PPMT function, 106–107
- pro forma financial statements, 130–134
- probability, 753–762. See also forecasting
  - additive rule for computing, 755
  - axioms for, 754
  - Bayes' theorem, 758–759
  - binomial, 770–773
  - Coke/Pepsi preference example, 771
  - defective elevator rails example, 771–772
  - overbooked flight example, 772
  - Village Deli example, 773
  - conditional, 756–757
  - contingency tables for, 757
  - cumulative, 770
  - events
    - definition of, 754
    - independent, 755–756
    - mutually exclusive, 754–755
  - experiments, 753
  - law of complements, 754
  - law of total probability, 757
  - making probability statements from forecasts, 791–794
  - Monte Carlo simulation, 907–917
  - 95 percent confidence interval for mean profit, 914
  - corporate use of, 907–908
  - as decision-making tool, 911–914
  - discrete random variables, 909–910
  - greeting-card case study, 911–914
  - history of, 907
  - normal random variables, 910–911
  - problems for, 916–917
  - RAND function, 908–909
  - RANDARRAY function, 914–915
  - random sample generation, 916
  - for normal random variables, 784–785
  - PDF (probability density function), 765–766, 903, 920
  - for Poisson random variable, 778
  - a posteriori, 758
  - probability mass function, 770
  - problems for, 759–762
  - sample space, 753
  - Weibull random variable, 906
  - probability density function (PDF), 765–766, 782–784, 903, 920
  - probability mass function, 770
  - problem constraints, in optimization models, 809
    - bank workforce scheduling problem, 826
    - product-mix problem, 815
    - software project selection problem, 838
    - transportation problem, 831
  - problem of points, 776
  - Problem5_9.xlsx file, 50
Analyze Data, 1028–1029
auditing options, 182
beta random variable, 906
binomial random variables, 775–776
bootstrapping, 934–935
capital budgeting, 842–844
charts, 614–615, 641–642
circular references, 120–121
conditional formatting, 278–281
consolidating data, 575
correlations and, 695
counting cells in ranges, 214–215
customer value, determining, 969–971
data importing from text files, 320
Data Model, 550
data types, 362
data validation, 481–482
database statistical functions, 438–439
dates, 82–83
demand curve, 998
descriptive statistics, 393–395
dynamic array functions, 471
EOQ (economic order quantity) model, 977–978
Evolutionary Solver, 893–894
Excel AutoFilter feature, 428
exponential growth modeling, 680
financial functions, 112–115
forecasting in presence of special events, 876
form controls, 313–314
gambling and sporting-event probabilities, 945
Goal Seek command, 201–202
histograms, 376
hypergeometric random variables, 775–776
IF function, 143–147
INDEX function, 41
INDIRECT function, 248–249
LET function, 1060
lognormal random variables, 798
lookup functions, 35–37
machine life, modeling, 906
maps, 657
MATCH function, 49–50
Microsoft Excel Solver, 827
Monte Carlo simulation, 916–917
multiple regression analysis, 703, 718
problems for, 703
negative binomial random variables, 775–776
NPV (net present value), 90–91
OFFSET function, 236–237
one-way analysis of variance (ANOVA), 731–732
optimal bids, calculating, 922
optimal product mix, determining with Solver, 822–823
option pricing, 965–966
Paste Special command, 163
PivotTables, 536–540
Poisson random variable, 777
power curve, 687–688
Power Query Editor, 340–341
problems

PowerPivot, 570
probability, 759–762
queueing theory, 992
random variables, 767
recording macros, 1047–1048
retirement savings, determining, 845–848
Scenario Manager, 207–208
sensitivity analysis, with data tables, 192–195
sorting, 409
sparklines, 664
sports team ratings, with Solver, 856–857
STOCKHISTORY function, 806
straight-line relationships, estimation of, 672–673
subjectively determined demand, 1006–1008, 1009–1010
subtotals, 583
text functions, 67–68
times, 155
transportation or distribution problems for, 834–836
two-way analysis of variance (ANOVA), 742–743
Winters method, 867
worksheet modeling, 9
Procter & Gamble, Monte Carlo simulation used by, 907
Prodmix.xlsx file, 820
Feasible Solution worksheet, 813
No Feasible Solution worksheet, 820–821
Set Values Do Not Converge worksheet, 821
product descriptions, extracting from text strings, 56–58
product IDs
extracting from text strings, 56–58
looking up prices from, 29–30
product sales
creating summary of, 244–245
forecasting of, 750–752
per month, returning, 45–46
Product worksheet, 458
production
accuracy of predictions, 671
cost, as function of number of units produced, 681–682
intercept of, 672
monthly variation in plant-operating costs, 670–671
relationship with operating costs, 667–670
R-squared value, 671
slope of, 672
time, cumulative units produced and, 683
Productlookup.xlsx file, 45, 299
product-mix problem, 813–820
Productmix.xlsx file, 182
Productsalespaste.xlsx file, 163
profit-maximizing price analysis, 184–188, 1005–1010
95 percent confidence interval for mean profit, 914
demand curve, 993–998. See also profit-maximizing price analysis
customer’s willingness to pay and, 997
definition of, 993
elasticity of demand, 994
estimating, 994–997
linear, 994
power, 994–997
problems for, 998
subjectively determined demand, 1005–1010
tie-ins, pricing products with, 999–1003
worksheet model for, 7–8
effect of price on, 7–8
nonlinear pricing plan, 1014–1018
price bundling, 1012–1014
profit-maximizing price analysis, 993–994
tie-ins, pricing products with, 999–1003
Proforma.xlsx file, 130
project duration, modeling, 904–905
project selection problem
additional constraints in, 840–841
example of, 837–840
PROPER function, 54
Protect Sheet dialog box, 962
Protected worksheet, 977
Ptableexample.xlsx file, 512
Ptablepartsdata.xlsx file, 538
Ptcustomers.xlsx file, 1047
Ptcustomers.xlsx file, 495
Pujols, Albert, 725
put options, 125, 953, 955–956, 958–959
Put worksheet, 954
PV function, 101–105
PV worksheet, 102

Q

Qb2013.xlsx file, 37
Qbinfo.xlsx file, 725
Qd.xlsx file, 1017
qualitative factors, in multiple-regression analysis, 705
quarterly US auto sales predictions, 705–710
US presidential elections, 710–714
quality ratings, of employees, highlighting with Evolutionary Solver, 892–893
range_lookup argument (VLOOKUP function)

quantitative independent variables, in multiple-regression analysis, 705
quantity discounts, 124, 125–126, 1011
quarterly corporate revenues, color coding of, 269–272
quarterly US auto sales predictions, 705–710
Quarterlygdpdata.xlsx file, 69
Quarterly.xlsx file, 867
Quarters worksheet, 140
queries, editing, 334
question mark (?), 31, 213
queueing theory, 987–992
  factors influencing, 987–988
  interarrival time in, 988
  mean and standard deviation of service times, 988
  number of servers in, 987
  overview of, 987
  problems for, 992
  queueing template, 989–991
  sensitivity analysis in, 989–991
  steady-state characteristics in, 988
  variability degrading performance of, 988–989
Queueingtemplate.xlsx file, 989–990
Quick Access toolbar
  placing macros on, 1037
  sorting with, 425–427
quotation marks ("), 211

