SUBJECT INDEX

Additive model, 194, 218, 229, 243, 313
  degrees of freedom, 213
  model, 218
  nonadditivity, 219, 222, 237
  Poisson, 142
  sums of squares, 213
Adequacy of fit, 466
Alias, 381, 399
  blocks, 336
  de-alias, 396
  generator, 383
Analysis of variance, 170, 213
  assumptions, 182
  components of variance, 582
  computation, 194, 241
  factorial, 313
  geometry, 178, 197, 212
  model, 194, 210, 218, 229
  one way, 189, 194
  randomized block, 214, 230
  regression, 460, 466
  two way, 209, 230
Assumptions, 64, 84, 104, 247
  IIDN $(0, \sigma^2)$, 78, 182, 584
  regression, 496, 505
  test procedures, 84-85
Average, 29, 30, 40, 560
  adjusted treatment, 275
  central tendency, 44
  exponential, 595
  sampling distribution, 66
  variance, 68, 88, 89, 604
  weighted, 594
Autocorrelation, 62, 88, 104, 496, 585

Balanced block, 208, 245, 275
  incomplete, 258, 269, 275
  model, 210, 275, 278, 588
Bayes, 115
  prior belief, 109
Binomial, 123
  coefficients, 124
  confidence interval, 131, 642, 643
  mean, 129
  test of significance, 130
  variance, 129
Blocking, 102, 103, 105, 336, 523
  factorials, 337, 340, 346, 384, 404
  fold-over, 340
  generators, 338
  interblock information, 341
  paired observations, 97, 102
  randomization, 102
  response surface, 523
  signature, 340

Canonical analysis, 531
Categorical variables, 291
Central limit theorem, 44, 89
Chi-square, 70, 89, 118, 142, 150, 634
  contingency tables, 145
  table, 634
Coding, 53, 307
Complementary design, 384
Components of variance, 571
Composite design, 306, 520
Confidence interval, 107, 110
  binomial, 131, 642, 643
  coefficient, 110
  conditional, 492, 493
  difference, 110, 116, 604
  distribution, 114
  marginal, 464, 470, 491, 492
  Poisson, 142, 644

regions, 470, 492
regression, 459, 478
variance, 119
variance ratio, 120
Confounding, 338, 381
partial, 340
resolution III, 397
resolution IV, 398, 411
resolution V, 408
semi, 489
Contingency tables, 145
Contours, 296, 517, 526
Contrast, 481
Control charts, 558, 600
Cum-sum, 562
Correction factor, 53, 172, 195
Correlation, 7, 61
auto, 62, 496, 585
between estimates, 471, 493
nonsense, 493
serial, 496, 590
Cumulative sum chart, 562
Curvature, 294, 516, 520
Cusum chart, 562

Data plots, 186, 191, 222, 249, 552, 556
Deduction, 1
Defining relation, 384, 409
Degrees of freedom, 40, 50, 175
additivity, 213
for nonadditivity, 222
Dependence, 37, 58, 60, 584
linear, 60
serial, 62, 82, 496
Density, 28
Design, 4
balanced block, 208, 245, 275
incomplete, 258, 269, 275
botched, 503, 509
completely randomized, 165, 177, 193
factorial, two level, 306
fold-over, 340, 399, 406
fractional, 374, 397, 398, 408, 411
Graeco-Latin, 255, 261, 262
hierarchial, 572
Latin square, 245, 261
matrix, 307, 519
nested, 572
nonlinear, 546, 553
optimal, 471
paired comparison, 99
Plackett and Burman, 398
poor, 487, 497
randomized block, 209, 241
saturated, 398
two-way, 228
Youden square, 260, 276
Diagnostic checks, 182, 220, 259, 333, 480, 517, 549
time series, 329, 597
Differential equations, 541
Distributions, 25
binomial, 123
Chi-square, 70, 89, 118, 634
confidence, 114
cumulative, 329
distribution free, 78, 104, 121
F, 121, 636, 637, 638, 639, 640
frequency, 29
Gaussian, 43
identical, 60
joint, 58
normal, 29, 43, 86, 630
parent, 44, 66, 90
Poisson, 77
probability, 27
randomization, 95, 99
rectangular, 82
reference, 21, 35, 37, 38, 79, 190, 226, 328
residuals, 183
sampling, 66, 89
skewed, 82
t, 15, 49, 70, 631, 632
scaled, 96, 101
s^2, 89.
$\bar{y}$ and s^2, 44, 89
Dot diagram, 25

