Subject Index

absolute value, 4
abundant number, 45
acute angle, 55
aggregation bias, *see* Simpson's Paradox
antiderivative, 209, 231
apostrophe notation, 92
argmin, 18
Aristotle, 38
arithmetic rules, 2
asymptote, 180

basis vectors, 266
Bayes
    Reverend Thomas, 315
Bayes Law, 315
Bayesianism, 337
bell shaped
    stupidity of expression, 381
Bernoulli PMF, 340
Bernoulli trials, 339
Bernoulli, Jacob, 22, 37, 284
Bernoulli, Johann, 201, 284
Bhaskara, 200
Binomial PMF, 340
Binomial Theorem, 289
Borel-field, 307
boundary notation, 17
Brahmagupta, 200
breakdown bound, 365

Cafe Med, 327
Carl Jacobi, 2
Cartesian coordinate system, 7, 133
Cartesian plane, 133
Cartesian to polar, 53
Cauchy PDF, 381
Celsius, Anders, 333
chain rule, 195, 196
characteristic equation, 162
characteristic root, *see* matrix, eigenvalue
χ^2 PDF, 352
choose notation, 288, 325
chord, 244
Chu Shï-kié, 290
circular functions, *see* trigonometric functions
Clement matrix, 173
collinearity, 135
column space, 136
comparison test, 262
complement, *see* set, complement
complementary angles, 60
complex number, 14
concave, 244
condition number, 164

Downloaded from https://www.cambridge.org/core. Aarhus Universitets Biblioteker, on 01 Feb 2022 at 14:42:13, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9780511806650
Cambridge Books Online © Cambridge University Press, 2009

conic section, 62
constrained optimization, 271
convex, 244
convex set, 9
cosine, 55
countable, 330
counting numbers, 14
counting rules, 285, 402
  ordered, with replacement, 287
  ordered, without replacement, 287
  unordered, with replacement, 289
  unordered, without replacement, 288, 326
coupling from the past, 395
covariance, 367
Cramer's rule, 177
craps, 373–378
cumulative distribution function (CDF), 348, 356

data
  categorical, 331
  continuous, 330
  definition, 6
  discrete, 330
  interval, 332
  levels of measurement, 330
  nominal, 331
  ordinal, 331
  polychotomous, 331
  ratio, 333
  single point: datum, 6
De Moivre, Abraham, 31, 284
de Morgan's Laws, 299, 324
decay rate, 44
deficient number, 45
definite integral, 207
degrees of freedom, 352
derivative, 185
  chain rule, 192
  exponent, 196
  higher order, 239–241, 280, 282
  logarithm, 196
  of a constant, 190
  partial, 199, 234–239, 279, 280
  power rule, 190
  product rule, 191
  quotient rule, 191
  second, 239
  sum, 190
  trigonometric functions, 225, 234
derivative notation
  Leibniz's, 185, 239
  Newton's, 185, 239
determinant, *see* matrix, determinant
differential equations, 217
differentiation, 185
Dirichlet, Lejeune, 6, 22
distribution function, 334
domain, 23
double factorial, 232

eigen-analysis, 160–167
eigenvalue, *see* matrix, eigenvalue
eigenvectors, *see* matrix, eigenvectors
ellipse, 67–69, 282
  definition, 67
  foci, 67
  major axis, 68
  minor axis, 68
  standard form, 67
  vertices, 67
entropy, 359–361
  information, 360
  Shannon, 360
equation
  definition, 18
equitable matrix, 127
Ergodic Theorem, 415
Euclid, 46, 290
Euler's expansion, 37, 46
Euler's integral, *see* gamma function
Euler, Leonhard, 20, 22, 37, 185, 222, 284
even function, 76
expected value, 370
  conditional, 372

