

Index

- $1/\beta^2$ energy loss regime, 426
- V^0 decays, 449
- V^0 particles, 449
- $E[x]$, 42
- $\text{Var}[x]$, 44
- α -point, 41
- χ^2 test, 268
- γ_1 , 46
- γ_2 , 47
- $\langle x \rangle$, 42
- $\text{Kurt}_{\text{old}}[x]$, 47
- $\text{Skew}[x]$, 46
- accelerator tuning, 407
- acceptance, 583
 - correction, 584
- acceptance/rejection method, 650; *see* pseudorandom numbers
- accuracy, 579
- ADC, 465
- addition theorem, 68
- alternative hypothesis, 255
- analog to digital conversion, 465
- analog-to-digital converters (ADC), 460
- anisotropic flow, 558; *see* flow
- anisotropic particle generation (flow), 676
- autocorrelation, 524
- average value, 42; *see* mean
- balance function, 522
- Bayes factor, 366, 368
- Bayes' theorem, 22, 55
- Bayesian inference, 31, 605
- Bayesian inference paradigm, 31
- Bayesian interpretation of probability, 30
- Bayesian network, 605
- Bayesian statistics, 31
- Bayesian unfolding, 605
- bell curve, Gaussian distribution, 118
- Bernoulli distribution, 88
- beta distribution, 115
 - definition, 115
 - properties, 115
- bias, 586
- Bichsel functions, 428
- bimodal distribution, 42
- bimodal functions, 43
- bin-by-bin method, 595
- binomial coefficients, computation, 96
- binomial distribution, 89
 - definition, 89
 - moments, 91
 - properties, 91
- Breit–Wigner distribution, 132
 - definition, 132
 - moments undefined, 133
 - relativistic, 133
- calorimeter
 - compensation, 420
 - homogeneous, 420
 - sampling, 420
- Cauchy distribution, definition, 133
- cause-effect network, 606
- centered moment, 44
- centered moments
 - robust, 156
- central interval, 231
- central limit theorem (CLT), 70
 - derivation, 70
 - generalized, 125
- characteristic function (CF), 66
 - definition, 67
 - moments of a PDF, 67
- Cherenkov radiation, 425
- chi-square distribution, 128
 - combining datasets, 131
 - definition, 128
 - derivation, 130
 - moments, 129
 - properties, 129
- chiral magnetic effect (CME), 568
- classical inference, 29
- classical statistics, 29
- closure test, 632
- collider experiments, 398
- collision diamond, 490
- combinatorial decays, 449
- composite midpoint rule, 645
- conditional PDFs, 56

- conditional probability, 21
- conditional probability density function, 53
- confidence interval, 229
 - ML and LS fitsn, 251
 - binomial, 248
 - central interval, 231, 242
 - confidence belt, 242
 - discrete variable, 237
 - empty intervals, 244
 - flip-flopping, 244
 - Gaussian, 249
 - Gaussian distribution, 230
 - general case, 241
 - likelihood ratio ordering, 245
 - lower limit, 243
 - minimal interval, 232
 - Neyman construction, 241
 - one-sided, 243
 - ordering principle, 245
 - Poisson, 245
 - unified approach, 245
 - unphysical values, 244
 - upper limit, 243
- confidence level, 229
- confidence region, 234
- conformal mapping method, 473
- conjugate distributions, 115
- conjugate priors, 314
- continuous random variable, 36
- contravariant vector, 392
- correction coefficient method, 595; *see* bin-by-bin method
- correlation coefficient, 65
 - intepretation, 65
- correlation functions, motivation, 503
- covariance, 61
 - calculation, 61
 - correlation coefficient, 65
 - definition, 61
 - estimator, 156
 - interpretation, 61
 - matrix, 64
- coverage, property, 229
- credible range, 49
- cumulants, 81
 - definition, 82, 505
 - joint, 84
 - scaling, 508
- cumulative density function (CDF), 38
- cumulative distribution function (CDF), 38
- Dalitz plot, 446
- data analysis workflow, 461
- data probability model, 88, 287
- decay topology, 440
- decay topology technique, 440
- deciles, 49
- degrees of freedom, 128
- design luminosity, 407
- detection, efficiency, 143
- detection acceptance, 583; *see* acceptance
- detection bias, 586; *see* bias
- detection efficiency, 584; *see* efficiency
- detector alignment, 473
- differential flow, 566
- Dirichlet distribution
 - definition, 117
 - properties, 118
- discrete random variable, 36
- displaced vertex, 440
- displaced vertex technique, 440
- distribution properties
 - bimodal, 42
 - deciles, 49
 - expectation value $E[x]$, 42
 - full width at half maximum (FWHM), 49
 - median, 41
 - mode, 42
 - multimodal, 42
 - percentiles, 49
 - population mean, 42
 - unimodal, 42
- efficiency, 584
- EGS, 685
- embedding
 - track, 631
- Erlang distribution, 114
- error function, definition, 120
- estimator, 140
 - asymptotically unbiased, 150
 - biased, 149
 - consistent, 147
 - covariance, 156
 - definition, 145
 - information, 175
 - mean square error (MSE), 150
 - minimal variance bound (MVB), 152
 - Pearson correlation coefficients, 156
 - unbiased, 149
 - variance, 154, 184
- event builders, 460
- event plane
 - calculation, 562
- event plane method, 562; *see* standard event plane (EP) method
- event plane resolution, 564
- event reconstruction, 460
- event triggering, 637
- excess kurtosis, 47
- exchangeable distributions, 98

