

# Index

## A

- Abs function, 91, 414
- Absolute referencing, 38–41
  - format, 39
- Access database, 290
- Accounting formatting, 27
- Activate method, 328, 355, 357
- ActiveChart, 371, 374
- ActiveConnection object, 603
- ActiveSheet, 376
- Active workbook, 355
- ActiveX controls, 345, 525
- ActiveX Data Objects (ADO), 601
- Add button, 22, 908
- AddFromFile method, 886
- Add-ins, Excel, 884–901
  - CPLEX, 900
  - Crystal Ball, 901
  - Premium Solver, 894
  - @RISK, 900
  - StatTools, 901
  - in VBA, 884–87
- Add-ins dialog box, 885
- AddIns object, 886
- Add method, 369, 594, 595
- Add property, 373
- AddShape method, 425
- Add Watch option, 907
- Advanced programming, 916–28
  - object-oriented programming, 916–23
  - opening applications from VBA, 923–28
- Algorithms, 206
  - Bubble Sort, 485, 486
  - Kruskal's, 634
- Alignment group, 24
- Alignment tab, 25
- All Commands option, 22
- AllTrials property, 570, 571
- Alphabetical sorting, 297
- Amplitude, 176
- Analysis
  - output, 637–38
  - in simulations, 572–73
- Analysis Toolpak, 95, 164, 165, 172
- AND function, 68, 69
- And operator, 457
- Animate procedure, 579, 580
- Animation, 571–72
  - procedure, 866
- Answer Report, 223
- Application object, 398–99, 573
- Application overview and model development
  - for birthday simulation, 666–68
  - for eight queens case study, 680–82
  - for facility layout case study, 768
  - for forecasting methods case study, 748–50
  - for inventory management case study, 698–99
  - for portfolio management and optimization case study, 788–89
  - for reliability analysis case study, 814–17
  - for retirement planning case study, 836–39
  - for warehouse layout case study, 718–23
- Applications
  - Microsoft, starting, 927–28
  - for properties and methods, 378–82
- Applications, for arrays, 486–90
  - phonebook, 486–90
- Applications, for large data, 609–15
  - transcript query, 609–15
- Applications, for mathematical programming,
  - 552–59
  - dynamic production problem, 552–59

- Applications, for programming structures, 468–74
    - banking account management, 468–74
  - Applications, for simulation, 261–77, 574–81
    - news vendor problem, 262–66
    - retirement planning problem, 272–77
    - single server queuing problem, 266–72, 574–81
  - Applications, for sub procedures, 444–47
    - derived math functions, 447
    - navigating procedures, 444–47
  - Applications, for user interface, 524–35
    - product search form, 528–35
    - real estate search spreadsheet, 524–28
  - Applications, for variables, 420–30
    - calculations and creating reports, 426–30
    - creating and modifying shapes, 420–26
  - Applications, of mathematical programs, 225–42
    - capital budgeting, 233–37
    - transportation problem, 225–27
    - warehouse location, 237–42
    - workforce scheduling, 228–32
  - ApplyCustomType method, 372
  - Apply Names option, 49
  - Arcsin function, 416
  - Arguments, 327
    - BackgroundQuery, 596
    - ByChange, 896
    - CellRef, 897
    - Connection, 595
    - ConnectionString, 601, 602
    - context, 412
    - Convergence, 897
    - Data Source, 601
    - default, 413
    - Derivatives, 897
    - Destination, 376, 396, 595, 596
    - Estimates, 897
    - FileFilter, 595
    - FileName, 609
    - FilterName, 609
    - FormulaText, 897
    - helpfile, 412
    - Interactive, 609
    - IntTol, 897
    - Iterations, 897
    - KeepFinal, 898
    - MaxMinVal, 896
    - MaxTime, 897
    - Multiselect, 595
    - PlotBy, 371
    - Precision, 897
    - Provider, 601
    - Relation, 897
    - ReportArray, 898
    - Scaling, 897
    - Search, 897
    - SetCell, 896
    - ShowRef, 897
    - Source, 371, 605
    - SourceData, 590
    - SourceType, 590
    - StepThru, 897
    - Title, 412, 595
    - Type, 396
    - UserFinish, 897
    - ValueOf, 896
    - Version, 590
    - xpos, 413
    - ypos, 413
  - Array function, 480, 481
  - Arrays, 480–95
    - applications for, 486–90
    - Boolean, 693
    - data, 481
    - defining, 480–82
    - dynamic, 483–84
    - indexing, 482
    - input, 483
    - multi-dimensional, 481–82
    - sorting, 484–86
    - storing data in, 570
    - using, 480
  - Asc function, 418
  - Atn function, 416
  - Auditing, 105–6
    - tracing dependents, 105, 106
    - tracing precedents, 105
  - AutoFill method, 396
  - AutoFilter, 359
  - AutoFilter method, 339, 527
  - AutoFit method, 389
  - Auto Fit options, 30
  - AutoSum command, 61
  - AVERAGE function, 52, 61, 64, 162, 167, 287, 398, 606
- B**
- BackgroundQuery argument, 596
  - Banking account management, applications for, 468–74
  - Bar chart, 117, 118, 119
  - Bar graph, 116
  - Basic error checking functions, 467–68
  - BasicShapes object, 375
  - Basis, 84
  - BeginArrowheadLength property, 377
  - BeginArrowheadStyle property, 377
  - BeginArrowheadWidth property, 377
  - BETA.DIST function, 95, 195
  - Beta distribution, 190, 195
  - BETA.INV function, 196
  - Binary, 206
  - BINOM.DIST functions, 194

- Binomial distribution, 190
  - BINOM.INV function, 196
  - Bin Range, 172, 173, 174
  - Bins, 172
  - Birthday simulation case study, 666–77
    - application overview and model development, 666–68
    - procedures, 671–75
    - re-solve options, 676
    - user interface, 670–71
    - worksheets, 668–70
  - Bold property, 366
  - Boolean array, 693
  - Boolean variables, 407, 457–58, 485, 506, 530
    - with Do loops, 463
  - BorderAround method, 364
  - Borders macro, 363, 365
  - Borders menu, 24, 25
  - Borders property, 361, 362
  - BoundColumn property, 503
  - Bound constraints, 214
  - Box-Whisker chart, 276
  - Breakpoints, 906–7
  - Bubble Sort algorithm, 485, 486
  - Buttons
    - Add, 22, 908
    - Command, 341, 342, 509
    - creating, 341
    - Exit, 469
    - Format, 28
    - functional, 634–36
    - in GUI design, 652
    - macro, 344–45
    - Macros command, 334
    - modify, 642
    - navigational, 630
    - New Tab, 347
    - Options, 299, 505–8, 653–54
    - Record Macro, 333
    - Rename, 22, 347
    - RUN SIMULATION, 581
    - Spin, 512–13
    - Start, 468
    - Sum, 469
    - Toggle, 505–8
    - worksheet, 635
  - ByChange argument, 896
  - Bypass Solver report, 550
  - By reference method, 439
  - ByVal, 439, 441
  - By value method, 439
- C**
- CalcAngles, 427, 429
  - CalcRandNum, 427, 428
  - Calculated Field, 153–54
  - Calculated Items, 153–54
  - Calculations, making, 426–30
  - Call command, 438
  - Capital budgeting, mathematical program applications for, 233–37
  - Caption property, 501, 506, 507
  - Case Else statement, 459
  - Case studies, overview of, 7–8
  - Categorized tab, 515
  - CDate function, 418
  - CDbl function, 417
  - CellRef arguments, 897
  - Cells
    - changing, 212
    - decision variable, 209, 224
    - entering data into, 13–14
    - format, 16
    - formatting, 24–28
    - group, 27
    - names for, 45–53, 385–91
    - Objective, 224
    - referencing, 38–45, 385–91
  - Cells property, 386, 387
  - Change event procedure, 511
  - Changing cells, 212
  - Chart commands, 114
  - Chart Output, 172
  - Charts, 371–75
    - axis, 121
    - bar, 117, 118, 119
    - box-whisker, 276
    - Chart Tools and, 117–24
    - creating, 114–16
    - dynamic, 127–30
    - gridlines, 123
    - Pareto, 573
    - pie, 116
    - pivot, 155–57, 629
    - scatter, 122, 123, 127, 183
    - types of, 115
  - ChartTitle property, 372
  - Chart Tools, 117–24, 174
  - ChartType property, 371
  - Check boxes, 505–8
    - option buttons *versus*, 653–54
  - CHISQ.DIST function, 95
  - Chr function, 418
  - CInt function, 417
  - Circular referencing, 45
  - Clarity
    - in GUI design, 647–50
    - in programming principles, 660–61
  - Classes, 328
  - Class modules, 916–17
  - Class objects, using new, 921–23