Downloaded from https://www.cambridge.org/core. Aarhus Universitets Biblioteker, on 01 Feb 2022 at 14:42:13, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9780511806650
Cambridge Books Online © Cambridge University Press, 2009

finite properties, 372, 373
exponent
properties, 34
exponential function, 36–40, 71
exponential PDF, 351

factor, 32
factorial function, 29, 285
Fermat, Pierre, 284
Fibonacci numbers, 291
Fibonacci sequence, 42
field, 83
Fourier function, 79
Fourier series, 79
frequentism, 336
function
asymptotic value, 180
continuous, 21
definition, 19
invertible, 21
limit, 179
limit examples, 181
limit properties, 181
linear, 24
monotonically decreasing, 183
monotonically increasing, 183
properties, 21
rate of change, 183
right-continuous, 348
symmetric, 179
unimodal, 179
function root, 247
Fundamental Theorem of Calculus, 211
Fundamental Theorem of Counting, 286

gamma function, 222, 232, 352
gamma PDF, 351
Gauss, Carl Friedrich, 284, 354
Gauss-Jordan elimination, 152–154
Gaussian PDF, *see* normal PDF
Glottochronology, 44
gradient, 270
Greek symbols, 49–50

Hamiltonian notation, 266
Hesse, Ludwig, 270
Hessian, 270
Hilbert matrix, 174
histogram, 364
Huygens, Christian, 37
hyperbola, 69–74, 282
definition, 70
standard form, 70

idempotent matrix, 118, 126, 130
identity matrix, 103, 113
independence, 317
conditional, 318
pairwise, 317
independence rule, 341
indexing, 11
computer notation, 13
inequalities, 378–380
inequality
Berge, 379
Cauchy-Schwarz, 96, 126, 151
Chebychev, 378
Cramer-Rao, 379
Hölder's, 96, 97, 126, 379
Jensen's, 378
Liapounov's, 379
Markov, 378
Minkowski, 379
Schwarz, 379
triangle, 96, 126
inequality notation, 18
infinity, 16
inflection point, 241, 278
integral
definite
properties, 212
discontinuities, 214
indefinite, 217, 232
multidimensional, 250–256
repeated, 250
trigonometric functions, 226
Integral Test, 260

Downloaded from https://www.cambridge.org/core. Aarhus Universitets Biblioteker, on 01 Feb 2022 at 14:42:13, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9780511806650
Cambridge Books Online © Cambridge University Press, 2009

integrand, 208
integration, 205
integration by parts, 219, 232
integration symbol, 207
intersection, *see* set, intersection
interval colon notation, 10
interval comma notation, 10
interval notation, 9
involutory matrix, 119, 126
irrational number, 37
irrational numbers, 14
iterated integral, 281
Iterated Integral Theorem, 254

J matrix, 113

Kolmogorov probability axioms, *see* probability, axioms
Kronecker product, *see* matrix, Kronecker product

Lagrange multiplier, 272, 283
  example, 273
Lagrange, Joseph Louis, 284
Laplace, Pierre-Simon de, 284
latent characteristics, 332
law of cosines, 95
Legendre, Adren-Marie, 284
Leibniz, Gottfried Wilhelm, 22, 204
L'Hospital's rule, 201, 223, 231
L'Hospital, Guillaume, 201
limit notation, 17
line
  parallel, 28
  perpendicular, 28
  point-slope form, 42
  slope-intercept form, 26
linear algebra
  definition, 136
linear combinations, 136
linear programming, 152
linear regression, 29, 46, 172
linear space, 138
linear subspace, 138
linear system of equations, 157–160
linear transformation, 138
  closed, 138
linearly dependent columns, 146
linearly independent, 146
location-scale distributions, 354
logarithm, 35–36
  base, 35
  change of base, 36, 197
  natural, 36
  properties, 36
logarithmic differentiation, 197, 230
logical symbols, 15

M-matrix, 175
marginal effects, 199
Markov chain, 393, 394, 409
  closed, 424
    absorbing, 409
  detailed balance equation, 417
  discrete, 395, 409
  ergodic, 415
  hitting times, 409
  homogeneous, 395
  j-step transition matrix, 399
  limiting distribution, 414
  marginal distribution, 413
  mixing, 414
  null recurrent, 410
  period, 405
  positive recurrent, 410
  recurrent, 409–411, 426
  reducible, 408
  reversibility, 417
  stability, 413–415
  state space, 407, 409
    absorbing, 409
    closed, 410
    irreducible, 407
    recurrent, 410
  stationarity, 414
  stationary distribution, 401, 427
  transient, 409

