

Index

- A*-test, *t*-test for dependent means, 207–210
- alternative hypothesis, hypothesis testing, 117
- analysis of variance (ANOVA), 231–288
 - assumptions of ANOVA, 249–250
 - assumptions of two-way ANOVA, 271
 - between- and within-groups variance ratio, 238–239
 - between-groups variance, 237–239
 - carrying out an ANOVA, 242–245
 - carrying out an LSD, 252–253
 - effect size, 253–255, 271–272
 - factorial designs, 260–261
 - F*-distribution, 240–242
 - formulas, 277
 - F*-ratio, 235
 - F*-ratio and factorial designs, 266–268
 - hypothesis-testing process for a two-factor ANOVA, 268–271
 - hypothesis-testing process for experiment A, 245–248
 - hypothesis-testing process for experiment B, 248–249
 - interactions and main effects, 262–266
 - jamovi software, 278–288
 - logic of ANOVA, 232–248
 - multifactor ANOVA, 261–262
 - multiple-comparison tests, 250–253
 - one-way ANOVA, 278–283
 - statistical power, 255–260, 273–276
 - two-way ANOVA, 271, 284–288
 - within-groups variance, 235–237, 238–239
- assumptions
 - ANOVA, 249–250, 271
 - error terms, 350–351
 - index of qualitative variation (IQV), 63
 - mean, 50–51
 - median, 46
 - mode, 42–43
 - multiple regression, 349–351
 - one-sample *t*-test, 185
 - Pearson correlation coefficient, 316–318
 - range, 64
 - specification error, 350
 - standard deviation, 71–73
 - t*-test for dependent means, 211–214
 - t*-test for independent means, 198–201
 - two-way ANOVA, 271
- assumptions underlying statistical procedures, 7–10
 - levels of measurement, 8–10
 - randomization, 7
 - sample size, 10
- bar graphs, 26–28
 - jamovi software, 36
- bivariate correlation, 293–326
 - asymmetric PRE interpretation, 303
 - correlation and association, 293–294
 - direction of association, 297–300
 - error-free association, 301
 - explained variation, 302–303
 - formulas, 323
 - meaning of measures of association, 294–296
 - Pearson correlation coefficient, 304–311
 - predictive utility, 301–304
 - proportional reduction in error (PRE), 303–304
 - statistical significance of association, 300–301
 - strength of association, 296–297
 - symmetric PRE interpretation, 303
 - unexplained variation, 302–303
- bivariate regression analysis, 335–338
 - jamovi software, 353–356
- central tendency measures. *See* measures of central tendency
- characteristics of statistics, 2–3
- chi-square test, 367–394
- Cohen's *d* effect size, 152–153, 163
- collinearity, multiple regression, 344
- confidence intervals
 - constructing confidence estimates, 159–161
 - hypothesis testing, 161
 - interval estimates, 159, 160
 - jamovi software, 169
 - population parameters, 159–161
- continuous variables, 6–7
- correlation and association, bivariate correlation, 293–294
- critical regions, hypothesis testing, 136–140
- critical values, one-sample *t*-test, 179
- cumulative frequency distribution, 25–26
- data, describing data, 20
- decision rules, hypothesis testing, 124
- differences between two correlations, Pearson correlation coefficient, 320–322
- directional test, hypothesis testing, 136–140
- directional vs. nondirectional tests, statistical power, 158
- discrete variables, 6
- effect size, 149–153, 157
 - ANOVA, 253–255, 271–272
 - Cohen's *d* effect size, 152–153, 163
 - formulas, 162
 - jamovi software, 163–169
 - one-sample *t*-test, 183–184
 - Pearson correlation coefficient, 313
 - statistical power, 149–157
 - t*-test for dependent means, 210–211
 - t*-test for independent means, 197

- error terms, multiple regression, 350–351
- errors
- hypothesis testing, 126–128, 133–336, 140
 - standard error of the mean, 126–128
 - Type I and Type II errors, 133–136