- ClearAll, 427, 430
- Clear All Breakpoints, 907
- ClearAll procedure, 576
- ClearContents method, 367, 368
- ClearFormats method, 367
- Clear method, 367
- ClearProb procedure, 558, 559
- Clear Rules option, 32
- Click-and-drag, 13
- Click event, 517
- Clipboard, 17
- Close command, 20
- Close method, 601
- Code
  - VBA, 53, 335–40
  - window, 325
- ColorIndex property, 360, 373
- Color property, 360, 361, 364, 366
- Color Scales, 32
- Column absolute referencing, 38, 40
- Column Field, 138
- Column Grand Totals, 138
- ColumnHeads property, 504
- Column Labels, 151
- Columns property, 387, 388
- ColumnWidths property, 503
- Combo boxes, 502–5
  - text boxes *versus*, 652–53
- Command buttons, 341, 342, 509
- Commands, 542
  - AutoSum, 61
  - Call, 438
  - Chart, 114
  - Close, 20
  - CONSTRAINT, 608
  - CREATE, 608
  - Define Name, 52
  - Dim, 406
  - End Sub, 325
  - INSERT, 608
  - Insert Function, 307
  - New Cell Style, 28
  - Open, 20
  - Options, 41, 45
  - Paste, 333
  - Print, 20
  - Recently Used, 61
  - Record Macro, 332
  - Redo, 19
  - Refresh All, 289, 295
  - Save, 19, 20
  - SQL, 588
  - Summarize Values by, 150
  - Undo, 19
  - Visual Basic, 20
- Compact view, 147
- CONCATENATE function, 73, 74
- Conditional formatting, 30–32, 126, 168
  - formulas, 102–4
- Connection argument, 595
- Connection object, 601
- ConnectionString argument, 601, 602
- Consistency
  - in GUI design, 650–52
  - style, 660–61
- Consolidation, data, 315–18
- Constants, 52–53, 408
- CONSTRAINT command, 608
- Constraints, 205, 542, 543
  - adding, 214
  - bound, 214
  - demand, 219
  - Product Mix, 208
- Context arguments, 412
- Contextual tabs, 15
- Continue procedure, 706
- Continuous distribution, 190
- Control data type, 521
- ControlSource property, 503
- ControlTipText property, 515
- Control Toolbox, 499, 502, 508, 509, 514
- Convergence, 235
  - argument, 897
- Conversion functions, 417–18
- CopyFromRecordset method, 603
- Copying, cells, 13
- Copy method, 356, 359, 371
- Correlation, 164
- Cos function, 93, 416
- COUNTA function, 309, 310
- COUNTBLANK function, 309
- COUNT functions, 95, 127, 128, 309, 310, 606
- COUNTIF function, 95, 309, 311
- Count method, 510
- Count property, 488
- Covariance, 164
- CPLEX, 900
- CreateArray procedure, 487, 489
- CREATE command, 608
- Create Names screen, 50
- CreateObject function, 925
- Crystal Ball simulation, 901
- CStr function, 418
- Cumulative distribution function, 190, 191
- Cumulative Percentage, 172
- Currency formatting, 27
- Customization
  - of Quick Access Toolbar, 21–23
  - of Ribbon, 21–23
- CutCopyMode property, 380

Cut method, 359, 426  
 shortcut for, 19

## D

### Data

applications for large, 609–15  
 consolidation, 315–18  
 control, 521  
 double, 488  
 doubles, 407  
 entering into cells, 13–14  
 exporting, 608–9  
 external, 594–608  
 histograms, 172–76  
 importing, 284–93, 594–604  
 integers, 407  
 large, using VBA with, 588–619  
 location, 139–40  
 pivot tables from, 137, 293–95  
 range of, 139  
 regression, 186–89  
 relationships in, 176–89  
 string, 407  
 transpose, 17  
 types, 406–9  
 understanding, 162–76  
 variant, 406  
 worksheet, 408–9

Data, importing  
 databases, 289–93  
 text files, 284–87  
 web addresses, 287–89

Data Access Object (DAO), 600

Data Analysis dialog box, 165, 888

Data Analysis ToolPak, 573, 888–90

Data arrays, 481

Databases, 3, 600–604  
 Access, 290  
 data consolidation, 315–18  
 data validation, 311–15  
 defined, 296  
 DFunctions, 306–11  
 Excel as, 296–318  
 filtering, 300–304  
 filters in, 291  
 importing, 289–93  
 parameter, 308  
 sorting, 296–300

DataCheck function, 709

Data collection, in simulation, 569–70

Data group, 150

Data Range, 118, 127

Data Source arguments, 601

Data sources, external, 139

Data Tables, 252–54

one-way, 252  
 two-way, 252

Data type, 72

Data validation, 311–15

Date Bars, 32

Date & Time functions, 83–90

DAVERAGE function, 306

DAYS360 function, 84, 85

DB function, 101

Debugging  
 Breakpoints, 906–7  
 Run to Cursor tool, 906  
 Step-Into stepping code, 906  
 Step-Out tool, 906  
 Step-Over tool, 906  
 tips, 909

Debug Toolbar, 905–7

Debug windows, 907–9  
 Immediate window, 909  
 Watch window, 907–8

Decision support systems (DSS), 2–3  
 application overview and model development, 622–23  
 applications, 5–6  
 charts, 114–34  
 components of, 3–4  
 defined, 3–5  
 development process, 622–44  
 input, 622–23  
 management information systems *versus*, 5  
 output, 623  
 procedures, 636–38  
 re-solve options, 639–42  
 testing and final packaging, 643  
 user interface for, 630–36  
 worksheets, 624–29

Decision Trees, 211

Decision variables, 204, 542  
 binary, 206  
 cells, 209  
 negative, 204  
 non-negative, 204  
 unrestricted, 204

Default argument, 413

Defined Names group, 51

Define Name command, 46–48, 52

Delete method, 370, 371

Demand constraint, 219

Dependents, tracing, 105

Dependent variables, 176

Derivatives argument, 897

Derived math functions, 416, 447

Descriptive statistics, 164, 165–71, 170

Descriptive Statistics option, 888, 889

Design Mode icon, 905

Design tab, 151

- Design tools, 117, 118, 146–52
  - Design View, 344
  - Destination argument, 359, 376, 396, 595, 596
  - Developer tab, 20
  - DFunctions, 306–11 (*See also* Functions List (Database))
  - Dialog box, 15
    - add-ins, 885
    - chart axis and, 121
    - Data Analysis, 165, 888, 889
    - Edit Series, 129
    - Excel Options, 22, 41
    - Format Cells, 24, 27, 29
    - Format Control, 344, 345
    - Format Trendline, 178, 179, 186
    - Function Arguments, 62
    - Insert Chart, 115
    - Insert Function, 62
    - Name Manager, 48
    - New Formatting Rule, 102
    - New Name, 51, 52
    - New Web Query, 287
    - Options, 885
    - Select Data Source, 118, 119, 123
    - Select Table, 295
    - Sort, 298
  - Dialog Launcher, charts and, 115
  - Dim statement, 406, 547
  - Discrete distribution, 190
  - Distributions, 190–97
    - Beta, 190, 195
    - binomial, 190
    - common, 257
    - continuous, 190
    - discrete, 190
    - exponential, 190
    - fitting in to a set of data, 258–59
    - generating random numbers with, 255–58
    - normal, 190, 191
    - Poisson, 190, 193
    - uniform, 190, 193
    - Weibull, 190, 814
  - DMAX function, 306
  - DMIN function, 306, 307, 308, 309
  - Do, Until loop, 462, 614
  - Do, While loop, 462
  - Documentation, 661
  - Do loops, 462–63
    - with Boolean variables, 463
  - Double data type, 488
  - DoubleMatrix object, 568
  - Doubles, 407
  - DSUM function, 306
  - DualValue properties, 549
  - Dynamic arrays, 483–84
  - Dynamic charts, 127–30
  - Dynamic controls, 655
  - Dynamic form controls, 633
  - Dynamic production problem, 552–59
  - Dynamic ranges, 127
  - Dynamic sparklines, 127–30
    - Ribbon and, 129
- E**
- Economic order quantity (EOQ), 2
  - Edit Series dialog box, 129
  - Efficiency, in programming principles, 661–63
  - Eight queens case study, 680–96
    - application overview and model development, 680–82
    - procedures, 685–89
    - re-solve options, 690–95
    - user interface, 683–85
    - worksheets, 682–83
  - Elseif statements, 454, 455, 457
  - Else statements, 454, 455, 457
  - EndArrowheadLength property, 377
  - EndArrowheadStyle property, 377
  - EndArrowheadWidth property, 377
  - End If statements, 457
  - End property, 390, 391
  - End statements, 466
  - End Sub command, 325
  - EndWith, 383
  - Enterprise resource planning (ERP), 2
  - EntireColumn property, 389
  - EntireRow property, 389, 390
  - Err object, 912–13
  - Error Alert message, 313, 314, 315
  - Error checking, 520–21, 910–13
    - Err object, 912–13
    - On Error GoTo statement, 911–12
    - On Error Resume Next statement, 911
    - Is functions, 910
  - Errors
    - logical, 904
    - standard, 186
    - types of, 904
    - user-created, 904
  - Estimates argument, 897
  - Event Procedures, 340–46, 516–19
    - Change, 511, 518
    - in GUI design, 656
    - Open, 358
    - Scroll, 518
  - Events, 327
    - defining, 920
  - Evolutionary Solver, 895
  - Excel