Downloaded from https://www.cambridge.org/core. Aarhus Universitets Biblioteker, on 01 Feb 2022 at 14:42:13, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9780511806650
Cambridge Books Online © Cambridge University Press, 2009

transition kernel, 398, 421
transition matrix, 398
Markovian cat, 393
Markovian property, 394
example, 396
martingale, 394
example, 397
matched pair, 26
matrix
addition, 107
block diagonal, 130
calculation
properties, 108
cofactor, 141
collinearity, 176
decomposition, 104
definition, 100
determinant, 90, 140, 176
graphical interpretation, 145
properties, 144
diagonal, 102
dimensions, 100
eigenvalues, 161, 171, 173, 176
properties, 163
eigenvectors, 161, 173, 175
elements, 100
entries, 100
equality, 101
Euclidean norm, 149
Frobenius norm, 149
full column rank, 146
full row rank, 146
Hadamard product, 129
idempotent
rank, 148
ill-conditioned, 164
indefinite, 168
inverse, 173, 176
properties, 154
Jordan product, 130
Kronecker product, 119–124, 131
exponents, 144
properties, 122
trace operation, 144
LDU decomposition, 168
left eigenvector, 165
Lie product, 130
lower triangular, 104
LU decomposition, 112, 130
minor, 141
multiplication, 107, 109–115
properties, 111
negative definite, 168
negative semidefinite, 168
noninvertible, 152
nonnegative definite, 168
nonpositive definite, 168
norm
properties, 150
matrix
order-k, 101
orthogonal, 172
p-norm, 126, 149
pivots, 143
positive definite, 168
positive semidefinite, 168
post-multiplication, 110, 112, 126
pre-multiplication, 110, 112, 126
quadratic forms, 167
rank, 146, 172
properties, 148
right eigenvector, 165
scalar division, 107
short rank, 146
singular, 152
skew-symmetric, 102, 116
square, 101
subtraction, 107
symmetric, 102, 116
trace, 139, 173
properties, 140
trace norm, 149
transposition, 115
properties, 116
upper triangular, 104
vectorization, 119, 131

Downloaded from https://www.cambridge.org/core. Aarhus Universitets Biblioteker, on 01 Feb 2022 at 14:42:13, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9780511806650
Cambridge Books Online © Cambridge University Press, 2009

matrix inverse, 151
maximization, 270
maximum likelihood estimation, 269
mean, 362
Mean Value Theorem, 203, 210, 234
measures of centrality, 361
measures of dispersion, 365
median, 362
median absolute deviation (MAD), 366
Mercator, Nicolaus, 37
mode, 362
modulo function, 32
moments, 380
    central, 380
multinomial choice, 289
mutually exclusive, *see* set, pairwise disjoint

Napier, John, 37
natural exponent, 38
natural numbers, 14
nautilus, 38
nested equation, 20
Newton's method, 247, 278
    example, 249
Newton, Isaac, 204, 247
Newton-Raphson, *see* Newton's method
nilpotent matrix, 118, 119
normal PDF, 354
    standard, 355
nth partial sum, 259
number typology, 14

odd function, 76
odds ratio, 321
order of operations, 3
ordered pair, 23, 133
Oughtred, William, 37

parabola, 64–66
    definition, 64
    directrix, 64
    focus, 64
Pareto's Law, 352
partial derivative, *see* derivative, partial
Pascal's Triangle, 290, 324
Pascal, Blaise, 284, 290
perfect number, 45
permutation matrix, 114
Plato, 2
PMF, *see* probability mass function
point
    on coordinate system, 7
Poisson PMF, 344
Poisson, Siméon Denis, 284
polar coordinates, 53
polar to Cartesian, 53
polynomial function, 33
power, 35
principle root, 4
prisoner's dilemma, 263
probability, 306–315
    as degree of belief, 337
    axioms, 308, 339, 414
    conditional, 312–315
    joint, 309, 315, 341
    multiplication rule, 315
    objective, 285
    rules for calculation, 309
    subjective, 285
    updating, 312
probability density function (PDF), 350
probability function
    definition, 307
probability mass function (PMF), 339
probability measure space, *see* triple
probability space, *see* triple
probit, 357
product operator, 12
projection, 134
    orthogonal, 134
pseudo-random numbers, 407
Pythagorean Theorem, 133
Pythagoreans, 38, 45