- estimated standard error, *t*-test for independent means, 192–193
- expected value of the mean, hypothesis testing, 125–128
- factorial designs, ANOVA, 260–261
- F*-distribution, ANOVA, 240–242
- Fisher *z* approximation, Pearson correlation coefficient, 320–322
- formulas
- ANOVA, 277
 - bivariate correlation, 323
 - effect size, 162
 - hypothesis testing, 142
 - mean, 55
 - median, 55
 - mode, 55
 - normal curve, 105
 - regression, 352
 - statistical power, 162
 - t*-test for dependent means, 215
 - variability, 74
- F*-ratio and factorial designs, ANOVA, 266–268
- F*-ratio, ANOVA, 235
- frequency distributions, 21–33
- cumulative, 25–26
 - graphs, 26–30
 - grouped, 23–25
 - shapes, 30–32
 - upper and lower limits, 25
- frequency polygons, 29–30
- frequency shapes, jamovi software, 37–38
- generalizability function, normal curve, 83
- graphs
- bar graphs, 26–28, 36
 - frequency distributions, 26–30
 - frequency polygons, 29–30, 37–38
 - histograms, 29, 37
 - jamovi software, 34–38
- grouped frequency distributions, 23–25
- histograms, 29
- jamovi software, 37
- hypothesis testing, 116–145
- alternative hypothesis, 117
 - confidence intervals, 161
 - critical regions, 136–140
 - decision rules, 124
 - directional test, 136–140
 - errors, 126–128, 133–136, 140
 - expected value of the mean, 125–128
 - formulas, 142
 - jamovi software, 142–145
 - levels of significance, 132–136
 - nondirectional test, 136–140
 - null hypothesis, 117–119
 - one-tailed test, 136–140
 - research hypothesis, 117
 - sampling distribution of means, 124–132
 - standard error of the mean, 126–128
 - tests of significance, 140
 - two-tailed test, 136–140
 - Type I and Type II errors, 133–136
 - z*-test, 130–132, 145
- hypothesis-testing process, 119–124
- ANOVA, experiment A, 245–248
 - ANOVA, experiment B, 248–249
 - ANOVA, two-factor ANOVA, 268–271
 - multiple regression, 349
 - one-sample *t*-test, 180–183
 - Pearson correlation coefficient, 307–313
 - regression, 340–343
 - t*-test for dependent means, 205–214
 - t*-test for independent means, 194–201
- index of qualitative variation (IQV), 61–64
- assumptions of IQV, 63
 - calculating IQV, 62–63
- interquartile range (IQR), 64–65
- jamovi software, 75–77
- interval estimates. *See* confidence intervals
- IQR. *See* interquartile range
- IQV. *See* index of qualitative variation
- jamovi software
- ANOVA, 278–288
 - bar graphs, 36
 - bivariate regression analysis, 353–356
 - confidence intervals, 169
 - effect size, 163–169
 - frequency distributions, 34–35
 - frequency shapes, 37–38
 - graphs, 34–38
 - histograms, 37
 - hypothesis testing, 142–145
 - interquartile range (IQR), 75–77
 - kurtosis, 110
 - mean, 56–57
 - median, 56–57
 - mode, 56–57
 - normal curve, 105–112
 - number of subjects, 163–169
 - Pearson correlation coefficient, 324
 - point estimates, 169
 - range, 75–77
 - regression, 353–356
 - skewness, 110
 - standard deviation, 75–77
 - statistical power, 163–169
 - t*-test for a single sample, 217–220
 - t*-test for dependent means, 222–225
 - t*-test for independent means, 220–222
 - using, 11–12, 34–38
 - variability, 75–77
 - variance, 75–77
 - z*-scores, 110
 - z*-test, 145
- kurtosis, 97
- jamovi software, 110
- levels of measurement, assumptions underlying statistical procedures, 8–10
- levels of significance, hypothesis testing, 132–136
- MAD (mean absolute deviation), 72–73
- mean, 48–57
- advantages, 50–51
 - assumptions, 50–51
 - comparisons, 51–53
 - disadvantages, 50–51
 - formulas, 55
 - grand mean, 53–54
 - grouped data, 49–50
 - jamovi software, 56–57
 - ungrouped data, 48–49
- mean absolute deviation (MAD), 72–73

426 Index

- mean differences, one-sample *t*-test, 189–190