R
radar charts, 607–608
RAND function, 908–909, 912, 923, 938, 940, 943
RANDARRAY function, 914–915, 916, 923, 950
Randarray.xlsx file, 916
RANDBETWEEN function, 923, 926–927, 930, 938, 947
Randdemo.xlsx file, 908
random errors, in forecasts, 876
random samples, generating, 916
random variables, 763–767
  beta
    determining probabilities with, 904–905
    problems for, 906
  binomial, 919–920
    BINOM.DIST function, 770–772
    BINOM.DIST.RANGE function, 770–772
    BINOM.INV function, 773
    computing binomial probabilities with, 770–773
    definition of, 770
    negative, 774–775
    problems for, 775–776
  continuous, 765
    definition of, 763
  discrete, 763–764, 909–910
  exponential
    computing probabilities for, 779–780
    problems for, 780
  hypergeometric
    binomial, 775–776
    definition of, 773–774
  independent, 766
lognormal, 795–798, 956
    definition of, 795
    LOGNORM.DIST function, 797–798
    LOGNORM.INV function, 798
    mean, 795
    modeling future prices of stock as, 796–797
    problems for, 798
    standard deviation, 795
    stock prices following, 796
    mean, 764–765
  negative binomial, 774–776
  normal, 781–790, 920
    CLT (central limit theorem), 786–787, 796
    computing probabilities for, 784–785
    finding percentiles for, 785–786
    mean, 786
    Monte Carlo simulation of, 910–911
    NORM.DIST function, 784–785
    NORM.INV function, 785–786, 787
    PDF (probability density function), 782–784
    problems for, 789–790
    properties of, 781–784
    standard deviation, 786
    variance, 786
    Z-scores, 787–788
  Poisson, 777–778
    computing probabilities for, 778
    definition of, 777
    POISSON.DIST function, 778
    problems for, 777
    problems for, 767
    standard deviation, 764–765
    uniform, 923
    variance, 764–765
    Weibull, 901–904
randomized blocks design, 734–736
Randy.xlsx, 629
range_lookup argument (VLOOKUP function), 25–26
ranges, 381–382
counting cells in, 209–215
  COUNT function, 210, 214
  COUNTA function, 210, 214
  COUNTBLANK function, 210, 214
  COUNTIF function, 209–210, 211–213
  COUNTIFS function, 210, 213
  DISTINCT COUNT function, 214, 547–549
problems for, 214–215
descriptive statistics for, 388
dynamic, 232–234
named
  applying to existing formulas, 19, 20
  AutoComplete capabilities for, 18
  AVERAGE function, 18
  case insensitivity of, 12
  creating, 11–16
  deleting, 16–17
  editing, 16–17
  for entire column, 18
  errors in, 22
  examples of, 17–18
  for last year’s revenues, 21–22
  Name Manager, 16–17, 19
  naming conventions for, 23
  noncontiguous, 13
  numbers in, 23
  pasting list of, 21
  problems for, 23
  referencing within formulas, 243–244
  symbols in, 23
  for total salary per day, 22
  for total sales, 17–18
  underscore (_) in, 23
  workbook/worksheet scope for, 18–19
totaling values in, 242–243
  RANK function, 387, 619, 625
  RANK.AVG function, 387
  RANK.EQ function, 298, 387, 940
  ranking numbers, 387
  rate formula, 846
  RATE function, 108
  ratings, of employees, 892–893
  Ratioma.xlsx file, 750
  ratio-to-moving-average forecasting method for, 749–752
  razors, profit-maximizing price analysis of, 999–1003
  Razorsandblades.xlsx file, 999
  Real Best Fit worksheet, 678
real options, 963–964
  Reapply option, Excel AutoFilter feature, 425
reciprocal cost allocation, 121
Record Macro button, 1032–1033, 1034, 1038, 1041, 1044, 1046, 1047
Record Macro dialog box, 1032–1033, 1034, 1038, 1041, 1044, 1046, 1047
recording macros, 1031–1048
to format a selected range of cells, 1031–1048
macros to format a selected range of cells, 1031–1048
minutes played by lineup, 1045–1046
overview of, 1031–1048
problems for, 1047–1048
Record Macro dialog box, 1032–1033
relative references, 1037–1040
step-by-step process for, 1032–1033
Top 10 Filter (Customer), 1047
weekly changes in sales, 1041–1044
recreation, gambling and sporting-event probabilities, 937–946
craps, 937–939
five-card draw poker, 939–942
NCAA men’s basketball Final Four, 942–944
problems for, 945
recursive LAMBDA functions, 1055–1056
redbold macro, 1034
Redbold.xlsm file, 1034
REDUCE helper function, 1058
references
  relative, 1037–1040
  structured, 294–295
regional sales
  consolidating data for, 571–575
  with Consolidate command, 571–575
  need for, 571
  problems for, 575
  subtotals of, 577–583
  need for, 577
  revenue and units sold by region, 577–580
  sales by each salesperson, 580–581
  worksheet model for, 169
regression, standard error of, 671
regression analysis, multiple, 697–703
accuracy of forecasts from, 702
with GROWTH function, 715–718
with LOGEST function, 715–718
nonlinearities and interactions, 719–726
definition of, 719–720
problems for, 720–723
testing for presence of, 720–723
predicted monthly operating costs, 697–701
problems for, 703, 718
qualitative factors, 705
quarterly US auto sales predictions, 705–710
US presidential elections, 710–714
quantitative independent variables in, 705
running with LINEST, 702–703
with TREND function, 714–715
Regression dialog box, 698–699
Input X Range, 712, 721
Input Y Range, 712, 721
regression forecasting model, 870
regression toward the mean, 694–695
regularly spaced time intervals, creating, 153–154
Reichheld, Frederick, 969–971
RELATED function, 562–567
relationships. See also trend curve
  correlations, 689–695
  Correlation dialog box, 689–691
  correlation matrix, 693
  definition of, 689
  between monthly stock returns during 1990s, 691–694
  overview of, 689–691
  problems for, 695
  regression toward the mean and, 694–695
  R-squared value and, 694
Data Model
  creating, 543–544
  managing, 546–547
power curve for, 681–688
  equation, 681
  learning curve and, 684–685
  problems for, 687–688
  properties of, 683
  relationships modeled by, 681–683
  SSE (sum of squared errors), 685
  trend curve parameters for, 686–687
straight-line, 643–652
  accuracy of predictions, 671
  dependent variables, 665–666
  Format Trendline options, 666–667
  independent variables, 665–666
  intercept of, 672
  between monthly production and monthly operating costs, 667–670
  monthly variation in plant-operating costs, 670–671
problems for, 672–673
  R-squared value, 671
  scatter charts of data points, 666–667
  slope of, 672
  trend curve, 665
  between workbooks/worksheets, 181
  relative references, 1037–1040
  Remove Arrows feature, 175, 177
  Remove Duplicates, in Excel AutoFilter, 424
  reorder-point policy
    lost-sales approach, 980–981
    overview of, 979–980
    problems for, 985
    service-level approach, 982–985
  Reorderpoint_backorder.xlsx file, 980
  Reorderpoint_lostsales.xlsx file, 982
  Repeatedhisto.xlsx file, 60
  Replace Current Totals check box, 578
  REPLACE function, 54
replication
  two-way ANOVA with, 737–742
  two-way ANOVA without, 734–737
Report Filter, 532–533
reports
  BOM (bill of materials), 1019
  PivotTable Reports Filter, 499–500
  Scenario PivotTable Report, 207
  Scenario Summary, 207
Reps worksheet (Datamodeltemp.xlsx), 541
REPT function, 54, 61
resampling, 947–951
residuals, 787–788, 874–876
resolving circular references, 118–120
result cells, 203, 206
results of calculations, moving, 157–159
retention rate (customer), profitability and, 967–969
Retire worksheet, 848
retirement savings
  determining, 845–849
  retirement-planning problem, 848–849
  returning future value of, 103–105
  return_array argument (XLOOKUP function), 26
Returnstemp.xlsx file, 17
revenues
  color coding of, 269–272
  exponential growth, 675–680
    CAGR (compound annual growth rate), 675–678
    equation for, 675
    Exponential command, 675–678
revenues

