Index

Remember to look at the contents for larger topics. Abbreviations used in this index: m.g.f. = moment generating function; p.g.f. = probability generating function.

abnormality, 305
absolute convergence, 125
acceptance sampling, 147
addition rule for E, 267
  extended, 268
addition rule for P, 41
  extended, 42
alarms, 46
American roulette, 6
Arbuthnot, J., 19, 118
archery, 224
arcsin density, 203, 237
asteroid, 81
averages, law of, 279
axioms, 42

Banach's matchboxes, 119
batsmen, leading, 211
Bayes' rule (theorem), 57
bell-shaped curve, 164, 178
Benford's distribution, 18, 132, 135, 243
Berkeley, 84
Bernoulli pin, 11
Bernoulli random variable, *see* indicator
Bernoulli trials, 37, 131, 240, 252
  non-homogeneous, 270
  Poisson number of, 281
  sequence of, 131, 316
Bertrand's paradox, 237
Bertrand's other paradox, 83
beta density, 203, 236
Bienaymé, I.J., 321
binary tree, 68
binomial coefficient, 99, 101, 124
binomial distribution, 139
  mean, 149
  mode, 169
  p.g.f., 312
  variance, 154, 274
binomial random variables, 240
  sums of, 261, 263
binormal density, 295
binormal random variable, 295, 332
birthdays, 105
bivariate density, *see* joint density
bivariate distribution, *see* joint distribution
bivariate log normal density, 296
bivariate normal density, 295
  standard, 295
body–mass index, 191, 296
Boole's inequality, 47, 272
branching process, 321
  extinction, 322
  geometric, 322
bridge, 106
Bristol, 157
Buffon's needle, 304
bumping, 158, 169
Buridan's mule, 27

calculus, fundamental theorem, 177
capek, 66
capture−recapture, 147
Cardano, 8, 11
cardinality, 26
Carroll, Lewis, 82
casino, 79, 331
Cauchy density, 202, 237
  characteristic function, 334
Cauchy−Schwarz inequality, 279
c.d.f., *see* cumulative distribution function
central heating, 60
central limit theorem, 323
centre of gravity, 148
change of units, 198, 216
change of variables, 298
characteristic function, 334
cheating with crooked die, 168
Chebyshov's inequality, 217
chi-squared density, 308
coloured sphere, 92
combinations, 99
complement, 25, 44
compounding, 319, 333
Conan Doyle, A., 280
conditional
  density, 226, 286
  distribution, 218, 226, 280
  expectation, 220, 228, 282
  independence, 64
  key rule, 219, 227, 282
  law of the unconscious statistician, 283
  probability, 49
conditioning rule, 49
constant random variable, 192, 194
continuity, 176
continuity correction, 166
continuity theorem, 315
continuous partition rule, 290
continuous random variable, 192, 199
convergence, 125
  absolute, 125
convolution rule, 261, 290
correlation, 276
correspondence rule, 94
coupons, 268, 272, 274, 302, 327, 330
covariance, 275
craps, 71
cumulants, 331
cumulative distribution function, 197

darts, 269
degraded signal, 77, 136
de Méré, 114
de Méré's problem, 45
de Moivre, A., 20, 77, 164, 309
de Moivre trials, 172, 182, 240, 328
density, 135, 170, 199