- mean of difference scores, *t*-test for dependent means, 204–205
- measures of central tendency, 10, 40–57
 - mean, 48–57
 - median, 43–48, 51–53, 54–57
 - mode, 40–43, 51–53, 54–57
- median, 43–48, 51–53, 54–57
 - advantages, 46
 - assumptions, 46
 - centiles, 46–48
 - comparisons, 51–53
 - deciles, 46–48
 - disadvantages, 46
 - formulas, 55
 - grouped data, 44–45
 - jamovi software, 56–57
 - quartiles, 46–48
 - ungrouped data, 43–44
- mode, 51–53, 54–57
 - advantages, 42–43
 - assumptions, 42–43
 - comparisons, 51–53
 - disadvantages, 42–43
 - formulas, 55
 - grouped data, 41–42
 - jamovi software, 56–57
 - ungrouped data, 40–41
- multifactor ANOVA, 261–262
- multiple regression, 343–351
 - assumptions, 349–351
 - carrying out a multiple regression analysis, 345–348
 - collinearity, 344
 - error terms, 350–351
 - hypothesis-testing process, 349
 - specification error, 350
- nondirectional test, hypothesis testing, 136–140
- nondirectional vs. directional tests, statistical power, 158
- nonnormal curves, 95–97
 - kurtosis, 97
 - skewness, 95–97
- normal curve, 81–112
 - converting raw scores to *z*-scores, 90–92
 - converting *z*-scores into raw scores, 92
 - formulas, 105
 - generalizability function, 83
 - importance, 82
 - interpreting the normal curve table, 87–90
 - jamovi software, 105–112
 - key concepts, 105
 - nonnormal curves, 95–97
 - odds, 100
 - other standard forms, 94–95
 - percentages of curve area, 84–86
 - probability, 97–103
 - p*-values and tails, 102–103
 - statistical inference function, 83
 - statistical test assumption, 83
 - tails and *p*-values, 102–103
 - tails of the curve, 86–87
 - z*-scores, 83–95
 - z*-scores and raw scores for samples, 92
 - z*-scores, raw scores, and the normal curve table, 93–94
- null hypothesis, hypothesis testing, 117–119
- number of subjects, jamovi software, 163–169
- odds
 - normal curve, 100
 - probability, 100
- one-sample *t*-test, 172–189
 - assumptions, 185
 - critical values, 179
 - effect size, 183–184
 - hypothesis-testing process, 180–183
 - mean differences, 189–190
 - population variance, 173–175
 - populations, same or different, 179
 - standard error of the mean, 176
 - statistical power, 184–185
 - t*-distribution, 177–179
 - t*-scores, 179
- one-tailed test, hypothesis testing, 136–140
- one-way ANOVA, 278–283
- outliers, Pearson correlation coefficient, 318
- Pearson correlation coefficient, 304–311
 - assumptions, 316–318
 - differences between two correlations, 320–322
 - effect size, 313
 - Fisher *z* approximation, 320–322
 - hypothesis-testing process, 307–313
 - jamovi software, 324
 - outliers, 318
 - proportional reduction in error (PRE), 306–307
 - restricted range, 319
 - statistical power, 313–315
- point estimates
 - jamovi software, 169
 - population parameters, 158–159, 169
- population parameters, 158–161
 - confidence intervals, 159–161
 - interval estimates, 159, 160
 - point estimates, 158–159, 169
- population variance
 - one-sample *t*-test, 173–175
 - t*-test for dependent means, 203
 - t*-test for independent means, 190–191
- populations, same or different, one-sample *t*-test, 179
- power. *See* statistical power
- PRE (proportional reduction in error), Pearson correlation coefficient, 306–307
- probability
 - normal curve, 97–103
 - odds, 100
 - p*-values and tails, 102–103
 - tails and *p*-values, 102–103
- proportional reduction in error (PRE), Pearson correlation coefficient, 306–307
- p*-values and tails
 - normal curve, 102–103
 - probability, 102–103
- randomization, assumptions underlying statistical procedures, 7
- range
 - assumptions of the range, 64