GROWTH function, 679–680
modeling, 676–678
overview of, 675
predictions based on, 679–680
problems for, 680
S-curve, 678
trend curve parameters for, 678–679
filtering tables on, 289–292
last year’s, named ranges for, 21–22
profit-maximizing price analysis, 184–188
subtotals by region, 577–580
summarizing annual, 136–137
Reversed.xlsx function, 237
Reversenames.xlsx file, 69
RIGHT function, 53, 59, 482
risk-free rate, 955
Robinson option (Map Projection menu), 645
Rock.xlsx file, 210, 214
Ronstadt, Linda, 353
ROW function, 137
Row Input Cell (Data Table), 969, 991
rows
locking, 4–5
transposing with columns, 159–160, 611–612
Rowsnamed.xlsx file, 22
RSQ function, 672
R-squared value, 671, 672, 677, 694
Rules Manager, Conditional Formatting, 257–258
running macros, 1035–1037
running Microsoft Excel Solver, 809–810

S
safety-stock level. See reorder-point policy
Salaries.xlsx file, 460
salary
total salary per day, 22
weekly wages, 1–2
sales
consolidating
with Consolidate command, 571–575
need for, 571
problems for, 575
as function of advertising, 682
listing with INDIRECT, 241–242
product sales per month, 45–46
summarizing with PivotTables
sales by month, 528–529
total sales to date, 526–527
total sales, named ranges for, 17–18
trend and seasonality in, 750–752
weekly changes in, 1041–1044
sales force, effectiveness of
two-way ANOVA with replication, 737–742
two-way ANOVA without replication, 734–736
Sales worksheet (Datamodeltemp.xlsx), 541
Salesdata.xlsx file, 49, 181
Salesfixfinal.xlsx file, 331–334
Salesfixtemp.xlsx file, 331–334
sales-force performance over time, charts of, 920–923
Salesstripping.xlsx file, 58
Salessummary.xlsx file, 181
sales-transaction data, sorting, 398–401
Sales.xlsx file, 438
sample space, 753
sample standard deviation, 381–382
sample variance, 381–382
samples, random, 916. See also resampling
Sandp.xlsx file, 278
satisfaction ratings, of employees, 892–893
Satissuper.xlsx file, 278
Savant, Marilyn vos, 759
Save As Template command, 621
Save Chart Template dialog box, 621
scale
chart axes, 612–613
projects, 95–96
SCAN helper function, 1059
scatter charts, 606–607, 666–667, 676
Scatter with Smooth Lines, 191, 623, 626, 631, 632
Scatter with Smooth Lines and Markers, 746
Scatter with Straight Lines, 995
Scatter.xlsx file, 606
Scenario Manager dialog box, 204, 205, 207
Scenario Manager, sensitivity analysis with, 203–208
Assumption cells, hiding/showing, 207
example of, 203–208
merging scenarios in, 207
Monte Carlo simulation, 207
problems for, 207–208
Scenario PivotTable Report, 207
Scenario Summary reports, 207–208
Scenario PivotTable Report, 207
Scenario Summary dialog box, 206–207
Scenario Values dialog box, 205
Scene Options pane, 650, 653
scheduling, traveling salesperson problem
definition of, 895, 896–898
example of, 203–208
merging scenarios in, 207
Monte Carlo simulation, 207
problems for, 207–208
Scenario PivotTable Report, 207
Scenario Summary reports, 207–208
SEQUENCE function, 469–470, 950
sequences of times, 153–154
Sequence.xlsx file, 469
sequencing problems
job-shop scheduling problems for, 895
traveling salesperson problem
definition of, 895, 896–898
examples of, 895–896
problems for, 898–899
sequential numbers, generating list of, 469–470
SER (standard error of regression), 671
serial format
for dates, 74–76
for times, 149
Serial Format worksheet, 74
Series Color section, Format Data Series pane, 645
Series dialog box, 913
servers, number of, 987
service-level approach, to reorder points, 982–985
Servicelevelreorder.xlsx file, 983
Set Objective option (Solver Parameters), 816, 821, 839, 896, 897
“Set values do not converge” message, 821–822
Shading.xlsx file, 280
shapes, histogram, 371–373
SHEET function, 246
Sheetnames.xlsx file, 18–19
shortcut keys, 1033
Show Calculation Steps option (Error Checking dialog box), 173
Show Data in Hidden Rows and Columns chart option, 597
Show Formulas feature, 172
Showbiz.xlsx file, 69
Show/Hide Comments button, 944
side-by-side view, 572
sigma, 910–911
Signif worksheet, 728
Sim worksheet, 909, 911, 914
Simplex LP engine, 810, 817–819, 827, 833–834, 849
simulation, Monte Carlo. See Monte Carlo simulation
Singers.xlsx file, 298
SKEW function, 381
skewness measure