E(Y), 39, 87
Effects, factorial, 309, 313
interaction, 229
linear, 9
main, 229, 309
standard errors, 319, 327
treatment, 180
variance, 320
Empirical model, 294, 300, 540
Error, 7, 24
components, 571

critical level, 37, 109
experimental, 7, 24
multiple comparison, 203
propagation, 563, 570
standard, 88
transmission, 563, 570
variance, 319, 459
Estimation, 76
least squares, 457, 498
likelihood, 239, 590
nonlinear, 545
sufficient, 70, 91
EVOP, 362, 550
Evolutionary Operation, 362, 550
Exponentially weighted average, 595
Expectation, 30, 39, 87
mean square, 109, 190, 582
Experiment, comparative, 94
noncomparative, 73
run, 24
Experimental error, 7, 24
Exponential model, 479
Exponentially weighted moving average, 595
Extrapolation, 544

$\dot{F}$ distribution, 121, 188, 199, 200, 225, 636
table, 636
tests, 222, 225, 249
t^2, 200
Factorial, 124
Factorial designs, 228, 306
botched, 503
blocked, 340, 346
embedded, 388, 393
fractional, 373
model, 229, 294
notation, 308, 383
redundancy, 375
reference distribution, 328
unreplicated, 325
Feedback, 497, 599
updating, 5
First degree polynomial, 479, 513
order model, 503
order moving average, 590
Fold-over, 340, 399
Forecast, 591

Fractional factorials, 373, 410
additional runs, 397, 413
alias, 381, 397, 399
alternative, 384, 394, 403
blocks, 309, 404
complementary, 384
embedded, 388, 393
fold-over, 341, 399
generator, 383, 409
half-fractions, 373
Plackett and Burman, 398
resulution, 385
III, 393
IV, 403, 412
V, 408
saturated, 393, 397, 398
screening, 388, 545
sequential use, 396, 489
Frequency, 137
Frequency distribution, 25

Gaussian distribution, 43
Generators, 383, 409
Geometry:
analysis of variance, 178, 197, 212
empirical models, 294
least squares, 500
t test, 202
vectors, 197
Gradient, 567
Graeco-Latin squares, 255, 261, 262
Graphical summaries, 25, 191, 250, 296, 531, 537
normal plots, 329
residuals, 186
Grouping interval, 28

Happenstance data, 487, 497
Hierarchial design, 572
Histogram, 26
Homogeneity, 142
Hypothesis, 1, 37, 202
alternative, 37, 65, 108
contingency table, 45
k means, 87, 225
lack of fit, 466, 481
multiple, 203
null, 32, 83, 108
random sampling, 30, 70, 81, 83, 86

regression, 460, 481, 483
testing, 21, 107
Independence, 38, 57, 59, 64, 78, 84
statistical, 57
not assumed, 37
time series, 584, 589
independent variable, 454
IIDN, 78, 182, 584
Incomplete blocks, 258, 269
analysis, 275
Indicator variable, 473
Induction, 1, 552
Inference, 107
Inflection point, 47
Interaction, 9, 218, 229
additivity, 313
checks, 516, 520
confounded, 202
effects, 229, 313
interpretation, 318
transformable, 218
Intervention analysis, 602
Iteration, 1, 10, 549

Kurtosis, 90

Lack of fit, 465, 481, 516, 523, 549
Lag correlation, 63, 585
Latin square, 245, 264
Graeco, 255
Hyper Graeco, 255
model, 246, 263
replicated, 266
tables, 261
Learning process, 1
Least squares, 239, 455, 457, 498
first order model, 479, 503, 513
matrix notation, 501
second order model, 482, 520
straight line, 453, 473, 507
weighted, 505
Likelihood, 239, 590
Linear combination, 87
constraints, 40
effects, 9
function, 44, 563
programming, 535
Lurking variable, 493

