About the Authors

Mauro Borgo received his B.A. and his Ph.D. in Electronic and Telecommunication Engineering in 1999 and in 2003 respectively, both from the University of Padova, Italy. His interests are in signal and data processing for wireless communication. He adapted his skills in signal processing to multisensor/multiactuator cellular systems. He has an international patent on "multisite–single-cell electroporation." He was a lecturer in electrical communication and in MATLAB at the University of Padova (Italy).

Alessandro Soranzo received his B.A. in experimental P\psychology in 1999 and his Ph.D. in experimental psychology in 2004, both from the University of Trieste, Italy. He also completed a postdoc in vision sciences at Glasgow Caledonian University (Glasgow, UK). He is senior lecturer in cognitive psychology at Teesside University in Middlesbrough (UK). His research interests are in color perception and psychophysical methods.

Massimo Grassi received his B.A. in experimental psychology in 1997 and his Ph.D. in experimental psychology in 2003, both from the University of Padova (Italy). He has also been a visiting scientist at the University of Sussex (UK). He is a lecturer in sensation and perception at the University of Padova (Italy). His research interests are in sound perception, cross-modal perception, and psychophysical methods.

M. Borgo et al., *MATLAB for Psychologists*,
DOI 10.1007/978-1-4614-2197-9, © Springer Science+Business Media, LLC 2012

Index

A
Analysis of Variance (ANOVA)
  anovan () function, 171–173
  description, 166
  one-way (*see* One-way ANOVA)
  three-way repeated-measure, 174–177
  two- and n-way (*see* Two- and n-way ANOVA)
  two-way repeated-measure, 173–174
AnsTime, 14–15

B
Barweb, 65
Bonferroni correction, 169
Boundary extension (BE)
  experiment, 176, 181

C
Cells
  arbitrary symbol, 93
  arrays, 38, 39, 73, 171
  defined, 38
  input and output variables, 85
  matrix variable, 90, 100, 166, 174
  output, cellplot command, 40
Chi-square (Chi2), 178–179
Code
  anovan () function, 171
  ASCII, 265
  Bonferroni correction, 169
  Friedman test, 182
  harmonic, factor, 110
  indentation, 97
  Kruskal–Wallis test, 181, 182
  linear regression plot, 158
  logistic regression analysis, 161
  MATLAB, 155, 193
  M-file, 189
  modularity, 97
  monophonic and stereophonic sound, 116
  onset and offset, sound, 126
  outputs, ANOVA table and box plot, 167
  SelectionChangeFcn function, 208
  soundsc () function, 110
  switch–case form, 72
  variables, 179
Computation
  anovan () function, 175
  expression, 4
  image creation, 144–149
  matrix, 2
  nchosek (n,x) function, 178
  numerical, 2
  polyfit function, 160
  statistics toolbox, 160
Computer
  factors, sound, 114
  languages, 14, 223, 225
  PTB routines, 223
  resources allocation, 250
  simulation, 8
  wavwrite () function, 108–109
Covariance, 156
Creativity, 96, 218, 219
Cycles
  code, 111
  and conditionals
    for loop, 104
    memoryscore, 71
    visualization, scope, 70
  cosine, 118
  sine, argument, 108

M. Borgo et al., *MATLAB for Psychologists*,
DOI 10.1007/978-1-4614-2197-9, © Springer Science+Business Media, LLC 2012

D
Data
  analysis, 20
  handling (*see* Data handling)
  import/export, 90–96
  matrix, 10
  plot (*see* Plot data)
  psychtoolbox commands, 82
  SekulerExp function, 214
  structure, 214
Data handling
  experiment, 44–46
  import/export, 40–42
  variables
    cells, 38–40
    logical, 25–31
    NaN, 35
    strings, 31–34
    structures, 35–38
3-D plots, 56–57

E
Experiment
  adaptive procedures, 80
  analysis, 104–105
  ANOVA, 168
  barweb, 65
  boundary extension (BE), 179, 181
  brick, 126–127
  calculation, column mean, 45
  corollary functions, 102
  discs movements, 245
  event table, 22–23
  "fixed stimuli" experiment, 21
  graphical interface, 45, 212
  hypothetical data, logistic regression analysis, 161
  hypothetical perceptual learning, 62
  iconic memory, 93
  MATLAB, ,20, 64, 214
  memory, 208
  M-script, 102
  objects, 20–21
  psychology, 79
  RTs, 164
  SekulerExp function, ,246–247, 270–272
  text properties, objects, 213
  ttest () function, 163, 179
  user input, 204–207
Export
  image, 132–133
  script examples
    analysis, 95–96
    commands, 91
    fprintf functions, 94
    howmany2.m, 92–93
    nStim, time, and Mpos functions, 93
    try–catch statement, 92