density, *cont.*
  arcsin, 203, 237
  beta, 203, 236
  Cauchy, 202, 237
  chi-squared, 308
  conditional, 226, 286
  doubly exponential, 202
  exponential, 171, 200
  gamma, 203, 260
  joint, 245, 248
  key rule for, 171, 199
  log normal, 296, 304
  marginal, 247
  of maximum, 305
  normal, 171, 200, 202
  Student's *t*-, 308
  triangular, 257
  uniform, 170, 200
derangement, 96, 120, 121, 285
derivative, 177
determinism, 28
deuce, 74
die, 75
difference, 25
difference equation, 87
difference rule, 45
discrete random variable, 192, 193
disjoint events, 35
disjoint sets, 25
dispersion, 150
distribution, 42
  arcsin, 237
  Benford's, 18, 132, 243
  binomial, 139
  bivariate, *see* joint distribution
  conditional, 218, 226, 280
  empirical, 132
  exponential, 202
  function, 134, 197, 201, 244
  geometric, 137
  hypergeometric, 146
  joint, 239
  key rule for, 134
  limiting, 315
  marginal, 240
  negative-binomial, 143
  normal, 202
  planar, 173
  Poisson, 156
  probability, 42, 131
  triangular, 194
  trinomial, 172
  trivariate, 240
  trivial, 194
  uniform, 134, 194, 202
doctor's paradox, 297
dominance, 215
doubly exponential, 202
drunkard's walk, 326
duration of play, 225

embarrassment, 70
empirical distribution, 132
empty set, 24
equivalence, 40
Euler, L., 309
Euler's constant, 275
evens, 79
event, 34
examination, 57
expectation, 9, 13, 147, 207
  addition rule for, 267
  conditional, 220, 282
  linearity of, 214
  of functions, 213
  product rule for, 273
experiment, 32
exponential limit, 126
exponential random variable, 200
  density, 171, 200
    doubly exponential, 202
    two-sided, 200
  distribution, 202
  m.g.f. for, 313
  moments for, 310
extinction, 322

factorial moments, 311
factorials, 97
fairness, 9, 14
fallacy
  gambler's, 138, 279
  prosecutor's, 53
falling factorial power, 97
false positives, 55, 57
families, 183
fashion retailer, 217
first moment, *see* mean
fixed die, 78
friendly function, 205
function of random variable, 191, 255
  expectation of, 213
functions, 27
fundamental theorem of calculus, 177

Galileo, 39, 47
Galton, F., 296
  paradox of, 82
Galton–Watson process, 321, 331
gambler's fallacy, 138, 279
gambler's ruin, 116, 225, 285
gamma density, 203, 260, 267
  m.g.f., 318
generating functions, 310
  cumulant, 330
  joint, 328
  m.g.f., 310
  p.g.f., 310
Genoese lottery, 110
geometric branching, 322
geometric random variable, 198
  distribution, 137
  mean, 150, 210
  mode, 153
  p.g.f., 312, 313
  variance, 154
goats and cars, 84
Graunt, J., 12
gravity, 149

histogram, 133
Holmes, Sherlock, 280
house, 304
Huygens' problem, 73, 326, 330
hypergeometric random variable
  distribution, 146, 155
  mean, 270
  mode, 182

impossible event, 24
inclusion, 24
inclusion–exclusion, 46, 95, 271
inclusion inequality, 47
independence, 59, 219, 273
  conditional, 64
  key rule for, 251
  pairwise, 333
  of random variables, 250
index, body–mass, 191, 296
indicator, 27, 193, 194
inequality
  Boole's, 47, 272
  Chebyshov's, 217
  dominance, 215
  inclusion, 47
  Markov's, 216
insurance, 58, 319
intersection, 25
inverse function, 27
inversion theorem, 311

joint density, 245
  key rule for, 245
joint distribution, 239, 244, 245, 248
  key rule for, 240
joint generating functions, 328
jointly uniform, 246

key rule
  conditional, 219, 227, 282
  for densities, 171
  for distributions, 134, 195
  for independent case, 251
  for joint densities, 245
  for joint distributions, 240
kidney stones, 48, 83
krakens, 143
kurtosis, 307

lack of memory, 227
lamina, 43
law
  Benford's, 18, 132, 135
  of averages, 279
  of large numbers (weak), 278

- of unconscious statistician, 214, 267, 283
- Stigler's, 18
- leading batsmen, 211
- limits, 125, 176
  - binomial limit of hypergeometric distribution, 155
  - central, 323
  - exponential limit of geometric distribution, 161, 316
  - local, 167
  - normal, 179, 324
  - normal limit of binomial distribution, 178
  - Poisson limit of binomial distribution, 156, 181, 183, 318, 330
- linearity of expectation E, 214
- local limit theorem, 167
- log normal density, 296, 304
  - bivariate, 296
- lottery, 16, 110