- add-ins, 884–901
- as database, 296–318
- decision support systems applications, 5
- object-oriented programming, 916–23
- objects, 12
- overview of, 6–7
- shortcuts, 14
- tables, 304–6
- VBA for, 7
- Excel Options dialog box, 22, 41
- ExcelSimModel procedure, 576, 577, 578
- Excel Standard Solver, 890–94
  - limitations and manipulations of, 899–900
- Executable program, starting, 923–24
- Exit button, 469
- Exit Statements, 464–68
  - Exit Do, 465
  - Exit for, 465
  - Exit Function, 464
  - Exiting loops, 465–66
  - Exiting procedures, 464
  - Exit Sub, 464
- Exp function, 183, 415
- EXPON.DIST function, 95, 193, 194
- Exponential distribution, 190
- Exponential Smoothing, 164
- Exponential trendlines, 177, 181, 182, 183, 184, 187
- Export file option, 522
- Exporting
  - data, 608–9
  - forms, 522
- Extend property, 373
- External data
  - pivot tables from, 293–95
  - source, 293
  - using, 594–608
- F**
- Facility layout, case study
  - application overview and model development, 768
  - procedures, 775–84
  - re-solve options, 785
  - user interface, 773–74
  - worksheets, 769–73
- FALSE function, 65, 66, 68, 69, 70, 71
- Field, 296
- FieldNames property, 596
- Field parameters, 308
- Field Settings, 138, 145, 146, 148
- FileFilter argument, 595
- File Menu, 20, 21
- FileName argument, 609
- Files
  - text, 284–87
  - writing, appending, and reading, 924–27
- FileSystemObject, 925
- Fill property, 377
- Filtering
  - databases, 300–304
  - macros, 336, 340
- FilterName argument, 609
- Filters, in databases, 291
- FinalValue properties, 549
- Financial functions, 96–102
- Floating form, 515
- Flyout menu, 303
- Font group, 15
- Font property, 366, 515
- Forecasting methods, case study, 748–66
  - application overview and model development, 748–50
  - input, 750
  - output, 750
  - procedures, 756–64
  - re-solve options, 764–65
  - user interface, 754–55
  - worksheets, 750–53
- ForeColor property, 377
- For loops, 461–62
- Format
  - absolute referencing, 39
  - cells, 16
  - function, 366
  - method, 550
  - relative referencing, 39
- Format Axis, 120
- Format button, 28
- Format Cells dialog box, 24, 27, 29
- FormatConditions object, 369, 370
- Format Control dialog box, 344, 345
- Format Gridlines, 120
- Format Painter brush, 28
- Formats, 17
- Formatting, 24–32
  - Accounting, 27
  - cells, 24–28
  - conditional, 30–32, 126, 168
  - Currency, 27
  - general, 28–30
  - mathematical programs, 204–6
  - numbers, 26, 27
  - unclear, 650
- Format tools, 120
- Format Trendline dialog box, 178, 179, 186
- Form Controls, 346
- Form design, 326
- Forms, 324, 326
  - floating, 515
  - importing and exporting, 522

- Forms (*cont.*)
  - input, 556
  - multiple, 656
- Formula Auditing group, 105, 106
- Formula Autocomplete, 61, 63
- Formula bar, 42
- Formula property, 394
- FormulaR1C1 property, 395, 396
- Formulas, 17, 42, 60–65
  - conditional formatting, 102–4
  - constraint, 209–10
  - entering, 153
  - naming, 52–53
  - in VBA, 394–99
- Formulas tab, 41, 43, 45, 47, 51, 61
- FormulaText argument, 897
- For Next loop, 547
- Frames, 507, 654
- FROM statement, 605
- Frontline's Premium Solver, 894–96
- Functional buttons, 634–36
- Function Arguments dialog box, 62
- Function Arguments window, 308
- Function Library group, 61
- Function objects, 572
- Function procedures, 440–43
- Function property, 592
- Functions List (Database), 306–11
  - COUNTA, 309
  - COUNTBLANK, 309
  - DAVERAGE, 306
  - DMAX, 306
  - DMIN, 306, 307, 308, 309
  - DSUM, 306
  - SUMIF, 311
- Functions List (Excel), 60–102, 162–171
  - ABS, 91
  - AND, 68, 69
  - AVERAGE, 52, 61, 64, 162, 167, 287
  - BETA.DIST, 95, 195
  - BETA.INV, 196
  - BINOM.DIST, 194
  - BINOM.INV, 196
  - CHISQ.DIST, 95
  - CONCATENATE, 73, 74
  - COS, 93
  - COUNT, 95, 127, 128, 309, 310
  - COUNTIF, 95, 309, 310, 311
  - DAYS360, 84, 85
  - DB, 101
  - Exp, 183
  - EXPON.DIST, 95, 193, 194
  - FALSE, 65, 66, 68, 69, 70, 71
  - FV, 97
  - GETPIVOTDATA, 154–55
  - HLOOKUP, 75
  - HOURL, 89
  - IF, 67, 69
  - IFERROR, 67
  - INDEX, 79, 80, 81
  - INTERCEPT, 188, 189, 749
  - IRR, 98, 99, 100
  - ISEVEN, 70
  - ISNUMBER, 71, 314
  - ISODD, 70
  - ISTEXT, 71
  - LOGNORM.INV, 196
  - LOWER, 73
  - MATCH, 78
  - MAX, 65, 398
  - MEDIAN, 95, 162, 163, 164
  - MIN, 65, 398, 606
  - MINUTE, 89
  - MMULT, 92, 93
  - MONTH, 86, 88
  - NETWORKDAYS, 84, 85, 86
  - NORM.DIST, 95, 190, 191
  - NORM.INV, 196, 256
  - NORM.S.DIST, 191, 192
  - NOT, 67
  - NOW, 84
  - NPER, 96, 97
  - NPV, 98, 99
  - OFFSET, 80, 82, 127, 128
  - OR, 68, 69
  - PERCENTILE.EXC, 170, 171
  - PERCENTILE.INC, 170
  - PERCENTRANK, 174
  - PERCENTRANK.INC, 170
  - PMT, 96
  - POISSON.DIST, 192, 193
  - PRODUCT, 91
  - RAND, 93, 94, 255, 566
  - RANDBETWEEN, 93, 95
  - RATE, 97
  - RSQ, 188
  - Sin, 93
  - SLN, 100
  - SLOPE, 188, 189
  - SQRT, 93
  - STANDARDIZE, 191, 192
  - STDEV, 95
  - STDEV.P, 163
  - STDEV.S, 163
  - STEYX, 188, 189
  - SUBSTITUTE, 73, 74
  - SUM, 38, 39, 61, 63, 64, 82, 90, 226
  - SUMIF, 95
  - SUMPRODUCT, 91, 92, 210, 226, 229, 234, 240
  - SYD, 100, 101