F
Fast Fourier transform (FFT), 120, 121, 124, 125
FFT *See* Fast Fourier transform (FFT)
"Fixed stimuli" experiment, 21
Friedman's Test, 181–182

G
Generalized linear model
  glmfit () function, 160
  hypothetical data, logistic regression analysis, 161–162
Graphical user interfaces (GUI)
  built-in MATLAB, fiting, 158, 159
  Edit menu, 216–217
  File menu, 216
  GUIDE
    layout editor, 190, 191
    M-file, 189
    quick start dialog form, 190
  GUI toolbar
    adding UiControls, 191–192
    cancel_callback function, 196
    change string and tag property, "cancel", 193, 194
    component palette, 191, 192
    property inspector box, 194, 195
    push button, 193
  Help menu, 218–219
  interaction tools, 189
  Layout menu, 217–218
  mystruct variable, 209
  output, regstats () function, 156, 157
  Radio button, 208
  RunExp, 214
  saving user input
    adding own functions, 207
    sum_calback function, 204

text properties, 213
Tools menu, 218
Uicontrols
align objects tool, 197, 199
displaying graphs and figures, 202–204
layout editor, 197
static text components, 197, 199
string property, 198, 201
'string' values, 200
sum-two-numbers, 196
View menu, 217
Graphics
handle, 58–61
MATLAB, 64
png format, 58
GUI *See* Graphical user interfaces (GUI)

I
ILD *See* Interaural level difference (ILD)
Images
Adobe Photoshop, 144
built-in functions, 42
colormap (cmap) and DefColMap, 130
colormapeditor, 132
computation
contrast and successive
contrast effect, 146
Gabor2D function, 148–149
Gaussian window, 148
plotting commands, 145
PsychToolbox, 144
Sinusoid2D, 147
defined, digital, 129
digital representations, 130, 131
display, 134–135
example, 5 × 5 gray-scale, 129, 130
import and export, 132–134
importing, 238–239
indexing, 130
manipulation
neighborhood processing, 136
point operations, 135
MATLAB, 130
neighborhood processing
concept, 140
defined, filtering, 140
edges, 144
example, 141
filter2 function, 141
FilterGSpecial, 142
fspecial function, 142
imresize function, 143
lunar, Gaussian, 142, 143
types, 142
point operations
intensity transformation, 136–138
windowing, 138–140
printing and saving, 58
retinal, 21
Import
data, 90–96
file formats, 41–42
images, 132–134, 238–239
variables subset, 41
Interaural level difference (ILD), 116
Interaural time difference (ITD), 116
ITD. *See* Interaural time difference (ITD)

K
Keyboard
manipulations, 264–265
and mouse functions
input, 262–263
instructions presentation, 254
reaction-time, 256–261
response, 253–254, 256
spacebar, 254–255
Kruskal-Wallis Test
ANVOA table, 181
defined, 180
Friedman's, 181–182
hypothetical data, BEs, 181

L
Labels
cell array, 55
customization, plots, 50
function analysis, 186
interaction, 175
Legend, 50–52
Linear regression, simple and multiple
built-in MATLAB,
basic fitting, 158, 159
diagnosis, structure, 156
GUI output, 156, 157
hypothetical data, 158
plots, 158
polynomials, 158–160
regstats () function, 156
Loops
for, 74, 256, 257, 259–261
while structure, 78, 255, 256, 259, 260,
263, 265, 267, 269

M
Mann-Whitney U Test, 180
MATLAB
  Avogadro's number, 3
  command lines, 5
  desktop, 1, 2
  experiment, 20–23
  functions, 4
  matrix, 8–15
  operations
    element-by-element operators, 17
    multiplication, 15–16
    techniques, matrices, 15
    visual interpretation, matrix product, 16
  precedence rules, 4
  use, 2
  variables, 5–8
  windows, 1
Matrix
  [anova1(X)], 166
  AnsTime, 14–15
  cell, 42
  cell matrix variable, 90
  color map, 55
  colormap (cmap) function, 130
  commands, 13
  corrcoef () function, 155
  covariance, 156
  2-D, 76
  3-D plots, 56–57
  function, 10
  Gaussian distributed random numbers, 54
  image, *jpg* and *png*, 133
  intensity, 138
  mapTrees, 135
  measure, central tendency, 153–154
  rectangular array, numbers, 8, 9
  RGB image, 133
  RGB values, 235, 239
  SqWindow, 141
  structures, 36, 37
  varargin, 89–90
  variables
    creation, 11
    implementation, 10
  and vectors, 9
  windowing, 150
Mouse
  input, 262–263
  placing discs with, 266–267