quadratic, 33, 46, 63

radian measurement, 51
radical index, 4

Downloaded from https://www.cambridge.org/core. Aarhus Universitets Biblioteker, on 01 Feb 2022 at 14:42:13, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9780511806650
Cambridge Books Online © Cambridge University Press, 2009

radican, 4
random variable, 338
randomness, 334, 337
range, 23
ratio test, 262
rational numbers, 14
real number line, 9
rectangle rule, 205
relation, 21, 23
resistance, 365
Riemann integral, 231
Riemann integration, 205
Riemann sum, 209
Riemen-Stieltjes integral, 372
right-hand-rule, 90
Rolle's Theorem, 203, 234, 246
root test, 262
roots of a polynomial, 33
row space, 136

Saint-Vincent, Gregory, 37
sample space, 292
Schur product, 129
second derivative, *see* derivative, second
second derivative test, 245
series, 256–266
  alternating, 263
  convergent, 260, 281
  divergent, 260, 281
  finite, 259
  geometric, 262, 263
  harmonic, 260, 281
  infinite, 259
  Maclaurin, 265, 282
  Mercator, 282
  power, 264
  Taylor, 265
set
  cardinality, 294
  complement, 298, 300
  containment, *see* subset
  countable, 293
  definition, 291
  difference operator, 298
  disjoint, 302
  element, 292
  empty, 295
  equality, 296
  event, 292
  finite, 293
  infinite, 293
  intersection, 297, 300
  null, 295
  operations, 295
  outcome, 292
  pairwise disjoint, 302
  partition, 302
  properties, 300
  uncountable, 293
  union, 296, 300
set notation, 16
sigma-algebra, 307
sigma-field, *see* sigma-algebra
Simpson's Paradox, 316
sine, 55
span
  matrix, 139
  vectors, 138
spectral component, 165
spectral decomposition, 161
standard deviation, 366
state space, 393
stem and leaf plot, 364
Stirling's Approximation, 31, 46
stochastic process, 393
structural equation models, 147
subjectivism, 337
submatrix, 141
subscript notation, 13
subset, 295
  proper, 295
summation operator, 11
support, *see* domain
symmetric difference, 298

tangent function, 55

Downloaded from https://www.cambridge.org/core. Aarhus Universitets Biblioteker, on 01 Feb 2022 at 14:42:13, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9780511806650
Cambridge Books Online © Cambridge University Press, 2009

tangent line, 185
Taylor series expansion, 247
tensor product, *see* matrix, Kronecker product
theorem, definition, 55
Total Probability Theorem, 309, 313, 314, 316, 325, 328
trace, *see* matrix, trace
transformation, 77
transition kernel, *see* Markov chain, transition kernel
transition matrix, *see* Markov chain, transition matrix
triangular matrix, 104
trigonometric functions, 55
  radian measure, 59
  reciprocal relations, 55
trigonometry
  definition, 55
triple, 308

uncertainty, 335
uncountable, 331
uniform PDF, 358
uniform PMF, 358, 361
union, *see* set, union
unit circle, 62
unit vector, 96
unit-radius circle, 53
utility
  definition, 5

Vandermonde matrix, 174
variable
  definition, 6
variance, 366
vector
  addition, 84
  algebra
    properties, 86
  basic calculations, 84
  basis, 138, 139
  column form, 84
  conforming, 85
  cross product, 89
    properties, 91
  definition, 83
  difference norm, 126
  dot product, 87
  inner product, 87
    properties, 88
  multiplication norm, 126
  nonconforming, 85
  norm, 93
    properties, 94
  orthogonal, 87
  outer product, 89
  p-norm, 96
  row form, 84
  scalar division, 85
  scalar multiplication, 85
  scalar product, 87
  subtraction, 85
  transpose, 92
vector function, 267
  differentiation, 268
  integration, 268
Venn diagram, 299

whole numbers, 14

zero, 3
zero matrix, 104

Downloaded from https://www.cambridge.org/core. Aarhus Universitets Biblioteker, on 01 Feb 2022 at 14:42:13, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/CBO9780511806650
Cambridge Books Online © Cambridge University Press, 2009