skewness measure, 381, 920
skewed left histograms, 372
skewed right histograms, 371–372
slash (/), 803
SLN (straight-line depreciation), 109–110
SLN function, 109–110
slope
in ratio-to-moving-average forecasting method, 751
of straight-line relationship predictions, 672
of trendlines, 751
SLOPE function, 671, 672, 679, 687, 751, 752
slugging percentage (SLG), 725
SMALL function, 47, 386
smoothing, Winters method of
equations for, 860–861
Forecast Sheet tool, 863–866
initialization of, 861
level of series, 860–861
overview of, 859
problems for, 867
seasonal index for current month, 860–861
smoothing constants, estimation of, 861
time series characteristics, 859–860
trend of series, 860–861
software project selection problem
additional constraints in, 840–841
example of, 837–840
solution engines, Microsoft Excel Solver, 810–811
Solver. See Microsoft Excel Solver
“Solver could not find a feasible solution” message, 820–821
Changing Cells option, 896
By Changing Variable Cells, 816, 820, 821, 839
Evolutionary Solver, 889–890
Ignore Integer Constraints, 898
Make Unconstrained Variables Non-Negative, 817, 821, 833
Select a Solving Method list, 840
Set Objective, 816, 821, 839, 896, 897
Solve, 821, 833
Subject to the Constraints, 821
songs played on radio, counting, 209–215
blank cells in ranges, 214
function syntax for, 209–211
nonblank cells in ranges, 214
songs longer than average length, 212
songs not sung by a particular singer, 212
songs of minimum length, 212
songs of specific length, 213
songs of specific length by specific singer, 213
songs played after a certain date, 213
songs played before a certain date, 213
songs sung by a particular singer, 211
songs sung by singers whose last names being with a certain letter, 212
songs sung by singers whose last names contain x letters, 213
Sort dialog box. See sorting
SORT function, 464–466, 479, 480. See also sorting
Sort Warning dialog box, 405
Sortandsortby.xlsx file, 465
SORTBY function, 464–466, 916
Sortday.xlsx file, 409
sorted data, charts based on, 627–628
Sortedgraph.xlsx file, 627
Sorticons.xlsx file, 409
sorting
across columns, 407–408
on a cell or font color, 401–402
by city, 405–407
dynamic array functions for, 464–466
on icon sets, 402–403
by lowercase/uppercase, 408–409
months in chronological order, 403–404
PivotTable fields, 493–494
problems for, 409
with Quick Access toolbar, 425–427
sales-transaction data, 398–401
without Sort dialog box, 405
South sales, extracting from total US sales, 58–60
Space data type, 351
spaces, sample, 753
spaces.xlsx file, 247
Sparkline Color option (Sparkline Tools Design), 661
Sparkline Date Range dialog box, 662
Sparkline Tools Design tab, 661
sparklines, 659–664
automatically updating, 663–664
daily customer counts, 659–660
modifying, 661–662
overview of, 659
problems for, 664
win/loss, 662–663
Stocks worksheet

- Sparklines.xlsx file, 659
  - Column Sparkline worksheet, 662
  - High Low worksheet, 661
- special formats, 67
- Special Tricks.xlsx, 67
- specifiers, table, 295
- spider plots, 1063–1065
- Spiderplottemplate.xlsx file, 1063
- #SPILL error, 22, 349, 464
- Spin Button form control, 302–307
- Split Column button, 333
- Split Column by Delimiter dialog box, 333
- Split Column by Number of Characters dialog box, 333
- sporting-event probabilities, 937–946
  - craps, 937–939
  - five-card draw poker, 939–942
  - NCAA men's basketball Final Four, 942–944
  - problems for, 945
- Sportslife.xlsx file, 614
- sports team ratings, with Solver, 853–857
  - NFL point spreads, setting, 854–856
  - nonlinear nature of, 856
  - overview of, 853–854
  - problems for, 856–857
- Sports.xlsx file, 614
  - spread of points, around least-squares line, 672
- SQRT function, 956–957
- squared errors, sum of, 670
- SSE (sum of squared errors), 670, 685
- stacked area charts, 603–606
- Stacked Bar chart option, 626
- Stacked Column chart option, 587, 652
- standard deviation, 381–382, 764–765, 920
  - lognormal random variables, 795
  - normal random variables, 786
  - of service times, 988
- standard error of regression (SER), 671
- StartFixMinutestemp.xlsx file, 1045
- state abbreviations, validating, 477–478
- Statedv.xlsx file, 477
- Stateincome.xlsx file, 657
- States.xlsx file, 16, 17, 552
- static times, entering, 154–155
- Staticdate.xlsx file, 79
- station wagon ownership, by family size and salary, 509–512
- Station.xlsx file, 509
- statistical inferences, resampling, 947–951
- statistics, descriptive. See descriptive statistics
- STDEV function, 382, 454, 788
- Stdevif.xlsx file, 453
- STDEV.S function, 382, 793, 901, 902, 905, 913, 956–957
- STDEVS function, 873
- steady-state characteristics of queueing system, 988
- STEYX function, 671
- Stock data type, 349–350
- stock volatility, 955
- Stockcorrel.xlsx file, 691
- STOCKHISTORY function, 799–806
  - arguments of, 800
  - importing past with, Bitcoin prices, 802
  - past data, importing
    - commodity prices, 804–805
    - currency exchange rates, 803
    - index or mutual funds, 804
    - trading data on stoc, 799–801
  - problems for, 806
- Stockhistoryfinal.xlsx file
  - Bitcoin worksheet, 802
  - Currency worksheet, 803
  - Stocks worksheet, 800
- Stockpricestemp.xlsx file, 1022–1024
- stocks
  - asset-allocation modeling, 929–934
  - beta, 671, 951
  - charts for, 639–641
  - modeling as lognormal random variables, 796–797
  - option pricing, 953–966
    - abandonment options, 964–965
    - American cash flows, 955
    - American options, 953
    - Black-Scholes formula, 798, 957–958, 959–961
    - call/put options, 953, 955–956, 958–959
    - in decision-making process, 963–964
    - European cash flows, 954–955
    - European options, 953
    - exercise date/expiration date, 953
    - historical volatility, 956–957
    - parameters for, 955
    - problems for, 965–966
    - real options, 963–964
    - volatility of stock, estimating, 956–957
  - worksheet protection, 961–963
- prices, finding patterns in, 1022–1024
- stock price simulation, 926–929, 951
- STOCKHISTORY function, 799–806
- Stocks worksheet, 800
Stock.xlsx file, 373, 376, 383, 393
Stop If True option, 275–277
Stop Recording button, 1033, 1038, 1044, 1046, 1047
Store Macro In option, 1033
Storesales.txt file, 552
storing, 620–621, 923
story problems for, Goal Seek for, 199–200
straight-line depreciation (SLN), 109–110
straight-line relationships, 643–652
accuracy of predictions, 671
dependent variables, 665–666
Format Trendline options, 666–667
independent variables, 665–666
intercept of, 672
between monthly production and monthly operating costs, 667–670
monthly variation in plant-operating costs, 670–671
problems for, 672–673
R-squared value, 671
scatter charts of data points, 666–667
slope of, 672
trend curve, 665
strings
converting to times, 152
extracting product ID, price, and product description from, 56–58
matching with MATCH function, 43–50
investment payback period, 47–48
MLB player salaries, returning, 46–47
problems for, 44, 49–50
product sales per month, 45–46
syntax of, 43–45
two-way lookups, 46
structured references, 294–295
Subject to the Constraints list (Solver Parameters dialog box), 821
subjectively determined demand, 1005–1010
equation for, 1005
example of, 1006–1008
problems for, 1006–1008, 1009–1010
SUBSTITUTE function, 55, 61
Subtotal dialog box, 577–581
SUBTOTAL function, 582–583
subtotals, 577–583
hiding in PivotTables, 501–502
need for, 577
nesting, 580–581
problems for, 583
revenue and units sold by region, 577–580
sales by each salesperson, 580–581
with Subtotal command, 577–581
with SUBTOTAL function, 582–583
Subtract option (Paste Special), 162
subtraction, with Paste Special command, 162
Suggestion1 worksheet, 1021, 1027
SUM function, 3, 137, 242, 573, 578, 871, 891, 897
sum of squared errors (SSE), 670, 685
SUMIF function, 218
copying across columns, 297
equation for, 218–220
examples of, 218–220
syntax of, 218
Sumifrows.xlsx file, 222
SUMIFS function, 449, 480
Sumindirect.xlsx file, 240
summaries of workbooks, 244–245
summarizing data
3D maps as 2D charts, 654
database statistical functions, 429–439
criteria ranges for, 434–435
equation for, 431–437
examples of, 431–437
problems for, 431–437
descriptive statistics, 377–395
doing data sets with, 384–385
glancing mean, 388–389
kurtosis, 381
mean and standard deviation, 379, 382–384
mode, 380–381
outliers, conditional formatting for, 383–384
overview of, 377–378
percentile rankings, 385–386
problems for, 393–395
range, 381–382, 388
ranking numbers in, 387
sample standard deviation, 381–382
sample variance, 381–382
second-largest or second-smallest number, 386–387
skewness measure, 381
trimmed mean, 387–388
typical value for data set, 378–381
histograms
comparing, 373–374
creating, 363–371
data sets with, 372–373
overview of, 363
problems for, 376