N
Nonparametric statistics
  categorical data
    binomial distribution, 177–179
  ordinal data
    Kruskal–Wallis test, 180–182
    Mann–Whitney *U* test, 180
    Wilcoxon signed rank test, 179–181
  STD index (*see* Signal-detection theory (STD))
Not a Number (NaN), 3, 35

O
Object orienting programming (OOP) technology, 207
One-way ANOVA
  anova1 () function, 166
  ANOVA table, 166
  hypothetical data, RTs, 166
  interactive plot, Bonferroni correction, 169
  multcompare () function, 168–169
  table and box plot, hypothetical probe, 167

P
Pictures, 62, 79, 149, 179, 202
Plot data
  control objects, 50–52
  3-D, 56–57
  handle graphics
    figure's characteristics, 61
    graphical object hierarchy, 60
    line and axes properties, 59
    production, simple graphs, 58
  layout, function, 47, 48
  LineSpec string, 49
  MATLAB, 47
  multiple plots, figure, 52–55
  printing and saving images, 58
  sinusoidal curve, 49
Png*See* Portable network graphics (Png)
Point operations
  intensity transformation
    description, 136
    "floor" function, 136
    MATLAB Image Toolbox, 138
    use, 138
    variations, 136, 137
  windowing
    concept, 138, 140
    SqWindow matrix, 139

Portable network graphics (Png), 58
Printing, 58, 216
Programming
  control flow statements
    break, 81
    cycles and conditionals, 70–72
    for loops, 74–78
    loops *vs.* matrices and if *vs.* logicals, 82–83
    switch case, 72–74
    try–catch, 82
    while, 78–81
  data import/export
    ASCII form, 90
    cell values, 95
    content, file, 91
    DisplayFile, 94
    iconic memory, 93
    test function, 96
    try–catch statement, 92
  functions
    cell matrix variable, 90
    input and output arguments, 83
    MATLAB built-in function, 84
    scope, variables, 86–87
    script line, 85
    statistic, 87
    statTwo, 88, 89
  guidelines, good style
    debug, 98–100
    design process, 96
    writing code, 96–97
  M-scripts and functions, 67–70
Programs
  key-press event, 231
  OOP technology, 207
  portability, 225
  and statistical analysis, 20
Psychological experiments
  anovan () function, 171
  chi2gof () function, 178
  glmfit () function, 161
  PTB functions, 251
  regression model, 156
  RTs, 164
Psychophysics toolbox (PTB)
  analysis, 241
  batch processing, 235
  control, timing, 242
  description, 223
  drawing figures
    closing, 230
    Flip subfunction, 229–230
    window opening, 227–229
  drawing, text, 236–238
  experiment, 245–247, 269–272
  getting information, screen uses, 225–226
  importing images, 238–239
  keyboard and mouse functions
    input, 262–263
    instructions presentation, 254
    reaction-time, 256–258
    response, 253–254, 256
    spacebar, 254–255
  for loops, 240
  onset/offset times, 243
  priority, 250–251
  reprise
    analysis, 231
    drawing shapes, 231–234
  screen function
    analysis, 225
    optional and unoptional input arguments, 224
    try-catch commands, 225
  screen refresh rate, 241–242
  shape characteristics manipulation, participants' input
    description, 263–264
    discs placing, mouse, 266–267
    keyboard, 264–265
  sound functions, 251–253
  timing, 249–250
PTB. *See* Psychophysics toolbox (PTB)

R

Reaction times (RTs)
  anova1 () and anova2 () function, 168, 169
  choice, 258–259
  description, 164
  detection, 256–258
  Go/No-Go, 259–260
  hypothetical data, 164, 166
  techniques, 260
Research, 97, 223, 243
RMS. *See* Root mean square (RMS)
Root mean square (RMS), 115
RTs. *See* Reaction times (RTs)

S

Signal detection theory (STD). *See also* Statistical analysis
  bias indexes (β and c), 182, 183
  description, 182
  nonparametric indexes (A□ and B□), 183, 184
  sensitivity index (d□), 182, 183