Matrix, 177, 501
Maximum, 526
likelihood, 239, 590
Mean, 29, 30, 41
Mean square, 169, 174
expected value, 190
ratio, 199, 224, 230, 249, 253, 257
Metric, 133, 238
Models, 545, 549
additive, 218
adequate, 239, 479, 549
approximate, 294
balanced block, 275
building, 452
diagnostic checking, 182, 220
discrimination, 545, 548, 554
dynamic, 496
empirical, 291
exponential, 479
first order, 513
fitting, 455, 549
identification, 303
Latin square, 246
Graeco, 255
linear, 44, 87, 479, 563
mechanistic, 294, 540, 546
nonlinear, 483, 523, 545
one-way classification, 182
polynomial, 479, 513
random sampling, 57, 65
randomized blocks, 210
second order, 482, 520
selection, 549
simulation, 429
sinusoidal, 479
specification, 549, 597
statistical, 37, 40, 57, 70, 84, 104, 588
straight line, 453, 473, 507
Taylor's series, 374
testing, 545, 550, 554
theoretical, 293
time series, 585
variance components, 572
Youden square, 278
Moving average, 590
Multiple comparisons, 193, 203
Multiple responses, 548, 554

$N(\eta,\sigma^2)$, 46
Nested designs, 572

Noise, 6, 104
  white, 550, 589
Nonadditivity, 219, 237, 336
  transformable, 220
Nonlinear model, 483, 523, 545
  designs, 546, 553
  effect, 9
  error function, 564
  estimation, 553
Nonparametric tests, 78
Normal distribution, 43, 46, 48, 630
  deviate, 48
  nonnormality, 43, 82, 90
  paper, 329, 407, 550, 641
  standard, 48
  table, 630
  unit, 48
Normal equations, 457, 464, 501

Observation decomposition, 175, 212, 243, 248
One factor at time, 312
  parameter model, 453
  way classification, 182
Optimal design, 471
Order, first, 513
  probability plot, 332
  second, 485, 520
  Yates, 323
Orthogonal, 199
  design, 504

Pair, comparison, 93, 102, 105
  fold over, 340, 399
Parameters, 30
  mean, variance, 40
  nonlinear, 546
  regression, 453, 479, 501
Pascal's triangle, 125
Percent, 145
  error, 186
Placket and Burman, 398
Planar surface, 467, 490, 514
Plotting, 136, 191, 222, 249, 552
  confidence intervals, 113
  histograms, 26
Poisson distribution, 137, 142, 144
  confidence limits, 644
Pooled estimate, 76, 319
Population, 27
Precision, 7, 313, 459
Probability, 24, 27
  binomial, 123
  joint, 58
  Poisson, 137
  varying, 135
Problems, 152, 281, 434, 606
Propagation of errors, 451, 563, 570
Proportion, 129
  proportionality constant, 454
Pseudo-variage, 507
Pythagoras' Theorem, 180, 213

Quadratic model, 294, 334, 482, 501
Quality control, 550, 558
Qualitative variables, 291
Quantitative variables, 291

Random, 28, 57
  sampling, 30, 57, 65, 81
  shocks, 590
  test, 101
  variable, 57
Randomization, 9, 93, 102, 105, 112
  distribution, 95, 99
Randomized block, 208, 214
  computation, 213, 243
  design, 177, 193
  geometry, 211
Range, 488, 560
Ranking, 80
Redundancy, 374, 534
Reference distribution, 21, 35, 37, 79
  external, 34, 38
  factorial, 328
  means, 191, 194, 226, 249, 250, 254, 258
    adjusted, 279
  serial data, 588
Regression, 453, 479
  adequacy, 466
  equation, 453, 487, 495
  factorial, 503
  happenstance data, 487
  matrix, 501
  semi-confounding, 489
  two parameters, 462
Replication, 105, 264, 319
Residuals, 40, 455
  analysis, 183, 221, 334