- TAN, 93
  - TODAY, 84
  - TRUE, 65, 66, 68, 70, 71
  - TYPE, 72
  - UPPER, 73
  - VLOOKUP, 75, 89
  - WEEKDAY, 87, 88
  - WEIBULL.DIST, 195, 196
  - XNPV, 99
  - YEARFRAC, 84, 86
  - Functions List (VBA), 414–8, 438–43, 454–68, 480–6
    - ABS, 414
    - Array, 480, 481
    - Arcsin, 416
    - Asc, 418
    - Atn, 416
    - AVERAGE, 398
    - CDate, 418
    - CDBl, 417
    - Chr, 418
    - CInt, 417
    - Cos, 416
    - CreateObject, 925
    - CStr, 418
    - DataCheck, 709
    - Exit, 464
    - Exp, 415
    - Format, 366
    - Int, 415
    - Is, 910
    - IsArray, 910
    - IsDate, 467, 910
    - IsNull, 532, 910
    - IsNumeric, 467, 472
    - LCase, 419
    - Len, 419, 489
    - LoadArea, 898
    - Log, 415
    - MID, 419
    - MOD, 414
    - Now, 380
    - QueryData, 610
    - Rnd, 415
    - SLOPE, 749
    - Sin, 416
    - RGB, 360
    - SaveArea, 898
    - Sec, 416
    - SheetName, 898
    - Shell, 923, 924
    - Sqr, 414
    - Tan, 416
    - TimeValue, 381
    - TypeName, 521
    - TypeNum, 898
    - UCase, 419
    - Val, 418
  - Functions List (RSP), 261–77
    - PsiDiscrete, 263
    - PsiExponential, 267
    - PsiMax, 268
    - PsiMean, 268, 274, 275
    - PsiOutput, 263, 268, 274
    - PsiResample, 272
    - PsiSenParam, 272, 275
    - PsiSimParam, 271
    - PsiStdDev, 268, 274, 275
    - PsiTarget, 266, 274, 275
    - PsiTriangular, 267
    - PsiUniform, 274
  - Functions List (Solver), 896–8
    - SolverAdd, 897
    - SolverChange, 897
    - SolverDelete, 897
    - SolverFinish, 897
    - SolverGet, 898
    - SolverLoad, 898
    - SolverOptions, 897
    - SolverReset, 896
    - SolverSave, 898
    - SolverSolve, 897
  - Functions Type (Excel), 60–102
    - basic operations, 60
    - categories, 60–65
    - date and time, 83–90
    - financial, 96–102
    - information, 70–72
    - lookup & reference, 75–83
    - logical, 65–69
    - mathematics and trigonometry, 91–95
    - statistical, 162–171
    - text, 73–75
  - Functions Type (VBA), 414–468
    - basic error checking, 467–68
    - conversion, 417–18
    - derived math, 447
    - string, 419
    - math, 414–19
    - passing variables in, 441–43
  - FV function, 97
- ## G
- Gauss-Seidel Iteration, 45
  - General formatting, 28–30
  - GetOpenFilename method, 595
  - GETPIVOTDATA function, 154–55
  - GetPivotData object, 591
  - Get property, 917
  - GoTo statement, 912
  - Gradient Fill option, 126

Grand Totals feature, 138, 142, 153  
 Graphical user interface (GUI), 2, 3, 4  
 Graphical user interface (GUI) design, 646–57  
   buttons and text boxes, 652–53  
   check boxes and option buttons, 653–54  
   clarity, 647–50  
   consistency, 650–52  
   dynamic controls, 655  
   effective, 646–56  
   event procedures, 656  
   frames, 654  
   ineffective, 652–56  
   labels *versus* text boxes, 655  
   multiple forms, 656  
   text boxes, list boxes, and combo boxes, 652–53  
 Graphs, bar, 116  
 Gridlines, 123  
 Grouping, 152

**H**

HasDataLabels property, 373  
 HasLegend property, 372  
 HasTitle property, 372  
 Header row, 299  
 Helpfile arguments, 412  
 Help menu, 12  
 Hidden property, 389, 523  
 Highlight Cells Rules, 30  
 Histograms, 164, 172–76, 628  
   multiple peaks, 176  
   negatively skewed, 176  
   positively skewed, 176  
   symmetric, 176  
 HLOOKUP function, 75  
 Home tab, 17, 28  
 HOUR function, 89

**I**

Icon Sets, 32  
 IFERROR function, 67  
 IF function, 67, 69  
   with MONTH function, 89  
 If statements, 454–58, 456  
   nested, 455  
 Images, 514  
 Immediate window, 326, 909  
 Import Data window, 290  
 Import file option, 522  
 Importing  
   data, 284–93, 594–604 (*See also* Data, importing)  
   forms, 522  
 Independent variables, 176  
 INDEX function, 79, 80, 81  
 Indexing, 482  
 Industrial engineering (IE), 2

Infeasibility, 219–20  
 Information functions, 70–72  
 Initialize procedure, 517  
 Init method, 547, 550  
 Input  
   in birthday simulation, 667–68  
   in decision support system, 622–23  
   for eight queens case study, 682  
   for forecasting methods case study, 750  
   for inventory management case study, 699  
   for multi server queuing simulations case study, 873  
   for portfolio management and optimization case study, 789  
   receiving, 630–34, 637  
   for reliability analysis case study, 816  
   for retirement planning case study, 839  
   for single server queuing simulations case study, 858  
   for warehouse layout case study, 722  
 Input array, 483  
 Input boxes, 411, 413–14, 422, 456  
 InputBox function, 413  
 Input form, 556  
 Input Message tab, 312, 314, 315  
 Input Range option, 165, 172  
 Input sheet, 624–26  
 Insert Chart dialog box, 115  
 INSERT command, 608  
 Insert Function command, 307  
 Insert Function dialog box, 62  
 Insert Module icon, 355  
 Installed property, 886  
 Integer programming (IP), 205–6  
 Integers, 407  
 Interactive argument, 609  
 Intercept, 186  
 INTERCEPT function, 188, 189, 749  
 Interest, calculating, 98, 99–100  
 Interior property, 360, 373  
 Int function, 415  
 IntTol argument, 897  
 Inventory management, case study, 698–715  
   application overview and model development, 698–99  
   procedures, 705–13  
   re-solve options, 713–15  
   user interface, 702–4  
   worksheets, 699–702  
 Inverse functions, 196  
 IRR function, 98, 99, 100  
 IsArray function, 910  
 IsDate function, 467, 910  
 ISEVEN function, 70  
 IsFunctions, 70, 910  
 IsNull function, 532, 910  
 ISNUMBER function, 71, 314

IsNumeric function, 467, 472  
 ISODD functions, 70  
 ISTEXT function, 71  
 Items, 138  
 Iterations argument, 897

**K**

KeepFinal argument, 898  
 Keyboard shortcuts, cut and paste, 19  
 Knowledge base, 4  
 Kruskal's algorithms, 634  
 Kurtosis, 169

**L**

Labels, 501–2  
   line, 912  
   text boxes *versus*, 655  
 LabelShape, 425  
 Lambda value, 193, 195  
 Layout tools, 119, 120  
 LCase function, 419  
 Least squares line, 178  
 Len function, 419, 489  
 Less Than option, 30  
 Let property, 917  
 Libraries, 328  
 LibraryPath property, 887  
 Limits Report, 224  
 Linear curves, 179  
 Linear programming (LP), 205–6  
 Linear trendlines, 177, 180, 188  
 Line labels, 912  
 Line number, 911  
 Line property, 377  
 LineStyle, 361, 364  
 LinkedCell property, 525  
 List boxes, 502–5  
   text boxes *versus*, 652–53  
 ListFillRange property, 526, 527  
 ListRows property, 504  
 LoadArea function, 898  
 Load method, 550  
 Locked property, 515, 523  
 Logarithmic trendlines, 177  
 Log function, 415  
 Logical checks, 457–58  
 Logical errors, 904  
 Logical functions, 65–69  
 LOGNORM.INV function, 196  
 Lookup & Reference functions, 72, 75–83  
 Loops, 460–63  
   For, 461–62  
   Do, 462–63  
   Do, until, 462, 614  
   Do, while, 462

  exiting, 465–66  
   Next, 461  
   For Next, 547  
 LOWER function, 73

**M**

Machine Number, 155  
 Macros, 23, 325, 332–46, 430  
   Borders, 363, 365  
   buttons, creating, 344–45  
   command button, 334  
   defined, 332  
   Event Procedures, 340–46  
   filtering, 336, 340  
   Quick Access Toolbar and, 346–49  
   recording, 332–34  
   referencing, 391  
   Ribbon and, 346–49  
   sorting, 338  
   VBA code, 335–40  
 Main sub procedure, 468, 610  
 Management information systems (MIS), decision support  
   systems *versus*, 5  
 MATCH function, 78  
 Mathematical programming, 542–64  
 Mathematical programs  
   applications, 225–42  
   formatting, 204–6  
   linear, integer, and nonlinear, 205–6  
   parts of, 204–5  
 Math functions, 91–95, 414–19  
   conversion, 417–18  
   derived, 416  
   string, 418  
   trigonometric, 416  
   typical, 414–16  
 Matrix, 93  
 MAX function, 65, 398, 606  
 Maximum values, 170  
 MaxMinVal arguments, 896  
 Max property, 513  
 MaxTime argument, 216, 897  
 Mean, 162, 166, 167  
 Median, 162, 166, 167  
 MEDIAN function, 95, 162, 163, 164  
 Members, 328  
 Message boxes, 411–13, 421  
 Methods, 84, 325, 327, 354–71  
   Activate, 328, 355, 357  
   Add, 369, 594, 595  
   AddFromFile, 886  
   AddShape, 425  
   applications for, 378–82  
   ApplyCustomType, 372  
   AutoFill, 396

Methods (*cont.*)