1120
skewed left (negatively skewed), 372
skewed right (positively skewed), 371–372
symmetric, 371
PivotTables, 485–489
sales by month, 528–529
total sales to date, 526–527
relationships, 695
Summary Below Data option, 579
Summary button (Scenario Manager dialog box), 205
Summary worksheet, 244
sum-of-years' digits depreciation (SYD), 109–110
SUMPRODUCT function, 443, 454–457, 814–815, 826, 832
sunburst charts, 635–638
Sundays, returning date of most recent, 78–80
Super Bowl outcomes, Z-scores for, 787–788
Superbowlspreads.xlsx file, 787–788
suppliers, cost paid to, 2–5
Suppliers.xlsx file, 314
supply constraints, 832
supply points, 831
surplus, consumer, 1012
SWITCH function, 140–141
Switch Row/Column chart option, 995
Switchfinal.xlsx file, 141
SYD (sum-of-years' digits depreciation), 109–110
SYD function, 109–110
symbols, in named ranges, 23
symmetric histograms, 371
Syrstad, Tracy, 1031

T
Table Design tab, 210, 284–287
Table Import Wizard, 554–556
table of contents, creating with INDIRECT, 247–248
table_range argument (VLOOKUP function), 25
Tableexampletemp.xlsx file, 283–284
Tableexample.xlsx file, 298
Tablemakeuptemp.xlsx file, 289, 299
Tablemakeuptotals.xlsx file, 291, 292
Tablepie.xlsx file, 299
tables, 283–299
appending, 338–340
conditional formatting in, 295–298
contingency, 757
creating from flat files, 328–329
creating line graphs from, 287–289
design options for, 283–287
filtering, 289–292
flattening, 327–328
lookup functions
computing tax rates with, 27–29
definition of, 25
looking up prices from product ID codes with, 29–30
mismatches between text and numbers in, 34
problems for, 35–37
syntax of, 25–27
wildcard characters with, 31
PivotTables
age/gender travel expenditure example, 505–509
blank rows in, 501–502
calculated items in, 519–522
chip microchip from different countries/regions, 512–515
conditional formatting in, 502–504
creating, 529–533, 542–543, 544–546
default settings for, 533
design options for, 491
drilling down, 522
dynamic array functions compared to, 535–536
editing, 509
fields, 487–488, 491–499, 515–517
GETPIVOTDATA function, 523–525
grouping items in, 518–519
hiding subtotals in, 501–502
layouts, 489–490
modifying empty cells in, 501–502
origins of name, 491
overview of, 483–485
PivotCharts, 498–499
PivotTable and PivotChart Wizard, 529–531
problems for, 536–540
Reports Filter, 499–500, 532–533
slicers, 500–501
station wagon ownership by family size and salary, 509–512
summarizing Bitcoin prices and returns with, 533–535
summarizing grocery sales with, 485–489
summarizing sales by month with, 528–529
summarizing total sales to date with, 526–527
Timeline feature, 525–526
updating calculations in, 504
sensitivity analysis with, 183–195
advanced sensitivity analysis, 1063–1065
break-even year analysis, 189–191
creating charts from, 191–192
tables