Resolution, 385, 393, 403, 408
Ridges, 526
Robustness, 43, 46, 89, 122

Sample, average, 29, 40, 53
  distribution, 66
  random, 30, 57, 64, 70
  standard deviation, 40, 53
  variance, 40, 53
Sampling, components, 579
  distribution, 66, 70
  minimum cost, 580
Saturated design, 393, 397, 398
Scheffe method, 206
Screening, 389, 545
Second order model, 501, 520, 544
  canonical, 526
Sensitivity, 226, 231, 336, 429, 546
Sequential, approach, 303, 537
  design, 519, 535
  factorials, 396
Serial correlation, 496, 590
Shewhart chart, 558
Signal-noise, 363
Significance, 21, 107
  difference, 34
  geometry, 202
  level, 35, 75, 81, 83, 109
  test, 21, 52, 64, 84, 109, 110
Similarity, 300, 374
Simulation, 429
Smoothness, 300, 374
Standard deviation, 40, 53
  error, 88
    average, 68
    difference, 74, 588
    effect, 319
    nonreplicate, 327
    regression, 459, 468
Statistics, 24, 30, 40, 68
  sufficient, 70, 91
Steepest ascent , 423, 517
Straight line, 295, 473
  inadequacy, 480
  shift origin, 476
  through origin, 453
Student, 14, 49
  see also t distribution
Sufficiency, 91
Sum of squares, 54, 176, 239
  additivity, 211
  function, 455, 499
  surface, 462, 484, 499
  weighted, 505

t distribution, 49, 70, 84, 93, 108
  Dunnett's, 205
  dubious use, 72, 84
  ordinate, 191, 632
  reference distribution, 101, 191
  scaled, 96, 101
  Student, 14, 49
  table, 631, 632
Tables, 630
  binomial confidence limits, 642, 643
  Chi-square, 634
  F, 636, 637, 638, 639, 640
  Gaussian, 630
  normal, 630
  Poisson confidence limits, 644
  scales for normal plots, 641
  t, 631, 632
Taylor's series, 374
Tests, 84, 107
  adequacy, 466, 481, 483
  adjusted average, 278
  analysis of variance, 224
  association, 145
  Bartlett's, 91
  binomial, 130
  Chi-square, 119, 142
  equal means, 187
  F, 222, 225, 249
  geometry, 202
  models, 545, 550, 554
  multiple-comparisons, 203
  non-additivity, 222
  regression, 460
  robustness, 89, 122
  Wilcoxon, 80
Time series, 497, 589
Transformations, 234, 240, 523
  binomial, 133
  Box and Cox, 239
  Box and Tidwell, 523
  factorial, 336
  non-additivity, 220, 232
  Poisson, 144
  variance stabilizing, 144, 232

Transmission of error, 563, 570
Treatment, 105
  adjusted, 275, 279
  effect, 188
Tukey, J. W., one degree of freedom, 222, 237, 244
  paired comparison, 204

Unit normal deviate, 48, 74

V(y), 39, 87
Validity, 93, 104
Variable, categorical, 291
  compound, 533
  dependent, 454
  fundamental, 532
  independent, 454
  natural, 532
  qualitative, 291
  quantitative, 291
  random, 57
Variance, 23, 40, 41
  adjusted, 275
  analytical, 319
  average, 84, 604
  average variance, 524, 544
  Bartlett's test, 91
  Chi-square, 70
  components, 571
  difference, 74, 320, 588, 604
  effect, 320
  equality, 70
  estimated value, 478, 523
  experimental, 319, 517
  fitted valves, 478, 524
  linear statistic, 87, 88, 588, 604
  mean known, 42
  population, 40
  pooled, 76, 319
  ratio, 120
  regression coefficient, 459, 461, 478, 505
  robustness, 122
  sample, 23, 319
  serial correlation, 88, 588, 604
  stabilizing transformation, 144, 232
  weighting, 505
  total, 572
Variation, study of, 556
Vectors, 175, 197, 212
Versions, 306

Weighted average, 594
  exponential, 595
  least squares, 505
White noise, 549, 589
Wilcoxen test, 80

Yates adjustment, 150
  algorithm, 323, 342, 407
  reverse algorithm, 344
Youden square, 245, 260, 278