- AutoFilter, 359, 527
- AutoFit, 389
- BorderAround, 364
- charts, 371–75
- Clear, 367
- ClearContents, 367, 368
- ClearFormats, 367
- close, 601
- Copy, 356, 359, 371
- CopyFromRecordset, 603
- Count, 510
- Cut, 359, 426
- defining, 919–20
- Delete, 370, 371
- for drawing objects, 375–78
- Format, 550
- GetOpenFilename, 595
- Init, 547, 550
- Load, 550
- Modify, 369
- Name, 371
- open, 601
- OpenTextFile, 925
- Paste, 376
- PasteSpecial, 356, 359
- “PrintPort,” 920
- Readall, 926
- Readline, 926
- by reference, 439
- Refresh, 596
- RefreshTable, 591
- Run, 573
- ScreenUpdating, 571
- Select, 371, 376
- SeriesCollection, 373
- SetSourceData, 371
- Show, 517
- Simulate, 674
- Sort, 359
- by value, 439
- Wait, 380, 571, 579
- Where, 371
- Write, 926
- Microsoft applications, starting, 927–28
- Mid function, 419
- MIN function, 65, 398, 606
- Minimum values, 170
- Mini toolbar, 20, 24
- Min property, 513
- MINUTE function, 89
- MMULT function, 92, 93
- Mode, 166, 167
- Model and calculation sheets, 626–27, 637

- Model base, 3–4
- Models, solving, 544–45
- Model tab, 261, 264
- Mod function, 414
- Modifications, to pivot tables, 141–55
- Modify buttons, 642
- Modify methods, 369
- Modules, 324, 325, 326
  - class, 916–17
- Monte Carlo simulation models, 567, 900
- MONTH function, 86, 88
  - with IF function, 89
- Moving Average trendlines, 164, 177
- MSO Values property, 377
- Multi-dimensional arrays, 481–82
- Multipages, 509–12, 653
- Multiple forms, 656
- Multiple peaks histogram, 176
- Multiplication, matrix and, 93
- Multiply operation, 18
- Multiselect argument, 595
- MultiSelect property, 505
- Multi server queuing model simulation and optimization, 871–73
- MyMacros tab, 348

**N**

- Name box, 46
- Name Manager dialog box, 48
- Name method, 371
- Name property, 359, 376, 499, 596
- Names
  - Apply, 49
  - for cells, 45–53
  - constants, 52–53
  - Create, 50–51
  - define, 46–48
  - formulas, 52–53
  - name box and, 46
  - ranges, 391–94
  - for references, 45–53
  - Ribbon and, 48
  - shortcuts for entering, 47
  - in VBA, 385–94
  - for worksheets, 45–53
- Naming standards, 661
- Navigating, in user interface, 522–23
- Navigational buttons, 630
- Navigational procedures, 638
- Negatively skewed histogram, 176
- Negative variables, 204, 542
- Nested If statements, 455
- Net present value (NPV), 233, 249, 250
- NETWORKDAYS function, 84, 85, 86

- New Cell Style command, 28
  - NewEntry procedure, 487
  - New Formatting Rule dialog box, 102
  - NewName dialog box, 51, 52
  - NewName variable, 487
  - New statement, 601
  - News vendor problem, for simulation application, 262–66
  - New Tab button, 347
  - New Web Query dialog box, 287
  - Next loops, 461
  - Nonlinear programming (NLP), 205–6
  - Non-negative variables, 204, 542
  - Normal curve, 169
  - Normal distribution, 190, 191
  - NORM.DIST function, 95, 190, 191
  - NORM.INV function, 196, 256
  - NORM.S.DIST function, 191, 192
  - NOT function, 67
  - Now function, 84, 380
  - NPER function, 96, 97
  - NPV function, 98, 99
  - Number Filters option, 302, 304
  - NumberFormat property, 366
  - Number group, 26, 27
  - Numbering, in Excel, 14
  - Number of Operators, 148, 149, 152, 155
  - Number property, 912
  - Number tab, 26, 27
  - NumCircles variable, 423, 424
  - NumSquares variable, 423, 424
- O**
- Object Browser, 327–29, 354
  - Object Database Connectivity (ODBC), 601
  - Object hierarchy, 12
  - Objective, 212
  - Objective functions, 205, 542, 543
    - maximized, 205
    - minimized, 205
  - Object model, 12
  - Object-oriented Application Programming Interface (API), 542, 546–51
    - accessing optimization results, 549–51
    - building problem in, 546–48
    - simulation using, 567–73
    - solver, running, 549
    - solver engine and parameters in, 548–49
  - Object-oriented programming, in VBA, 916–23
    - class modules, 916–17
    - defining events, 920
    - defining methods, 919–20
    - defining properties, 917–18
    - using new class objects, 921–23
  - Objects, 324, 325
    - ActiveConnection, 603
    - AddIns, 886
    - application, 398–99, 573
    - BasicShapes, 375
    - class, 921–23
    - Connection, 601
    - defining set of, 12
    - DoubleMatrix, 568
    - drawing, 375–78
    - Err, 912–13
    - FormatConditions, 369, 370
    - Function, 572
    - GetPivotData, 591
    - QueryTables, 594
    - range, 394–97
    - Recordset, 601
    - Shapes, 375, 376
    - Sheet, 359
    - Solver, 546
    - Source, 603
    - Statistics, 578
    - Variable, 572
  - Object variable, 409
  - OFFSET function, 80, 82, 127, 128
    - with SUM function, 82
  - Offset property, 385, 386, 456, 571
  - On Error GoTo statement, 911–12
  - On Error Resume Next statement, 911
  - One-way Data Tables, 252
  - Open command, 20
  - Open event procedure, 358
  - Open method, 601
  - OpenTextFile method, 925
  - Operations, 18
    - Multiply, 18
    - undoing, 19
  - Operations research (OR), 2
  - Operators
    - And, 457
    - Or, 457
  - Optimization, 211, 223
    - accessing results, 549–51
    - case study, 871–73, 875
  - OptimizeStaats property, 549
  - Option buttons, 505–8
    - check boxes *versus*, 653–54
  - OptionExplicit, 406
  - Options
    - Add Watch, 907
    - All Commands, 22
    - Apply Names, 49
    - Auto Fit, 30
    - Clear Rules, 32
    - Descriptive Statistics, 888

- Options (*cont.*)
  - Export file, 522
  - Gradient Fill, 126
  - Import file, 522
  - Input Range, 165
  - Less Than, 30
  - Number Filters, 302, 304
  - Output Range, 165, 166
  - Paste, 17
  - Paste Special, 17, 18
  - PivotTable, 146–52
  - Protect Sheet, 27
  - re-solve, 639–42
  - Text control, 24
  - Use a formula, 102–4, 169
  - Value Field Setting, 143, 144
- Options button, 299
- Options command, 41, 45
- Options dialog box, 885
- Options tab, 148, 150
- ORDER BY statements, 606
- OR function, 68, 69
- Orientation property, 513, 591
- Or operator, 457
- Outlier values, 167, 168
- Output
  - analysis and display, 637–38
  - for birthday simulation, 668
  - in decision support system, 623
  - for eight queens case study, 682
  - for forecasting methods case study, 750
  - for inventory management case study, 699
  - for multi server queuing simulations case study, 873
  - for portfolio management and optimization case study, 789
  - for reliability analysis case study, 817
  - for retirement planning case study, 839
  - for single server queuing simulations case study, 858
  - for warehouse layout case study, 723
- Output Range option, 165, 166
- Output sheet, 627–29
- Output tab, 241
- P**
- Page Layout tab, 28
- Parameters
  - database, 308
  - field, 308
  - identifying, 548–49
  - PathName, 923
  - Step, 461
  - WindowState, 923
- Parameters Report, 260
- Pareto chart, 573
- Passing variables, 441–43
- Paste command, 333
  - shortcut for, 19
- Paste method, 376
- Paste option, 17
- PasteSpecial method, 356, 359
- Paste Special option, 17, 18
- PathName parameter, 923
- Path property, 601
- Pattern property, 360
- PERCENTILE.EXC function, 170, 171
- PERCENTILE.INC function, 170
- PERCENTRANK functions, 174
- PERCENTRANK.INC function, 170
- Phonebook, application for arrays, 486–90
- PictureAlignment property, 514
- Picture property, 514
- PictureSizeMode property, 514
- Pie chart, 116
- PivotCaches, 590
- Pivot charts, 155–57, 629
- PivotFields, 592
- PivotItems, 592
- PivotTable options, 146–52
- PivotTables, 590
- Pivot tables, 136–41
  - creating, 139–40, 140
  - creating from external data, 293–95
  - creating with VBA, 588–94
  - grouping, 152
  - location, 140
  - modifications, 141–55
  - terminology, 138–39
- PivotTable Styles group, 152
- Platform tab, 216
- PlotBy argument, 371
- PMT function, 96
- POISSON.DIST function, 192, 193
- Poisson distribution, 190, 193
- Polynomial trendlines, 177
- Portfolio management, 5–6
- Portfolio management and optimization, case study
  - application overview and model development, 788–89
  - input, 789
  - output, 789
  - procedures, 797–808
  - re-solve options, 809–10
  - user interface, 796–97
  - worksheets, 790–96
- Position properties, 515
- Positively skewed histogram, 176
- Power trendlines, 177, 184, 185, 187
- Precedents, tracing, 105
- Precision argument, 897

