

# Index

- acre, 217
- AE, 217
- ampere, 215
- analysis of variance, 48
- Angstrom, 217
- ANOVA, *see* analysis of variance
- are, 217
- array methods
  - Python code, 170
- atmosphere, 218
- atto, 215
- avdp, 217
- average
  - of data series, 57
  - standard uncertainty, 154
- barn, 217
- barrel, 217
- Bayes, 112
- Bayesian inference, 114
- becquerel, 216
- Bernoulli trial, 33
- bias, 138
- binomial
  - coefficient, 33
  - distribution, 32, 143
  - Python code, 173
- bivariate normal distribution, 206
- block average
  - method, 155
  - Python code, 195
- bootstrap method, 65
  - Python code, 175
- box and whisker display, 8
- btu, 218
- cable, 217
- calibration, 78
  - correction, 80
  - table, 80
- calorie, 218
- candela, 215
- Cauchy distribution, 43
- cdf, *see* cumulative distribution
- Celsius, 217
- centi, 215
- central limit theorem, 41, 148
- central moments, 30
- characteristic function, 31, 141
- chi-squared distribution, 47
  - cdf, 199
  - data sheet, 199
  - equation, 199
  - moments, 199
  - Python code, 184
  - table, 200
- chi-squared test, 95
- combining uncertainties, 135
- compass example, 80
- complementary error function, 39
- confidence interval, 11, 31
  - Student's t-distribution, 60
- confidence limit, 31
- constants, *see* physical constants
- contour
  - plot for chi-square, 103
  - python code, 184
- convolution, 141
- correlation coefficient, 135
  - between parameters, 99
  - between coordinates, 91
  - between parameters, 90

- correlation length, 59, 152, 154
- coulomb, 216
- covariance, 135
- covariance matrix, 99, 161
  - of parameters, 163
  - Python code, 187
- criterion
  - one-sided, 64
  - two-sided, 64
- cumulative distribution
  - function (cdf), 31, 32
  - of data, 54
  - Python code, 171
- curie, 218
- data
  - average, 8, 57
  - correlation length, 59
  - cumulative distribution, 54
  - distribution function, 54
  - graphical presentation, 71
  - histogram, 54
  - mean squared deviation, 8, 57
  - processing, 53
  - properties, 6
  - root-mean-squared deviation, 8
- debye, 218
- deca, 215
- deci, 215
- decile, 31
- decimal separator, 9
- degrees of freedom
  - chi-squared test, 96
  - Student's t-distribution, 60
- density function, 27
- derived SI units, 216
- deviation
  - systematic, 18
- direct probability, *see* probability
- discrete probability distribution, 27
- distribution
  - cumulative of data, 54
  - distribution functions, *see* probability distributions
  - binomial, 143
  - multinomial, 144
- drachme, 217
- dyne, 217
- Eadie–Hofstee plot, 75
- ellipsoid for chi-square, 164
- enzyme kinetics, 75
- epistemic probability, *see* probability
- erf, *see* error function
- erfc, *see* complementary error function
- erg, 218
- error, *see* inaccuracy
- error function, 39
- error propagation
  - in functions, 21, 136
  - in products, 21, 136
  - in sums, 21, 135
  - Monte Carlo, 23
  - with covariances, 22, 136
- error sum of squares, 48, 106
- errors
  - classification, 18
  - random, 19
  - systematic, 18, 138
  - truncation, 58
- estimate
  - best fit parameters, 88
  - excess, 60
  - mean, 58
  - minimal variance, 158
  - rank-based, 64
  - robust, 63
  - sign-based, 64
  - skewness, 60
  - standard deviation, 58
  - unbiased, 162
  - variance, 58, 151
  - variance of the mean, 154
- esu, 218
- exa, 215
- excess, 30
  - estimate, 60
- expectation, 29
- expected value, *see* expectation
- experimental design, 48
- explanatory variable, 87
- exponential distribution, 45