- marginal densities, 247
- marginal distribution, 240
- Markov, A.A., 12, 28
- Markov inequality, 216
- matching, 128, 272, 285
- maximum of geometrics, 258
- mean, 147, 207
  - binomial, 149, 270
  - exponential, 209
  - gamma, 314
  - geometric, 150
  - hypergeometric, 270
  - log normal, 296, 304
  - negative binomial, 268
  - normal, 209
  - Poisson, 154
  - uniform, 154, 209
- median, 153
- meteorite, 157
- method of indicators, 270
- m.g.f., 310
  - binormal, 332
  - exponential, 313
  - gamma, 314
  - normal, 313
- Mills' ratio, 167
- minimum
  - of exponential random variables, 258
  - of geometric random variables, 257, 258
- mode, 153
  - binomial, 169
  - geometric, 153
  - hypergeometric, 182
- modelling, 14, 16
- moment generating function, *see* m.g.f.
- moments
  - factorial, 331
  - second, 151
- Monopoly, 136
- Montmort, 118
- Monty Hall problem, 84
- multinomial, 99, 124, 182, 329
- multinormal, 334
- multiplication rule, 52, 95
  - extended, 52
- Mythy Island, 92

- negative binomial distribution, 143, 266
  - theorem, 125
- Newcomb, S., 18
- Newton, I., 47
- non-homogeneous Bernoulli trials, 270
- normal limit theorem, 179, 323
- normal
  - approximation, 164
  - density, 171, 200
    - bivariate, 295
    - m.g.f. for, 313
    - mean of, 209
    - standard, 171, 206
    - variance of, 216
  - distribution, 202
  - limit, 323
  - random variable, independent, 252
  - sample, 335
  - sum, 264

- occupancy, 120
- odds, 78
- one-to-one function, 196, 204
- opinion, 14
- opinion poll, 154
- order-statistics, 299

- pairwise independence, 333
- paradox
  - Bertrand's, 236
  - Bertrand's other, 83
  - Carroll's, 82
  - doctor's, 297
  - Galton's, 82
  - prisoners, 86
  - Simpson's, 83
  - switching, 84
  - voter, 245
- parimutuel betting, 80
- partition, 26, 36
- partition rule, 54, 222, 280
  - continuous, 290
  - extended, 56
- Pascal, B., 102, 114
- Pearson, K., 325
- Pepys' problem, 47
  - extended, 265
- permutation, 97
- Petersburg problem, 218
- p.g.f., 310
- pirates, 54
- pizza problem, 127
- placebo, 297
- planar distribution, 173
- plane, random walk in, 333
- plates, 308
- plutocrat, 9, 50
- points, problem of, 113, 118, 128
- Poisson–Bernoulli trials, 281
- Poisson–de Moivre trials, 329, 334
- Poisson
  - distribution, 156
  - generating function, 313
  - mean, 154
  - mode, 158
  - process, 201, 289
  - sum, 263, 318
  - variance, 180
- poker, 107, 127
- polling, 154
- potatoes, 293
- powers of random variables, 206
- prisoners paradox, 86
- probability, 22
  - conditional, 49
- probability density, 170, 199
- probability distribution, 42, 131, 194
- probability generating function, *see* p.g.f.
- probability scale, 2
- problem of the points, 113, 118, 128
- product of two sets, 25
- product rule, 59, 273
- prophylaxis, 66
- prosecutor's fallacy, 53
- protocol, 85
- Pythagoras, 304