- Preserve statement, 483
- Primal (dual) tolerance, 216
- Print command, 20
- “PrintPort” method, 920
- Private declaration, 410
- Private procedures, 443
- Probability density function, 190
- Procedures
  - Animate, 579, 580
  - Animation, 866
  - in birthday simulation, 671–75
  - ClearAll, 576
  - ClearProb, 558, 559
  - continue, 706
  - CreateArray, 487, 489
  - for decision support system, 622, 636–38
  - for eight queens case study, 685–89
  - ExcelSimModel, 576, 577, 578
  - exiting, 464
  - for facility layout case study, 775–84
  - for forecasting methods case study, 756–64
  - function, 440–43
  - Initialize, 517
  - for inventory management case study, 705–13
  - navigating, 444–47
  - navigational, 638
  - NewEntry, 487
  - for portfolio management and optimization case study, 797–808
  - private, 443
  - public, 443
  - queuing simulations, 876–79
  - for reliability analysis case study, 822–28
  - Results, 712
  - for retirement planning case study, 846–51
  - Search, 487
  - SetParameters, 554, 555
  - Simulation, 825, 866
  - SimulationResults, 578
  - for single server queuing simulations case study, 864–70
  - SolveBackOrder, 709
  - SolveEOQ, 708
  - SolveProb, 558
  - UserInput, 707
  - ViewResults, 558
  - for warehouse layout case study, 727–37
- PRODUCT function, 91
- Product Mix problem, 208–10
- Product search form, application for user interface, 527–35
- Professional appearance, of user interface, 523–24
  - sheet options, 524
- Programming principles, 660–63
  - clarity, 660–61
  - documentation, 661
  - efficiency, 661–63
  - naming, 661
- Programming structures, 454–78
  - applications for, 468–74
  - exit statements and end, 464–68
  - If, Then statements, 454–58
  - loops, 460–63
  - Select, Case statement, 459–60
- Project Explorer, 324–25
- Prompt, 412
- Properties, 325, 327, 354–71
  - Add, 373
  - AllTrials, 570, 571
  - applications for, 378–82
  - BeginArrowheadLength, 377
  - BeginArrowheadStyle, 377
  - BeginArrowheadWidth, 377
  - Bold, 366
  - Borders, 361, 362
  - BoundColumn, 503
  - Caption, 501, 506, 507
  - Cells, 386, 387
  - charts, 371–75
  - ChartTitle, 372
  - ChartType, 371
  - Color, 360, 361, 364, 366
  - ColorIndex, 360, 373
  - ColumnHeads, 504
  - Columns, 387, 388
  - ColumnWidths, 503
  - ControlSource, 503
  - ControlTipText, 515
  - Count, 488
  - CutCopyMode, 380
  - defining, 917–18
  - for drawing objects, 375–78
  - DualValue, 549
  - End, 390, 391
  - EndArrowheadLength, 377
  - EndArrowheadStyle, 377
  - EndArrowheadWidth, 377
  - EntireColumn, 389
  - EntireRow, 389, 390
  - Extend, 373
  - FieldNames, 596
  - Fill, 377
  - FinalValue, 549
  - Font, 366, 515
  - ForeColor, 377
  - form controls and, 499
  - Formula, 394
  - FormulaR1C1, 395, 396
  - Function, 592
  - Get, 917

Properties (*cont.*)

- HasDataLabels, 373
- HasLegend, 372
- HasTitle, 372
- Hidden, 389, 523
- Installed, 886
- Interior, 360, 373
- Let, 917
- LibraryPath, 887
- Line, 377
- LineStyle, 361, 364
- LinkedCell, 525
- ListFillRange, 526, 527
- ListRows, 504
- Locked, 515, 523
- Max, 513
- Min, 513
- MultiSelect, 505
- Name, 359, 376, 499, 596
- Number, 912
- NumberFormat, 366
- Offset, 385, 386, 456, 571
- OptimizeStauts, 549
- Orientation, 513, 591
- Path, 601
- Pattern, 360
- Picture, 514
- PictureAlignment, 514
- PictureSizeMode, 514
- Position, 515
- ranges, 359–71
- Round, 399
- RowNumbers, 596
- Rows, 387, 388, 488
- RowSource, 503, 531
- SchemeColor, 377
- ScreenUpdating, 378, 379, 489
- ShapeRange, 377
- ShowPivotTableFieldList, 593
- Size, 366
- Slack, 549
- SolverType, 546
- Style, 504
- SubTotals, 592
- TabStop, 515
- TaxIndex, 515
- Text, 372
- TextFile\_Delimiter, 596
- TextFileParseType, 596
- TextFileStartRow, 596
- TextFileTextQualifier, 596
- Value, 365, 428, 502, 511, 549
- VB Constant, 360
- Visible, 445, 501, 507, 522, 523, 556, 592
- visible, 357

- WebConsecutiveDelimitersAsOne, 598
- WebFormatting, 598
- WebPreFormattedTextToColumns, 598
- WebSelectionType, 598
- WebTables, 598
- Weight, 361, 364, 377
- window, 325, 343, 500
- workbooks and worksheets, 354–59
- WorksheetFunction, 398, 399
- xlHidden, 591
- Protect Sheet option, 27
- Provider arguments, 601
- PsiDiscrete function, 263
- PsiExponential function, 267
- PsiMax function, 268
- PsiMean function, 268, 274, 275
- PsiOutput function, 263, 268, 274
- PsiResample function, 272
- PsiSenParam function, 272, 275
- PsiSimParam function, 271
- PsiStdDev function, 268, 274, 275
- PsiTarget function, 266, 274, 275
- PsiTriangular function, 267
- PsiUniform function, 274
- Public declaration, 410
- Public procedures, 443

**Q**

- Quadratic Assignment Problem (QAP), 6
- Quadratic programming (QP), 217
- Query, 290
  - with SQL, 604–8
- QueryData function, 610
- QueryTables object, 594
- Quick Access Toolbar, 15–23
  - adding to, 20
  - customizing, 21–23, 346–49
  - interface components and, 19–21
  - macros, adding, 23
- Quick Watch tool, 908

**R**

- RANDBETWEEN function, 93, 95
- RAND function, 93, 94, 255, 566
- Rand function, 415
- Random numbers, generating with distributions, 255–58
- Range, 170, 336, 408
- Range object, 394–97
- Ranges, 359–71
  - naming, 391–94
  - referencing, 385–91
- RATE function, 97
- RIC1 notation, 41–43
- Readall method, 926
- Readline method, 926



- Real estate search spreadsheet application, 524–38
- Recently Used command, 61
- Recording, of macros, 332–34
  - steps in, 335
- Record Macro button, 333, 334
- Record Macro command, 332
- Recordset object, 601
- ReDim statement, 483, 488
- Redo command, 19
- RefCell, 82
- RefEdit, 514
- References, in VBA, 884–87
- Referencing
  - absolute, 38–41
  - cells, 38–45
  - circular, 45
  - column absolute, 38, 40
  - macros, 391
  - ranges, 385–91
  - RIC1 notation, 41–43
  - relative, 38–41
  - row absolute, 38, 41
  - in VBA, 385–94
  - worksheets and workbooks, 43–44
- Refresh All command, 289, 295
- Refresh method, 596
- RefreshTable method, 591
- Regression, 186–89
- Relation argument, 897
- Relationships, in data, 176–89
- Relative referencing, 38–41
  - format, 39
- Reliability analysis, case study
  - application overview and model development, 814–17
  - input, 816
  - output, 817
  - procedures, 822–28
  - re-solve options, 828–33
  - user interface, 821–22
  - worksheets, 817–20
- Remove Arrows drop-down list, 106
- Rename button, 22, 347
- ReportArray argument, 898
- Report Field, 138
- Reports, creating, 426–30
- Residual, 178
- Re-solve options, 639–42
  - for birthday simulation, 676
  - for eight queens case study, 690–95
  - for facility layout case study, 785
  - for forecasting methods case study, 764–65
  - for inventory management case study, 713–15
  - for portfolio management and optimization case study, 809–10
  - for queuing simulations, 880
  - for reliability analysis case study, 828–33
  - for retirement planning case study, 852
  - for single server queuing simulations case study, 870
  - for warehouse layout case study, 738–44
- Response, 413
- Results procedure, 712
- Retirement planning, case study
  - application overview and model development, 836–39
  - input, 839
  - output, 839
  - procedures, 846–51
  - re-solve options, 852
  - user interface, 844–46
  - worksheets, 840–43
- Retirement planning problem, for simulation application, 272–77
- RGB function, 360
- Ribbon, 15–23, 123
  - charts and, 114
  - Chart Tools, 117–24
  - customizing, 21–23, 324, 346–49
  - data analysis on, 165, 172
  - dynamic sparkline and, 129
  - Formulas tab on, 41, 47, 51, 61
  - inserting tables, 139
  - names and, 48
  - sparklines and, 125
  - tabs on, 15
- Right-Click Shortcut Menu, 20
- @RISK, 900
- Risk Solver Platform, 206, 207–25, 543, 626, 815, 838, 890
  - add-ins and, 884
  - analyzing simulation results with, 259–60
  - fitting distribution in to set of data, 258–59
  - generating random numbers with distributions, 255–58
  - models, solving, 544–45
  - object-oriented Application Programming Interface (API) in, 542, 546–51
  - simulation using, 254–61, 566–67, 569
  - solving, 211–18
  - steps, 207–22
- Round property, 399
- Row absolute referencing, 38, 41
- Row Fields, 138
- Row Grand Totals, 138
- Row Labels, 151
- RowNumbers property, 596
- RowSource property, 503, 531
- Rows property, 387, 388, 488
- RSQ function, 188
- R-Squared value, 186, 187, 188
- Run method, 573
- Run simulation, 255
- RUN SIMULATION button, 581
- Run to Cursor tool, 906