- F-distribution, 47
  - data sheet, 201
  - pdf and cdf, 201
  - Python code, 193
  - reflexive relation, 201
  - table, 202
  - use in ANOVA, 201
- F-ratio, 48
- F-test
  - on ANOVA, 49
  - on functional fit, 106
- factorial design, 48
- Fahrenheit, 217
- farad, 216
- fathom, 217
- femto, 215
- fermi, 217
- fit, *see* least-squares fit
- fit (Python code), 189
- fl.oz., 217
- foot, 217
- Fourier transform
  - Python code, 194
- functions
  - fit to data, 84
  - linearization, 73
- FWHH, 43
- gallon, 217
- Gauss, 218
- Gauss function, 37, 205
- giga, 215
- grain, 217
- gray, 216
- Hanes plot, 75
- hartree, 219
- hazard function, 45
- hecto, 215
- henry, 216
- histogram, 54
  - python code, 169
- horse power, 218
- inaccuracy
  - absolute, 10
  - graphical estimate, 77
  - relative, 10
- inch, 217
- indicator function, 54
- inverse probability, *see* probability
- inverse survival function, 32
- isf, *see* inverse survival function
- jackknife procedure, 155
- joule, 216
- kelvin, 215
- kgforce, 217
- kilo, 215
- kilogram, 215
- kurtosis, 30
- kWh, 218
- least-squares fit, 72, 84, 160
  - accuracies, 98
  - best parameter estimates, 88
  - correlation coefficient, 204
  - covariances, 99
  - data sheet, 203
  - general, 92
  - general equations, 203
  - harmonics, Python code, 182
  - linear parameters a,b, 160
  - linear regression, 87, 161, 204
  - nonlinear, 93, 165
  - nonlinear example, 93
  - parameter covariances, 163, 203
  - Python program, 189
  - residuals, 85
  - sum of square deviations, 161
  - uncertainties parameters, 89
  - uncertainty in x, 88
  - urease, python code, 183
  - variances, 89
- lifetime distributions, 45
- likelihood, 86, 163
- linear regression, 87, 161
  - uncertain x, 88
- linearization of functions, 73
- Lineweaver–Burk plot, 75
- liter, 217
- log plot
  - Python code, 172
- log-normal distribution, 42

- Lorentz distribution, 43
- lumen, 216
- lux, 216
  
- marginal distribution, 118
- mass function, 27
- matrix notation, 160
- maxwell, 218
- mean, 11, 29
  - estimate, 58
- mean squared deviation, 57
- median, 8, 11, 31
- mega, 215
- meter, 215
- Michaelis–Menten kinetics, 75
- micro, 215
- mil, 217
- mile, 217
- milli, 215
- minimal variance estimate, 158
- mm Hg, 218
- mode, 11
- mol, 215
- molar, 14
- mole, 14
- moment, 30
- moment-generating function, 141
- Monte Carlo
  - methods, 23
  - Python code, 173
- msd, *see* mean squared deviation
- multinomial distribution, 36, 144
- multivariate normal distribution, 206
  
- nautical mile, 217
- newton, 216
- non-SI units, 217
- nonlinear fit, *see* least-squares fit
- normal distribution, 37
  - bivariate, 206
  - characteristic function, 205
  - data sheet, 205
  - moments, 205
  - multivariate, 206
  - one-sided excess table, 208
  - standardized, 38
  - table, 205
  - two-sided excess table, 207
  
- oerstedt, 218
- ohm, 216
- one-sided criterion, 64
- ounce, 217
- outliers, 63
  
- parsec, 217
- pascal, 216
- pdf, *see* probability density function
- percentile, 8, 31
- percentiles
  - python code, 172
- peta, 215
- phot, 218
- physical constants
  - accuracies, 210
  - data sheet, 209
  - Python code, 170
  - table of values, 209, 210
- physical probability, *see* probability
- pico, 215
- pint, 217
- pmf, 27, *see* probability
- poise, 218
- Poisson distribution, 36, 146
  - mean and variance, 36
- population statistics, 46
- posterior probability, 113
- pound, 217
- poundforce, 217
- prior probability, 114
- probability
  - density function, 27
  - direct, 111
  - epistemic, 111
  - inverse, 111
  - mass function, 27
  - physical, 111
  - posterior, 113
  - prior, 114
  - subjective, 111
- probability density function, 32