Simulation, 8
Software
  characteristics, 224–225
  processes, 243
Sounds
  analysis
    acoustical characteristics, 123
    FFT, 124
    magnitude spectrum, “chirp”, 124, 125
    sr and bits variables, 123
  anharmonic tone, 110
  condition, 44, 45
  discs’ motion, 21
  envelope
    digital synthesis, 118
    graphs, 119–120
    offsetgate = fliplr (gate);, 119
    smoothing, 118
    sound (tone, sr), 118
  filtering
    description, 120
    Gaussian white noise, 122–123
    noise = fft (noise);, 120, 121
  functions
    MakeBeep() function, 253
    subfunctions, PsychPortAudio, 251–252
  manipulation, level
    factors, MATLAB, 114
    soundsc () function, 114
    waveforms, 115
  MATLAB warning, 107–108
  M-script and graphical result, 111
  multiple
    noise–tone sequence, 113
    pulsation threshold, 112
    temporal offset, 113–114
    tone and noise synthesis, 113
  sawtooth wave, 110, 111
  sinusoidal tone, 108
  soundsc (harmonic, sr);, 110
  stereophonic, ITD and ILD
    description, 116
    digital synthesis, 117
    loop iteration, 118
    microsecond expression, 116–117
    mutatis mutandis, 116
  wavplay () function, 108
  wavwrite () function, 108
  white noise, 107–112
Statistical analysis
  bivariate and multivariate
    arguments, 155–156
    covariance, 156
    defined, correlation and covariance, 155
    generalized linear model, 160–162
    hypothetical data, 155
    linear regression, simple and multiple, 156–160
  central tendency
    measures, 153, 154
    toolbox, 153, 154
  dispersion
    measures, 154
    unbiased estimator, 154
  inferential
    ANOVA, 166–177
    parametric, 162–163
    t-test, 163–166
  nonparametric
    categorical data, 177–179
    ordinal data, 179–182
    STD (*see* Signal-detection theory (STD))
Statistics, 45, 46, 54, 84, 87*See also* Statistical analysis
STD. *See* Signal detection theory (STD)
Strings
  conversion specification and special characters, 34
  creation, formatted strings, 33
  defined, 31
  functions, 32–33
  linespec, 48, 49
  “static text”, 197
  and tag properties, 193
  Uicontrol, 193
  variable implementation, 32
Structures
  anova1 () function, 166
  cell values, 95
  confidence intervals, 164
  diagnostic statistics, 156
  dynamic field names, 37–38
  for, 74
  guidata, 208
  harmonic spectrum, 124
  if – else – end, 70
  input/output arguments, 97
  loop, 74

MATLAB, 214
multicomparison test, 169
mystruct variable, 211
OutputFcn function, 208
regression coefficients, 158, 160
SubjectTest variable, 35–36
t-tests, 165
while, 78

T
t-Test
functions, 163
one-sample
binary form, 163–164
defined, 163
two-sample
hypothetical data, RTs, 164–165
ttest2 ( ), 164
Two- and n-way ANOVA
anova2 ( ) function, 169
hypothetical data, RTs, 169, 171
significance, variables, 171
table output, 170

V
Variables
anovan () function, 173
cell matrix, 89–90
cells, 38–40
clear command, 7, 8
correlation and covariance, 155
counter, 74
DefColMap, 130
defined, 5
dependent (DV), 161
diagonal, output matrix, 156
digital synthesis, 118
Friedman test, 182
geometric and harmonic mean, 154
global, 86
independent (IV), 161
input and output, 85
ITD, 118
kruskalwallis () function, 180
logical
categorization, response time, 30
creation, 25–26
functions, 30–31
relational operators, 26–27
vectors, 29–30
magnitude spectrum, chirp, 124
mandrill and map, 136
MATLAB prompt, 209
memoryscore, 71
multcompare () function, 174
NaN, 35
persistent, 86
PNG image, 133
predefined names, 7
regstats () function, 156, 157
response keys, 270
rules, variable names, 6
scope, 86–87
sine waves, 109
“sr and bits”, 124
strings, 31–34
structures, 35–38
two-way repeated-measures, 175
user inputs, 200
whos command uses, 6

W
Waveforms
sawtooth wave, harmonics, 110, 111
sound level, 115
timbre, complex tone, 110
Wilcoxon signed rank test, 179–180

Z
z-test, 162–163