**S**

- Sample variance, 167
- SaveArea function, 898
- Save command, 19, 20
- Scaling argument, 897
- Scatter charts, 122, 123, 127, 183
- Scenario Manager, 249–52
- Scenario Report, 251, 252
- SchemeColor property, 377
- ScreenUpdating method, 571
- ScreenUpdating property, 378, 379, 489
- Scroll bars, 512–13
- Scroll Event Procedure, 518
- Search argument, 897
- Search procedure, 487
- Sec function, 416
- Select, Case statement, 459–60
- Select Data Source dialog box, 118, 119, 123
- SelectedControl, 510
- Select method, 371, 376
- SELECT statement, 605
- Select Table dialog box, 295
- Sensitivity Analysis, 211
- Sensitivity Analysis Report, 260
- Sensitivity Report, 224
- Serial number, 83
- Series, 119
- SeriesCollection method, 373
- SetCell argument, 896
- Set declaration, 408
- Set objective, 212
- SetParameters procedure, 554, 555
- SetSourceData method, 371
- ShapeRange property, 377
- Shapes
  - creating and modifying, 420–26
  - object, 375, 376
- SheetName function, 898
- Sheet options, 524
- Sheets object, 359
- Shell function, 923, 924
- Short-cut menu, 174
- Shortcuts, for entering cell names, 47
- Show method, 517
- ShowModal, 515
- ShowPivotTableFieldList property, 593
- ShowRef argument, 897
- Show Values As tab, 145
- Simple values, 13
- Simulate method, 674
- Simulation, 211, 566–86
  - analysis in, 572–73
  - animation, 571–72
  - applications for, 262–77, 574–81
  - creating problem, 568
  - Crystal Ball, 901
  - defined, 248–49
  - defining, 566
  - models, 269, 270
  - Monte Carlo, 567, 900
  - using object-oriented Application Programming Interface (API), 567–73
  - results, analyzing, 259–60
  - using Risk Solver Platform, 254–61, 566–67
  - run, 255
  - runs and data collection, 569–70
  - single server queuing, 856–58
  - trials, 255, 841
  - what-if analysis tools and, 249–54
- Simulation procedure, 825, 866
- Simulation Report, 259, 260
- SimulationResults procedure, 578
- Simulations, case studies
  - birthday, 666–77
  - eight queens, 680–96
  - multi server queuing model, 871–73
  - single server queuing, 856–70
- SIN function, 93
- Sin function, 416
- Single server queuing problem, for simulation applications, 266–72, 574–81
- Single server queuing simulations, case study, 856–58
  - input, 858
  - output, 858
  - procedures, 864–70
  - re-solve options, 870–71
  - user interface, 862–63
  - worksheets, 859–61
- Size property, 366
- Skewness, 169, 170
- Slack property, 549
- Slicers, 148
- SLN function, 100
- Slope, 186
- SLOPE function, 188, 189
- SLOPE functions, 749
- SolveBackOrder procedure, 709
- SolveEOQ procedure, 708
- SolveProb procedure, 558
- Solver, 890–900
  - commands in VBA, 896–98
  - Excel Standard, 890–94
  - Frontline’s Premium Solver, 894–96
- SolverAdd function, 897
- SolverChange function, 897
- SolverDelete function, 897
- Solver Engine, 548–49
- SolverFinish function, 897
- SolverGet function, 898
- SolverLoad function, 898

- Solver object, 546
  - running, 549
- SolverOptions function, 897
- Solver Output tab, 218
- Solver reports, understanding, 223–24
- SolverReset function, 896
- SolverSave function, 898
- SolverSolve function, 897
- SolverType property, 546
- Sort dialog box, 298
- Sorting, 296–300
  - alphabetical order, 297
  - arrays, 484–86
  - macros, 338
- Source argument, 371, 605
- SourceData argument, 590
- Source object, 603
- SourceType argument, 590
- Sparkline Design tab, 125
- Sparklines
  - creating, 124–27
  - defined, 124
  - dynamic, 127–30
- Spin buttons, 512–13
- Spreadsheets, preparing, 209–10, 543–44, 891
- SQL commands, 605–7
  - AND, 606
  - ASC, 606
  - AVG, 606
  - BETWEEN, 606
  - COUNT, 606–7
  - DESC, 606
  - FROM, 605
  - GROUP BY, 606–7
  - HAVING, 607
  - LIKE, 606
  - MAX, 606–7
  - MIN, 606–7
  - NOT, 606
  - OR, 606
  - ORDER BY, 606
  - SELECT, 605
  - WHERE, 605
- Sqr function, 414
- SQRT function, 93
- Standard deviation, 163, 167
- Standard error, 167, 186
- Standard Evolutionary Engine window options, 235, 236
- STANDARDIZE function, 191, 192
- Standards, naming, 661
- Standard Solver. *See* Excel Standard Solver
- Start button, 468
- Statements
  - Case Else, 459
  - Dim, 547
  - End, 466
  - End If, 457
  - Exit, 464
  - Exit Do, 465
  - Exit For, 465
  - Exit Function, 464
  - Exit Sub, 464
  - GoTo, 912
  - If ... Then, 454
  - If ... Else, 454–6
  - If ... Elseif, 455–6
  - nested If, 455
  - New, 601
  - On Error GoTo, 911–12
  - On Error Resume Next, 911
  - Preserve, 483
  - ReDim, 483, 488
  - Unload Me, 517, 520
  - VALUES, 608
  - While, Wend, 463
- Statistical functions, 64, 95
- Statistics, descriptive, 164, 165–71, 170
- Statistics object, 578
- StatTools, 901
- STDEV function, 95
- STDEV.P function, 163
- STDEV.S function, 163
- Step-Into stepping code, 906
- Step-Out tool, 906
- Step-Over tool, 906
- Step parameter, 461
- StepThru argument, 897
- STEYX function, 188, 189
- String, 407
- String functions, 419
- Structured Query Language (SQL). *See also* SQL
  - performing queries with, 604–8
- Style, consistency, 660–61
- Style property, 504
- Styles group, 27, 28
- Sub procedures, 438–40
  - applications for, 444–47
  - calling other, 438–39
  - Main, 468, 610
  - passing variables in, 439–40
- SUBSTITUTE function, 73, 74
- Subtotals, 138, 145, 146, 153
- SubTotals property, 592
- Sum buttons, 469
- SUM function, 38, 39, 61, 63, 64, 90, 226
  - with OFFSET function, 82
- SUMIF function, 95, 311
- Summarize value field, 144
- Summarize Values by command, 150
- Summary Statistics box, 165

SUMPRODUCT function, 91, 92, 210, 226, 229, 234, 240, 552, 554  
 Sum values, 170  
 SYD function, 100, 101  
 Symmetric histogram, 176

**T**

TabIndex property, 515  
 Tables  
   Excel, 304–6  
   pivot, 136–41  
 Tabs, 509  
   Alignment, 25  
   Categorized, 515  
   contextual, 15  
   Design, 151  
   Developer, 20  
   Formulas, 41, 43, 45, 47, 51, 61  
   Home, 28  
   home, 17  
   Input Message, 312, 314, 315  
   Model, 261, 264  
   MyMacros, 348  
   Number, 26, 27  
   Options, 148, 150  
   output, 241  
   Page Layout, 28  
   Platform, 216  
   on ribbon, 15  
   Show Values As, 145  
   Solver Output, 218  
   Sparkline Design, 125  
 TabStop property, 515  
 Tab strips, 509–12, 653  
 TAN function, 93, 416  
 TaskId, 924  
 Task pane, 268  
 Testing and final packaging, of DSS, 643  
 Textboxes, 501–2  
 Text boxes  
   in GUI design, 652–53  
   labels *versus*, 655  
 Text control options, 24  
 TextFile\_Delimiter property, 596  
 TextFile\_ParseType property, 596  
 Text files, importing, 284–87, 594–604  
 TextFile\_StartRow property, 596  
 TextFile\_TextQualifier property, 596  
 Text functions, 72–75  
 Text Import Wizard, 284, 285, 286  
 Text property, 372  
 Themes group, 28  
 Then statements, 454–58, 456  
 TimeValue function, 381