- Quetelet index, *see* body mass index
- quiz, 182, 223, 332

- random
  - sample, 209
  - stakes, 307
  - sum, 284, 320
- random variable, 190
  - Cauchy, 202, 237
  - continuous, 192, 199
  - discrete, 192, 193
  - doubly exponential, 202
  - exponential, 200
  - gamma, 203, 260
  - geometric, 198
  - indicator, 193, 194
  - log normal, 296
  - normal, 200
  - triangular, 194
  - trivial, 192, 194
  - two-sided exponential, 200

CAMBRIDGE

random variable *cont.*
  uniform, 194, 200
random walk, 324
  in plane, 333
  on triangle, 333
Rayleigh, 326
recurrence, 88
red ace, 58
regression, 297
ringing, 277
risk, 28
rivets, 168
Robbins' formula, 124
robot, 66, 303
roulette, 6
rounding errors, 324
ruin, gamblers', 116, 225, 285
rule,
  addition, 94
    extended, 42
    for E, 267
    for P, 41
  Bayes', 57
  conditional key, 219, 282
  conditional partition, 54
  conditioning, 49
  continuous partition, 290
  convolution, 261, 290
  correspondence, 94
  difference, 45
  inclusion–exclusion, 45, 95
  key
    conditional, 219, 227, 282
    for densities, 171
    for distribution, 134, 195
    for independent case, 251
    for joint density, 245
    for joint distribution, 240
  multiplication, 52, 95
  partition, 54, 222, 280
  product, 59
runs, 111, 181, 220, 303

St Petersburg problem, 218
sample, normal, 335
sample mean, 148, 149
sample space, 33
scaling, 204
Schwarz, *see* Cauchy–Schwarz inequality
seeds, 293
sequence, 95, 131
set, 24
sex ratio, 12
shapes, 107
Sherlock Holmes, 280
shifting, 204
significant digits, 18
simple random walk, 324
Simpson's paradox, 83
size, 26
skewness, 235, 279
sparse sampling, 156
squared normal random variable, 314
standard deviation, 151
  normal, 171, 206
    bivariate, 295
Steffensen, J.F., 321
Stigler's law, 18
Stirling's formula, 122
stones, 48, 83
Student's *t*-density, 308
sudden death, 138
sums of independent random variables, 316
  binomial, 261, 263
  continuous, 262
  discrete, 261
  exponential, 264, 267, 320
  gamma, 318
  geometric, 263, 266, 317
  log normal, 296
  normal, 264, 296, 318
  Poisson, 263, 318
  random, 284, 320
  uniform, 256, 264
  variance, 273
survival function, 197
switch, 195
switching paradox, 84
symmetric difference, 25
symmetric distribution, 303

table of generating functions, 329–30
tables of means and variances, 231
tagging, 181
tail, left and right, 198
tail generating function, 327, 331
tail integral, 210
tail sum, 210, 271
tennis, 71, 108, 225
  real, 109
test, 55, 57, 69
thistles, 293
tote, 80
tree, 67
  binary, 68
trial
  Bernoulli, 37, 131
  de Moivre, 172
triangle random walk on, 333
triangular random variable, 194, 257
trinomial, random variable, 172
trivariate random variable, 240
trivial random variable, 192
two-sided random variable, 197, 200

unconscious statistician, laws of, 214, 267, 283
uncorrelated random variables, 275
uniform random variables, 194, 202
  jointly uniform, 246, 253
  sums of, 256
union, 25
uniqueness therorem, 311
unordered sample, 99
unsavoury function (Ω is not countable), 191
urns, 41
utopia, 183

value, 9, 13, 148
Van der Monde's formula, 103
variance, 151, 215
  Bernoulli, 151
  binomial, 154, 274
  exponential, 310
  geometric, 154
  normal, 216
  Poisson, 180
  of sum, 273
  uniform, 154
vending machine, 14
Venn diagram, 25, 36
voter paradox, 245

waiting, 201
waiting times, 268
Waldegrave's problem, 77, 91, 224, 294, 326, 329
Wald's equation, 284
weak law of large numbers, 278
wildlife, 146

Yarborough, 127

Zodiac, 126