- probability distributions, 27
  - binomial, 32, 143
  - bivariate, 212
  - Cauchy, 43
  - cdf, 212
  - central moment, 30
  - characteristic function, 31, 141
  - characteristic functions, 211
  - chi-squared, 47
  - continuous, 27
  - cumulative, 31
  - data sheet, 211
  - discrete, 27
  - excess, 30
  - expectation, 211
  - exponential, 45
  - F-distribution, 47, 201
  - from Poisson to normal, 146
  - hazard function, 45
  - kurtosis, 30
  - life time, 45
  - log-normal, 42
  - Lorentz, 43
  - moment, 30
  - multinomial, 36
  - normal, 37, 205
  - normalization, 29
  - Poisson, 36, 146
  - properties, 29
  - skewness, 30
  - Student's t-distribution, 47, 213
  - survival function, 212
  - Weibull, 47
- probability function
  - meaning of, 32
- probability paper, 40
- probability scale, 40
- propagation, *see* error propagation
- propagation of errors, 19
- propagation of uncertainties, 20
- Python
  - array methods, 170
  - binomial functions, 173
  - block average, 195
  - bootstrap method, 175
  - chi-squared cdf, 184
  - covariance from B matrix, 187
  - covariance matrix, 187
  - cumulative distributions, 171
  - F-distribution, 193
  - generate contour, 184
  - harmonic fit, 182
  - histogram, 169
  - instructions for use, 169
  - logarithmic plot, 172
  - Monte Carlo, 173
  - nonlinear fit, 183
  - pdf by Fourier transform, 194
  - percentiles, 172
  - physical constants, 170
  - plotsvg, 169
  - program "fit", 189
  - program "report", 176
  - Weibull distributions, 174
- quart, 217
- quartile, 8, 31
- röntgen, 218
- rad, 218
- random errors, 19
- rank-based estimates, 64
- rank-based methods, 63
- regression
  - linear, 87
- regression sum of squares, 48, 106
- rem, 218
- report (Python code), 176
- residuals, 85
- rms, *see* root-mean-squared deviation
- rms deviation, 30
- rms error, *see* rms deviation
- robust estimates, 63
- root-mean-squared deviation, 57
- rounding numbers, 10
- s.d., *see* standard deviation
- second, 215
- separator
  - decimal, 9
- sf, *see* survival function
- SI units
  - basic, 215
  - derived, 216

- siemens, 216
- sievert, 216
- sign-based estimates, 64
- significant deviation, 41
- significant figures, 9
- skewness, 30
  - estimate, 60
- Snedecor, *see* F-distribution
- SSE, *see* error sum of squares
- SSQ, *see* sum of square deviations
- SSR, *see* regression sum of squares
- SST, *see* total sum of squares
- standard deviation, 30
  - accuracy, 60, 157
  - estimate, 58
  - of fitted parameters, 99
- standard error, *see* standard uncertainty
- standard uncertainty, 30
- statistical weights, *see* weights
- stilb, 218
- stokes, 218
- stone, 217
- Student's t-distribution,
  - 47, 60
  - cdf table, 214
  - data sheet, 213
  - equation, 213
  - moments, 213
- sufficient statistics, 116
- sum of square deviations, 161
- survival function, 32
- systematic errors, 18, 138
  - exponential function, 138
- t distribution, *see* Student's t-distribution
- tera, 215
- tesla, 216
- ton, 217
- torr, 218
- total sum of squares, 106
- trace of a matrix, 160
- transpose of a matrix, 160
- truncation error, 58
- two-sided criterion, 64
- typographical conventions, 14
- uncertainties
  - combining, 135
  - propagation, 20
  - random, 19
  - systematic, 22
- units
  - atomic, 219
  - basic SI units, 215
  - data sheet, 215
  - derived SI, 216
  - molar, 14
  - mole, 14
  - molecular, 219
  - non-SI, 13, 217, 218
  - prefixes, 215
  - SI, 13
- variance, 30
  - accuracy, 157
  - estimate, 58, 151
  - estimate with correlation, 152
  - estimate without correlation, 151
  - of the mean, 154
- watt, 216
- weber, 216
- Weibull distribution, 47
  - Python code, 174
- weights
  - average, 158
  - unequal, 61, 158
  - weight factor, 62
  - weighted average, 62
  - weighted inaccuracy, 62
- yard, 217
- yocto, 215
- yotta, 215
- zepto, 215
- zetta, 215