- expectation value $E[x]$, 42
- exponential distribution, 110
 - definition, 110
 - moments, 112
 - properties, 111
- extended sum rule, 52
- extrapolation, 206
- F* distribution, 131
- factorial moments, 506
- factorization method, 655; *see* pseudorandom numbers
- falsifiability, 4
- fast simulators, 678
- first moment, 42
- Fisher information, 167
 - definition, 167
 - derivation, 167
 - matrix, 169
 - properties, 170
 - reparametrization, 170
- Fisher–Snedecor distribution, 131
- fixed target experiments, 398
- flat rapidity distribution
 - simulation, 666
- flow
 - triangular flow, 560
 - directed flow, 560
 - elliptic flow, 560
 - fluctuations, 561
 - pairwise correlation method, 565
 - quadrangular flow, 560
 - two-particle cumulant method, 566
- FLUKA, 685
- forward–backward correlations, 542
- four momentum vector, 392
- Fourier transform, 66
- frequentist inference paradigm, 29
- frequentist interpretation of probability, 29
- frequentist statistics, 29
- full width at half maximum (FWHM), 49
- functions of random variables, 39
- gamma distribution, 113
 - definition, 113
 - moments, 115
- Gaussian distribution, 118; *see* normal distribution
 - moments, 119
- Gaussian generator, 656; *see* pseudorandom numbers
- Gaussian test, 265
- GEANT, 685
- generalized entropy, 302
- global likelihood, 369
- goal function, 178; *see* objective function
- goodness-of-fit, 140
- goodness-of-fit test, 268
- hierarchical boundary method, 655; *see* pseudorandom numbers
- histogram, 159
 - 1D, 160
 - 2D, 164
 - concept, 159
 - definition, 159
 - errors, 163
 - multidimensional, 164
 - profile, 166
- histograms compatibility test, 272
- hit, definition, 412
- Hough transform method, 473
- hypergeometric distribution, 99
- hypothesis testing, 253
 - alternative hypothesis, 255
 - definition, 254
 - discriminating power, 255
 - null hypothesis, 254
 - significance level, 255
 - test properties, 257
- ill conditioned, 198
- information entropy, 300
- informative priors, 291; *see* priors
- instrumental correlations, 622
- integrated histogram method, 653; *see* pseudorandom numbers
- interquartile range, 49
- interval estimation, 229
- inversion method, 648; *see* pseudorandom numbers
- isotropic exponential distribution, 664
- joint probability density function, 50
- Kalman filter, 209
 - algorithm, 213
 - control, 210
 - extended, 218
 - features, 210
 - gain matrix, 216
 - gain matrix derivation, 220
 - optimal estimation, 210
 - origin, 209
 - smoother, 210, 218
 - state vector, 213
- kinetic theory, 135
- Kolmogorov–Smirnov test, 273
- Kullback entropy, 302
- kurtosis, 47
 - leptokurtic, 48
 - mesokurtic, 48
 - mesokurtotic, 48
 - platykurtic, 48
- Landau distribution, 427
- Laplace transform, 66