mortgage payment analysis, 188–189
one-way data tables, 184, 185–186
overview of, 183–184
problems for, 192–195
profit-maximizing price analysis, 184–188
spider plots, 1063–1065
two-way data tables, 184
structured references in, 294–295
table slicers, 292–294
table specifiers, 295
Tablestructure.xlsx file, 294
Tablexpvdata.xlsx file, 299
Taleb, Nassim Nicholas, 798
target cells, 826
target cells, in optimization models
bank workforce scheduling problem, 826
optimization problems for, 808
product-mix problem, 815
software project selection problem, 838
transportation problem, 831
tariff, two-part, 1012
tax rates, computing with VLOOKUP function, 27–29
Teachers.xlsx file, 1028
teaching evaluation scores, bar graph of, 60–61
team wins/losses, sparklines for, 662–663
Teams.xlsx file, 376
temperature data, conditional formatting of, 253–255
Temperature2020.xlsx file, 253
templates
queueing, 989–991
storing charts as, 620–621, 923
terminology, for Microsoft Excel Solver, 811
Terrain data type, 347–348
testing, for nonlinearities and interactions, 719–720
Test.xlsx file, 278
text (TXT) files, importing data from, 315–320
problems for, 320
Text Import Wizard, 315–320
Text Encoding option (File Conversion), 316
TEXT function, 54, 80, 81, 622–623
text functions, 51–69
& (ampersand), 54
CHAR, 54, 61
CLEAN, 55, 61
CONCATENATE, 54, 57
FIND, 53, 57–58, 59, 61
Flash Fill, 62–64
LEFT, 53, 56, 57–58, 59
LEN, 53, 56, 59
LOWER, 54
MID, 53, 57, 59
overview of, 51–52
problems for, 67–68
PROPER, 54
REPLACE, 54
REPT, 54, 61
RIGHT, 53, 59
SEARCH, 53–54
SUBSTITUTE, 55, 61
syntax of, 52–56
TEXT, 54, 80, 81, 622–623
TEXTJOIN, 54, 64–69
TRIM, 53, 56, 57
UNICHAR, 61, 65
UNICODE, 61, 65
Unicode characters in, 64–65
UPPER, 54
VALUE, 54, 57, 61
Text Import Wizard
importing files with, 315–320
problems, 320
text strings
converting to times, 152
extracting product ID, price, and product description from, 56–58
matching with MATCH function, 43–50
investment payback period, 47–48
MLB player salaries, returning, 46–47
problems for, 49–50
product sales per month, 45–46
syntax of, 43–45
two-way lookups, 46
wildcard characters with, 44
Text That Contains dialog box, 254
Textandnumbers.xlsx file, 34
Textfunctions.xlsx file, 52
TEXTJOIN function, 54, 61–65
Textjoinfinal.xlsx file, 65
text/number mismatches, 34
Textstylesdata.xlsx file, 69
thermometer charts, 620–621, 923
Thorpe, Edward, 139–140
Three-Color heat maps, 645
three-dimensional formulas
multiple-worksheet workbooks
hyperlinks in, 167–169
navigating between, 167–169
setting up, 165–167
<table>
<thead>
<tr>
<th>Term</th>
<th>Page/Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>trading data, importing</td>
<td>799–801</td>
</tr>
<tr>
<td>Threetimes.xlsx file</td>
<td>280</td>
</tr>
<tr>
<td>tie-ins, pricing products</td>
<td>999–1003</td>
</tr>
<tr>
<td>tilde (~)</td>
<td>31</td>
</tr>
<tr>
<td>TIME function, 152</td>
<td></td>
</tr>
<tr>
<td>time functions</td>
<td></td>
</tr>
<tr>
<td>HOUR, 152</td>
<td></td>
</tr>
<tr>
<td>MINUTE, 152</td>
<td></td>
</tr>
<tr>
<td>NOW, 151</td>
<td></td>
</tr>
<tr>
<td>SECOND, 152</td>
<td></td>
</tr>
<tr>
<td>TIME, 152</td>
<td></td>
</tr>
<tr>
<td>TIMEVALUE, 152</td>
<td></td>
</tr>
<tr>
<td>TODAY, 151</td>
<td></td>
</tr>
<tr>
<td>time series</td>
<td></td>
</tr>
<tr>
<td>base of, 859</td>
<td></td>
</tr>
<tr>
<td>characteristics of, 859–860</td>
<td></td>
</tr>
<tr>
<td>forecasting future values of</td>
<td>859</td>
</tr>
<tr>
<td>forecasting in presence of</td>
<td>869–876</td>
</tr>
<tr>
<td>special events, 869–872</td>
<td></td>
</tr>
<tr>
<td>forecast accuracy, 872–876</td>
<td></td>
</tr>
<tr>
<td>overview of, 869</td>
<td></td>
</tr>
<tr>
<td>problems for, 876</td>
<td></td>
</tr>
<tr>
<td>random errors in, 876</td>
<td></td>
</tr>
<tr>
<td>moving averages, 745–747</td>
<td></td>
</tr>
<tr>
<td>four-period moving average, 745–746</td>
<td></td>
</tr>
<tr>
<td>moving-average graphs, 745–746</td>
<td></td>
</tr>
<tr>
<td>ratio-to-moving-average forecasting method for, 749–752</td>
<td></td>
</tr>
<tr>
<td>seasonal indexes</td>
<td></td>
</tr>
<tr>
<td>in forecasting of future product sales, 750–752</td>
<td></td>
</tr>
<tr>
<td>interpretation of, 749–750</td>
<td></td>
</tr>
<tr>
<td>Toys &quot;R&quot; Us example, 715–718</td>
<td></td>
</tr>
<tr>
<td>Walmart example, 749–750</td>
<td></td>
</tr>
<tr>
<td>seasonality of, 860</td>
<td></td>
</tr>
<tr>
<td>smoothing, Winters method of</td>
<td></td>
</tr>
<tr>
<td>equations for, 860–861</td>
<td></td>
</tr>
<tr>
<td>Forecast Sheet tool, 863–866</td>
<td></td>
</tr>
<tr>
<td>initialization of, 861</td>
<td></td>
</tr>
<tr>
<td>level of series, 860–861</td>
<td></td>
</tr>
<tr>
<td>overview of, 859</td>
<td></td>
</tr>
<tr>
<td>problems for, 867</td>
<td></td>
</tr>
<tr>
<td>seasonal index for current month, 860–861</td>
<td></td>
</tr>
<tr>
<td>smoothing constants, estimation of, 862–863</td>
<td></td>
</tr>
<tr>
<td>trend of, 860–861</td>
<td></td>
</tr>
<tr>
<td>Timeline feature, PivotTables</td>
<td>525–526</td>
</tr>
<tr>
<td>times, 149–155</td>
<td></td>
</tr>
<tr>
<td>computations with, 150–151</td>
<td></td>
</tr>
<tr>
<td>converting text strings to, 152</td>
<td></td>
</tr>
<tr>
<td>creating, 152</td>
<td></td>
</tr>
<tr>
<td>data validation of, 481</td>
<td></td>
</tr>
<tr>
<td>displaying current, 151</td>
<td></td>
</tr>
<tr>
<td>entering, 150</td>
<td></td>
</tr>
<tr>
<td>entering sequences of, 153–154</td>
<td></td>
</tr>
<tr>
<td>extracting hour/minute/second from, 152</td>
<td></td>
</tr>
<tr>
<td>formats for, 150, 151</td>
<td></td>
</tr>
<tr>
<td>length of time worked by employees, calculating, 152–153, 312–313</td>
<td></td>
</tr>
<tr>
<td>problems for, 155</td>
<td></td>
</tr>
<tr>
<td>regularly spaced time intervals, creating, 153–154</td>
<td></td>
</tr>
<tr>
<td>serial numbers assigned to, 149</td>
<td></td>
</tr>
<tr>
<td>static, 154–155</td>
<td></td>
</tr>
<tr>
<td>time-series data, moving averages of, 745–747</td>
<td></td>
</tr>
<tr>
<td>four-period moving average, 745–746</td>
<td></td>
</tr>
<tr>
<td>moving-average graphs, 745–746</td>
<td></td>
</tr>
<tr>
<td>Timeseries.xlsx file, 603</td>
<td></td>
</tr>
<tr>
<td>TIMEVALUE function, 152</td>
<td></td>
</tr>
<tr>
<td>Time.xlsx file, 151</td>
<td></td>
</tr>
<tr>
<td>titles, of straight-line relationship charts, 669</td>
<td></td>
</tr>
<tr>
<td>TODAY function, 76, 79, 151</td>
<td></td>
</tr>
<tr>
<td>Tolerance settings. See Integer Optimality settings</td>
<td></td>
</tr>
<tr>
<td>Top 10 Filter dialog box, 496–497, 1047</td>
<td></td>
</tr>
<tr>
<td>Top 10 Items dialog box, 1016</td>
<td></td>
</tr>
<tr>
<td>Top5.xlsx file, 280</td>
<td></td>
</tr>
<tr>
<td>Top20.xlsx file, 657</td>
<td></td>
</tr>
<tr>
<td>Top/Bottom conditional formatting, 253–255</td>
<td></td>
</tr>
<tr>
<td>Top/Bottom Rules, 252</td>
<td></td>
</tr>
<tr>
<td>total probability, law of, 757</td>
<td></td>
</tr>
<tr>
<td>Total Wages worksheet, 454–457</td>
<td></td>
</tr>
<tr>
<td>totals</td>
<td></td>
</tr>
<tr>
<td>subtotals, 577–583</td>
<td></td>
</tr>
<tr>
<td>need for, 577</td>
<td></td>
</tr>
<tr>
<td>nesting, 580–581</td>
<td></td>
</tr>
<tr>
<td>problems for, 583</td>
<td></td>
</tr>
<tr>
<td>revenue and units sold by region, 577–580</td>
<td></td>
</tr>
<tr>
<td>sales by each salesperson, 580–581</td>
<td></td>
</tr>
<tr>
<td>with Subtotal command, 577–581</td>
<td></td>
</tr>
<tr>
<td>with SUBTOTAL function, 582–583</td>
<td></td>
</tr>
<tr>
<td>total sales</td>
<td></td>
</tr>
<tr>
<td>extracting East, North, and South sales from, 58–60</td>
<td></td>
</tr>
<tr>
<td>named ranges for, 17–18</td>
<td></td>
</tr>
<tr>
<td>summarizing with PivotTables, 526–527</td>
<td></td>
</tr>
<tr>
<td>Toys &quot;R&quot; Us, seasonal indexes in, 715–718</td>
<td></td>
</tr>
<tr>
<td>Toysrusformat.xlsx file, 278</td>
<td></td>
</tr>
<tr>
<td>Toysrus.xlsx file, 222</td>
<td></td>
</tr>
<tr>
<td>Trace Dependents feature, 174–177</td>
<td></td>
</tr>
<tr>
<td>Trace Error option, 174</td>
<td></td>
</tr>
<tr>
<td>Trace Precedents feature, 174–175, 177–178</td>
<td></td>
</tr>
<tr>
<td>trading data, importing, 799–801</td>
<td></td>
</tr>
</tbody>
</table>
two-bin policy. See reorder-point policy
two-part tariff, 1012, 1014
two-way analysis of variance (ANOVA), 733–743
  forecasting with, 736–737, 740–742
  overview of, 733–734
  problems for, 742–743
  with replication, 737–742
  without replication, 734–736
two-way data tables. See also sensitivity analysis, What-If Analysis, 184
two-way lookups
  with MATCH function, 46
  with XLOOKUP, 48–49
Type the Cell Reference option (Insert Hyperlink dialog box), 167