Title argument, 412, 595  
 TODAY function, 84  
 Toggle Breakpoint tool, 907  
 Toggle buttons, 505–8  
 Toolbars  
   Customizing Quick Access, 346–49  
   Debug, 905–7  
   Mini, 20, 24  
   Quick Access, 15–23  
   Virtual Basic Editor, 326–27  
 Toolbox, Control, 499, 502, 508, 509, 514  
 Top/Bottom rules, 30  
 Tracing  
   dependents, 105, 106  
   precedents, 105  
 Transcript query, applications for, 609–15  
 Transportation, mathematical program applications for, 225–27  
 Transpose, 17  
 Trend curve, 177–86  
 Trendlines  
   defined, 178  
   exponential, 177, 181, 182, 183, 184, 187  
   linear, 177, 180, 188  
   logarithmic, 177  
   moving average, 177  
   polynomial, 177  
   power, 177, 184, 185, 187  
 Trials, 194  
   simulation, 255  
 Trials per Simulation property, 261, 263, 268, 274, 567  
 Trigonometric functions, 91–95, 416  
 TRUE function, 65, 66, 68, 70, 71  
 Two-way Data Tables, 252  
 Type argument, 396  
 TYPE function, 72  
 TypeName function, 521  
 TypeNum function, 898

**U**

UCase function, 419  
 Unboundedness, 220–21  
 Uncertain functions, 261, 567  
 Uncertain variables, 261, 567  
 Undo command, 19  
 Uniform distribution, 190, 193  
 Unload Me statement, 517, 520  
 Unrestricted variables, 204, 542  
 UPPER function, 73  
 Use a formula option, 102–4, 169  
 User, 4  
   GUI design and, 646–47  
 User-created errors, 904  
 UserFinish argument, 897

- User form controls, 498–514
    - check boxes, option buttons, and toggle buttons, 505–8
    - combo boxes and list boxes, 502–5
    - command buttons, 509
    - images and RefEdit, 514
    - labels and textbooks, 501–2
    - scroll bar and spin buttons, 512–13
    - tab strips and multipage, 509–12
  - User form options, 515–16
  - User forms, 498, 499, 631–34
    - dynamic form controls, 633
  - UserInput procedure, 707
  - User interface, 498–540
    - applications, 524–35
    - for birthday simulation, 670–71
    - for decision support system, 622, 630–36
    - for eight queens case study, 684–85
    - error checking, 520–21
    - event procedures, 516–19
    - for facility layout case study, 773–74
    - for forecasting methods case study, 754–55
    - functional buttons, 634–36
    - importing and exporting forms, 522
    - for inventory management case study, 702–4
    - navigating, 522–23
    - navigational buttons, 630
    - for portfolio management and optimization case study, 796–97
    - professional appearance, 523–24
    - queuing simulations, 874–76
    - receiving input, 630–34
    - for reliability analysis case study, 821–22
    - for retirement planning case study, 844–46
    - for single server queuing simulations case study, 862–63
    - user form controls, 498–514
    - user form options, 515–16
    - variable scope, 519–20
    - variables in, 411–14
    - for warehouse layout case study, 725–26
- V**
- Val function, 418
  - Value Field, 138, 154
  - Value Field Setting options, 143, 144
  - ValueOf argument, 896
  - Value property, 365, 428, 502, 511, 549
  - Values, 17
    - conditional formatting and, 31
    - data type, 72
    - HLOOKUP function and, 77
    - as items, 138
    - lambda, 193, 195
    - Maximum, 170
    - Minimum, 170
    - net present, 233, 249, 250
    - outlier, 167, 168
    - of properties, 327
    - R-squared, 186, 187, 188
    - simple, 13
    - Sum, 170
    - variable, tracking, 411
  - VALUES statement, 608
  - Value variable, 469
  - Variable collection, 547
  - Variable declarations, 705
  - Variable objects, 572
  - Variables, 406–36, 487, 488
    - applications, 420–30
    - Boolean, 407, 457–58, 485, 506, 530
    - constant, 408
    - decision, 204, 542
    - declarations, 406–9
    - dependent, 176
    - independent, 176
    - Input boxes, 411, 413–14
    - Message boxes, 411–13
    - negative, 542
    - non-negative, 542
    - NumCircles, 423, 424
    - NumSquares, 423, 424
    - object, 409
    - passing in procedures, 439–40
    - private declaration, 410
    - public declaration, 410
    - range, 408
    - scope, 410–11
    - selecting, 212–13
    - tracking values of, 411
    - uncertain, 261, 567
    - unrestricted, 542
    - in user interface, 411–14
    - value, 469
  - Variable scope, 519–20
  - Variance, 163
  - Variant data type, 406
  - VBA, for Excel
    - add-ins in, 884–87
    - application object, 398–99
    - arrays in, 480–95
    - code, 53
    - data types, 72
    - external data, 594–608
    - formulas in, 394–99
    - math functions, 414–19
    - names and referencing in, 385–94
    - object-oriented programming in, 916–23
    - overview of, 7
    - pivot tables, creating, 588–94

- VBA, for Excel (*cont.*)
    - Solver commands in, 896–98
    - variable declarations in, 406–9
    - working with large data using, 588–619
  - VBA code, 335–40
    - adding, 338
    - modification of, 337
    - updated, 338
  - VB Constant, 360
  - Version argument, 590
  - ViewResults procedure, 558
  - Views
    - Compact, 147
    - Design, 344
  - Visible property, 357, 445, 501, 507, 522, 523, 556, 592
  - Visual Basic command, 20
  - Visual Basic Editor (VBE), 324–27, 886
    - code, 332
    - Code window, 325
    - Immediate and Watch windows, 326
    - Object Browser, 327–29
    - Project Explorer, 324–25
    - Properties window, 325
    - toolbars, 326–27
  - Visual Basic for Applications (VBA). *See* VBA, for Excel
  - VLOOKUP function, 75, 89
- W**
- Wait method, 380–2, 571, 579
    - Now argument, 380–2
    - TimeValue argument, 381–2
  - Warehouse layout, case study, 718–45
    - application overview and model development, 718–23
    - procedures, 727–37
    - re-solve options, 738–44
    - user interface, 725–26
    - worksheets, 723–25
  - Warehouse location, mathematical program applications
    - for, 237–42
  - Watch Expression, 908
  - Watch window, 326, 907–8
    - Add Watch, 907–8
    - Quick Watch, 908
  - Web addresses, importing, 287–89
  - WebConsecutiveDelimitersAsOne property, 598
  - WebFormatting property, 598
  - Webpages, importing, 594–604
  - WebPreFormattedTextToColumns property, 598
  - WebSelectionType property, 598
  - WebTables property, 598
  - WEEKDAY function, 87, 88
  - WEIBULL.DIST function, 195, 196
  - Weibull distribution, 190, 814
  - Weight property, 361, 364, 377
  - Welcome sheet, 624, 682, 840
  - What-if analysis tools, 249–54
    - Data Tables, 252–54
    - Scenario Manager, 249–52
  - Where method, 371
  - WHERE statement, 605
  - While, Wend statement, 463
  - Windows, debug, 907–9
  - WindowState parameter, 923
  - With construct, 382–84
  - Workbooks, 354–59
    - active, 355
    - referencing, 43–44
  - Workforce scheduling, mathematical program applications
    - for, 228–32
  - WorksheetFunction property, 398, 399
  - Worksheets, 354–59, 408–9
    - for birthday simulation, 668–70
    - buttons, 635
    - in decision support system, 624–29
    - for eight queens case study, 682–83
    - for facility layout case study, 769–73
    - for forecasting methods case study, 750–53
    - form controls on, 631
    - input sheet, 624–26
    - for inventory management case study, 699–702
    - model and calculation sheets, 626–27, 637
    - names for, 45–53
    - output sheet, 627–29
    - for portfolio management and optimization case study, 790–96
    - queuing simulations, 873–74
    - referencing, 43–44
    - for reliability analysis case study, 817–20
    - for retirement planning case study, 840–43
    - for single server queuing simulations case study, 859–61
    - storing data in, 570
    - for warehouse layout case study, 723–25
    - welcome sheet, 624
  - Write/read files from VBA, 924–7
    - CreateObject, 925
    - FileSystemObject, 925
    - OpenTextFile, 925–6
    - Readall method, 926–7
    - Readline method, 926–7
    - Write method, 926
- X**
- xlHidden property, 591
  - XNPV function, 99
  - Xpos argument, 413
- Y**
- YEARFRAC function, 84, 86
  - Ypos argument, 413