 - interquartile range (IQR), 64–65
 - jamovi software, 75–77
- regression, 331–356
 - bivariate regression analysis, 335–338, 353–356
 - formulas, 352
 - hypothesis-testing process, 340–343
 - jamovi software, 353–356
 - logic of regression, 331–334
 - multiple regression, 343–351
 - regression coefficients, 339–340

- regression equation, 334–335
- z*-scores, 338
- research hypothesis, hypothesis testing, 117
- research process, 3–5
- research, theory and statistics, 3
- restricted range, Pearson correlation coefficient, 319
- role of statistics, 1
- sample size
 - assumptions underlying statistical procedures, 10
 - statistical power, 156
- sampling distribution of means, hypothesis testing, 124–128, 128–132
- Sandler *A*-test, *t*-test for dependent means, 207–210
- skewness, 95–97
 - jamovi software, 110
- specification error, multiple regression, 350
- standard deviation, 65, 70–73
 - assumptions, 71–73
 - jamovi software, 75–77
 - mean absolute deviation (MAD), 72–73
 - meaning of *SD*, 70–71
- standard error of difference scores, *t*-test for dependent means, 204
- standard error of the mean
 - hypothesis testing, 126–128
 - one-sample *t*-test, 176
- statistical inference function, normal curve, 83
- statistical power, 154–158
 - ANOVA, 255–260, 273–276
 - computing statistical power, 154–156
 - directional vs. nondirectional tests, 158
 - effect size, 149–157
 - factors influencing power, 156–158
 - formulas, 162
 - jamovi software, 163–169
 - one-sample *t*-test, 184–185
 - Pearson correlation coefficient, 313–315
 - sample size, 156
 - t*-test for dependent means, 211
 - t*-test for independent means, 197–198
 - statistical test assumption, normal curve, 83
 - subjectivity of statistics, 1
- tails and *p*-values
 - normal curve, 102–103
 - probability, 102–103
- tails of the curve, normal curve, 86–87
- t*-distribution, one-sample *t*-test, 177–179
- tests of significance, hypothesis testing, 140
- theory, research and statistics, 3
- t*-scores, one-sample *t*-test, 179
- t*-test, 172–225. *See also t*-test for independent means; *t*-test for dependent means; *t*-test for a single sample; one-sample *t*-test
 - t*-test for a single sample, jamovi software, 217–220
 - t*-test for dependent means, 201–205
 - A*-test, 207–210
 - assumptions, 211–214
 - effect size, 210–211
 - formulas, 215
 - hypothesis-testing process, 205–214
 - jamovi software, 222–225
 - mean of difference scores, 204–205
 - population variance, 203
 - Sandler *A*-test, 207–210
 - standard error of difference scores, 204
 - statistical power, 211
 - t*-test for independent means, 189–201
 - assumptions, 198–201
 - differences between two means, 193–194
- effect size, 197
- estimated standard error, 192–193
- hypothesis-testing process, 194–201
- jamovi software, 220–222
- population variance, 190–191
- statistical power, 197–198
- two-tailed test, hypothesis testing, 136–140
- two-way ANOVA, 271, 284–288
- Type I and Type II errors, hypothesis testing, 133–136
- variability, 61–77
 - formulas, 74
 - index of qualitative variation (IQV), 61–64
 - jamovi software, 75–77
 - key concepts, 74
 - range, 64–65
 - standard deviation, 65, 70–73
 - variance, 65–70
- variables, 5–7
 - continuous variables, 6–7
 - discrete variables, 6
- variance, 65–70
 - jamovi software, 75–77
- z*-scores
 - converting raw scores to *z*-scores, 90–92
 - converting *z*-scores to raw scores, 92
 - jamovi software, 110
 - normal curve, 83–95
 - other standard forms, 94–95
 - regression, 338
- z*-scores and raw scores for samples, 92
- z*-scores, raw scores, and the normal curve table, 93–94
- z*-test
 - hypothesis testing, 130–132, 145
 - jamovi software, 145