U
uncertain demand, inventory modeling with, 979–985
  lost-sales approach, 980–981
  overview of, 979–980
  service-level approach, 982–985
uncertainty. See also random variables
  bootstrapping approach to, 925–935
    asset-allocation modeling, 929–934
    problems for, 934–935
    stock price simulation, 926–929
  inventory modeling with uncertain demand, 979–985
    lost-sales approach, 980–981
    overview of, 979–980
    service-level approach, 982–985
  Monte Carlo simulation, 907–917
    95 percent confidence interval for mean profit, 914
    corporate use of, 907–908
    as decision-making tool, 911–914
    discrete random variables, 909–910
    greeting-card case study, 911–914
    history of, 907
    normal random variables, 910–911
    problems for, 916–917
    RAND function, 908–909
    RANDARRAY function, 914–915
    random sample generation, 916
    optimal bids, calculating, 919–923
    bidding simulation model, 920–922
    binomial random variables, 919–920
    normal random variables, 920
    problems for, 922
underscore (_), 23
variables, random

Unemployment.xlsx file, 376
Unfreeze Panes command (Freeze Panes menu), 128
Unhide Columns command, 189
Unhide Rows command, 189
UNICHAR, 61, 65
UNICODE, 61, 65
Unicode characters, 64–65
uniform random variables, 923
UNIQUE function, 461–464
unique IRRs (internal rates of return), 95
Unique.xlsx file, 462
unit sales
  filtering tables on, 289–292
  subtotals by region, 577–580
universities, in Excel formulas, 351
Universities data type, 351
unlocking formulas, 961–963
Unpivot Columns command (Transform tab), 327–328
up blocks, 662
UPPER function, 54
uppercase, sorting on, 408–409
US city population data, importing into Excel, 323–327
US presidential elections, predictions for, 710–714
US T-bill interest rates, 160–162
USC.xlsx file, 794
Use a Formula option (New Formatting Rule dialog box), 270–271
Use a Formula to Determine Which Cells to Format option, 873, 892–893
Use Automatic Scaling option, 848
Use Function menu commands, 1–2
Use Multistart option (Solver), 984
Use Relative References option, 1039
USfilledmapstemp.xlsx file, 646

V

Valentine.xlsx file, 911, 914
validating data, 473–482
  AutoComplete feature, 481
  clearing data validation, 481
  custom, 476–477
  dates, 475–476
  error alerts, 474–475
  Go To Special dialog box, 481
  length of text in cell, 481
  minimum/maximum criteria, 473–475
  nested/dependent drop-down menus, 478–480
  nonnumeric values, 476–478
  numeric values, 476–477
  problems for, 481–482
  state abbreviations, 477–478
  time of day, 481
  in versions prior to Excel 2010, 481
#VALUE error, 61–62
Value Field Settings dialog box, 506, 508, 514, 559
VALUE function, 54, 57, 61
Values option, Paste Special dialog box, 158
Van Exel, Nick, 316
variability, in queueing theory, 988–989
variables, 726
  alpha, 904
  beta, 901, 904–906
    determining probabilities with, 904–905
    problems for, 906
  discrete random, 909–910
dummy, 706
  lagged independent, 708
  lognormal random, 956
  normal random, 910–911, 920
  qualitative, 705
  quantitative independent, 705
  Weibull, 901–904
variables, business. See business variables
variables, random, 763–767
  binomial, 919–920
    BINOM.DIST function, 770–772
    BINOM.DIST.RANGE function, 770–772
    BINOM.INV function, 773
    computing binomial probabilities with, 770–773
    definition of, 770
    negative, 774–775
    problems for, 775–776
  continuous, 765
    definition of, 763
  discrete, 763–764
  exponential
    computing probabilities for, 779–780
    problems for, 780
  hypergeometric
    binomial, 775–776
    definition of, 773–774
  independent, 766
  lognormal, 795–798
    definition of, 795
    LOGNORM.DIST function, 797–798
    LOGNORM.INV function, 798
    mean, 795

1125
variables, random

- modeling future prices of stock as, 796–797
- problems for, 798
- standard deviation, 795
- stock prices following, 796
- mean, 764–765
- negative binomial, 774–776
- normal, 781–784
- CLT (central limit theorem), 786–787, 796
- computing probabilities for, 784–785
- finding percentiles for, 785–786
- mean, 786
- NORM.DIST function, 784–785
- NORM.INV function, 785–786, 787
- PDF (probability density function), 782–784
- problems for, 789–790
- properties of, 781–784
- standard deviation, 786
- variance, 786
- Z-scores, 787–788
- PDF (probability density function), 765–766, 782–784
- Poisson, 777–778
- computing probabilities for, 778
- definition of, 777
- POISSON.DIST function, 778
- problems for, 777
- problems for, 767
- standard deviation, 764–765
- variance, 764–765
- variance, 381–382, 764–765, 786. See also analysis of variance (ANOVA)
- Varianceanalysis.xlsx file, 278
- VAR.S function, 382
- VBA (Visual Basic for Applications), 1031
- Verizondata.xlsx file, 236
- Verizonindirectdata.xlsx file, 249
- Verizon.xlsx file, 237
- vertical lines, adding to charts, 628–629
- View Side by Side command (Window group), 572
- View tab, Freeze Panes option, 127–128
- Village Deli case study, 773
- Visual Basic for Applications (VBA), 1031
- VLOOKUP function, 134, 244, 312, 313, 751, 871, 927, 941, 943, 949
  - avoiding use of, 542
  - computing tax rates with, 27–29
  - #N/A errors, 134–136
  - nonlinear pricing plan, 1014
  - syntax of, 25–26
  - wildcard characters with, 31
- volatility
  - historical, 956–957
  - implied, 796
  - of stock, 955, 956–957, 960
- Volatility.xlsx file, 965
- Volume-High-Low-Close chart option, 640
- Volume-Open-High-Low-Close chart option, 641

W

- wage*hours function, 22
- wages
  - hourly, 442–444
  - total salary per day, 22
  - weekly, 1–2
- Wages.csv file, 1–2
- Wages.xlsx file, 1–2
- wait time. See queueing theory
- waiting in line. See queueing theory
- Walmart
  - ratio-to-moving-average forecasting method for, 750–752
  - seasonal indexes in, 749–750
  - summarizing annual revenues for, 136–137
  - Walmartdata.xlsx file, 752
  - Walmartdata.xlsx file, 752
  - Walmartrev.xlsx file, 136
- Watch Window feature, 174
- waterfall charts, 633–635
  - Waterfallcashtemp.xlsx file, 634
  - Waterfallpandltemp.xlsx file, 633
- weather data, in Excel formulas, 357–359
- week of year, 80
- WEEKDAY function, 78, 272, 482
- weekend dates, color coding of, 272–273
  - of basketball players’ abilities, 274–275
  - Weekendformatting.xlsx file, 278
- weekly changes in sales, macro for, 1041–1044
  - weekly wages, worksheet model for, 1–2
  - WEEKNUM function, 80
  - WEEKNUM.xlsx file, 80
- Weibull random variable, 901–904
- WEIBULL.DIST function, 901–904
- WEIBULLDIST function, 904
- Weibuldest.xlsx file, 901
  - Weirddata.xlsx file, 69
- Westinghouse Corporation, 973
- West.xlsx file, 571, 575
- What-If Analysis. See data tables, sensitivity analysis with; Goal Seek
worksheets

wildcard characters, 31, 44
willingness to pay, demand curve and, 997
Win Loss worksheet, 662
Window group commands, 572
Win/Loss option (Sparkline Tools Design), 661
win/loss sparklines, 662–663
Winters, Peter, 859
Winters method
equations for, 860–861
Forecast Sheet tool, 863–866
initialization of, 861
level of series, 860–861
overview of, 859
problems for, 867
seasonal index for current month, 860–861
smoothing constants, estimation of, 862–863
time series characteristics, 859–860
trend of series, 860–861
wizards
Convert Text to Columns Wizard, 59–60
Function Wizard, 135
PivotTable and PivotChart Wizard, 529–531
Table Import Wizard, 554–556
Text Import Wizard
 importing files with, 315–320
problems for for, 320
WKRP radio station, counting songs on
 blank cells in ranges, 214
 function syntax for, 209–211
 nonblank cells in ranges, 214
 songs longer than average length, 212
 songs not sung by a particular singer, 212
 songs of minimum length, 212
 songs of specific length, 213
 songs of specific length by specific singer, 213
 songs played after a certain date, 213
 songs played before a certain date, 213
 songs sung by a particular singer, 211
 songs sung by singers whose last names being with a
certain letter, 212
 songs sung by singers whose last names contain x
 letters, 213
Workbook Analysis button (Inquire add-in), 181
Workbook Relationship button (Inquire add-in), 181
workbooks. See also individual workbooks
 analyzing relationships between, 181
 analyzing structure of, 181
 comparing, 180
consolidating data in
 with Consolidate command, 571–575
 need for, 571
 hyperlinks in, 181
multiple-worksheet
 changing number of worksheets in, 166
 hyperlinks in, 167–169
 navigating between, 167–169
 number of worksheets in, 166
 problems for, 169
 setting up, 165–167
opening new, 166
scope, 18–19
WORKDAY function, 76–77
WORKDAY.INTL function, 77
workdays
determining date that is x workdays after another
date, 76–77
determining number of workdays between two dates, 78
workforce. See employees
workgroups, assigning employees to, 890–892
Worksheet Analysis Report dialog box, 181
worksheet models
cost paid to supplier, 2–5
customer estimation, 5–6
demand curve, 7–8
employee weekly wages, 1–2
order of operations in, 6–7
problems for, 9
total salary per day, 22
Worksheet Relationship button (Inquire add-in), 181
worksheet scope, for named ranges, 18–19
Worksheetnames.xlsm file, 245
worksheets. See also individual worksheets
 analyzing relationships between, 181
 auditing options for, 171–182
 Error Checking, 173–174
 Inquire add-in, 179–182
 multiple worksheets, 178–179
 Remove Arrows, 175, 177
 Show Formulas, 172
 Trace Dependents, 174–177
 Trace Precedents, 174–175, 177–178
 viewing, 172
 Watch Window, 174
dates. See dates
hyperlinks in, 167–169, 181
inserting into workbooks, 165–167
listing, 245–247
worksheets

multiple-worksheet workbooks
hyperlinks in, 167–169
navigating between, 167–169
problems for, 169
setting up, 165–167
navigating between, 167–169
number of, 166
Paste Special Divide Before, 160–161
Paste Special Transpose, 159
Paste Special Value, 157
viewing side by side, 572
World option (Map Projection menu), 645
Worldball.xlsx file, 857
worst-case scenario, for automobile sale, 203–208

X
XIRR function, 93–94
XLOOKUP function

examples of, 31–34
syntax of, 26–27
two-way lookups, 48–49
wildcard characters with, 31
XLOOKUP.xlsx file, 31
.xlsx extension, 320
XNPV function, 88–90

Y
years
extracting from dates, 78
leap years, 74
recovering, 78
Yeartodate.xlsx file, 237
Yoga data type, 352–353

Z
Z-scores, 787–788