- law of total probability, 23, 146
 - with PDFs, 56
- least squares method (LS), 190
 - binned data, 203
 - correlated data points, 198
 - derivation, 191
 - errors, 201
 - estimators, 193
 - generalized linear models, 199
 - goodness-of-fit, 205
 - Hessian matrix, 352
 - Levenberg–Marquardt, 353
 - modified least squares (MLS), 204
 - numerical methods, 205
 - polynomial, 196
 - recursive, 210
 - steepest descent, 353
- likelihood, 31
 - function, 149
 - global, 146
- linear regression, 193; *see* straight line fit
- log normal distribution, 124
 - definition, 124
 - generalized CLT, 125
 - moments, 124, 126
- Lorentz transformation, 393
- Mandelstam variables, 397
- marginal PDF, 52
- marginal probability density function, 51
- marginalization, 51, 52
- maximum likelihood method (ML), 179
 - binned data, 187
 - extended, 188
- Maxwell speed distribution, 134; *see* Maxwell–Boltzmann distribution
- Maxwell–Boltzmann distribution, 134
 - definition, 134
 - derivation, 135
 - properties, 134
 - simulation, 667
- mean
 - arithmetic, 152
 - estimator, 153
 - geometric, 158
 - harmonic, 158
 - sample, 153
- mean square error (MSE), 150, 153, 586
 - mean, 153
 - variance, 155
- mean value theorem, 645
- measurement noise, 12, 214, 578
- measurement precision, 585; *see* resolution
- measurement resolution, 585; *see* resolution
- median, 41
- merit function, 178; *see* objective function
- method 1, 529
- method 2, 529
- minimum ionizing particle (MIP), 426
- mode of a distribution, 42
- moment, 44
 - $\text{Var}[x]$, 44
 - $\text{Kurt}_{\text{old}}[x]$, 47
 - $\text{Skew}[x]$, 46
 - calculation w/ characteristic function, 67
 - centered, 44
 - first, 42, 60
 - fourth, 47
 - generating function (MGF), 66
 - kurtosis, 47
 - multivariate, 60
 - second, 44, 60
 - skewness, 46
 - standardized, 45
 - third, 46
- moment about the mean, 44; *see* centered moment
- moment generating function (MGF)
 - definition, 67
- moments
 - robust, 156
- Monte Carlo integration, 644
 - rule, 645
- most powerful test, 261
- MSE, 586; *see* mean square error (MSE)
- multimodal distribution, 42
- multimodal functions, 43
- multinomial distribution, 96
 - definition, 96
 - moments, 98
 - properties, 98
- multivariate function, 57
 - moment, 60
- multivariate probability density, 57
- negative binomial distribution
 - definition, 95
 - formula, 96
- Neyman–Pearson test, 276
 - formulation, 277
 - sample mean comparison, 278
- noninformative priors, 291; *see* priors
- nonflow effects, 561
- normal distribution, 118
 - central limit theorem, 122
 - definition, 118
 - moments, 119
 - multidimensional, 122
 - probability of one, two, ..., sigmas, 122
- normalized deviate, 205
- normalized correlation functions, 511
- normalized factorial moments, 511
- normalized inclusive densities, 511
- normalized scientific notation, 580
- null hypothesis, 254

objective function, 178	priors odds ratio, 366
Occam factor, 369	probability
Occam's razor, 269, 367, 369, 378	axioms, 20
offline analysis, 460	foundation, 19
online analysis, 460	properties, 21
orthogonal functions, 199	probability density, 37
orthogonal polynomials, 198	probability density function (PDF),
orthogonal transformation, 77	37
oversampling, 630	conditional, 53
	joint, 50
parent particle, 440	marginal, 51
parent population, 141	posterior, 146
participant nucleons, 402	prior, 146
particle density	probability distribution closure, 315
semi-inclusive, 514	probability distribution function (PDF),
particle discovery, 455	36
particle identification (PID), 425	multivariate, 57
Armenteros–Podolansky plot, 452	probability sample, 142
calorimetry, 440	process noise, 12, 214, 579
Dalitz plot, 445	pseudorandom numbers, 646
specific energy loss technique, 425	acceptance/rejection method, 650
three-body decays, 445	definition, 646
time of flight (TOF), 430	factorization method, 655
V ⁰ topological reconstruction, 447	Gaussian generator, 656
Pearson correlation coefficient, 65	hierarchical boundary method, 655
estimator, 156	integrated histogram method, 653
percentiles, 49	inversion method, 648
physics analysis, 460	transformation method, 648
Poisson distribution, 99	uniform deviate method, 647
definition, 99	weighing method generator, 660
large λ limit, 105	pseudorapidity, 395
large N limit of binomial distribution,	
104	quality criteria, 408
moments, 101	quality cuts, 408
properties, 101	quantile of order α , 41; <i>see</i> α -point
Poisson fluctuations, 103	
Poisson noise, 103; <i>see</i> Poisson	radial flow, 558
fluctuations	random variable, 21
population mean, 42	continuous, 36
position calibration, 471	discrete, 36
posterior, 286	random walk, 78
calculation, 293	Rao–Cramer–Frechet inequality (RCF),
summaries, 293	186
posterior marginalization, 368	rapidity, 394
posterior predictive distribution,	rapidity gap, 542
297	reduced cumulants, 511; <i>see</i> normalized correlation
power function, 260	functions
power law distribution, 664	reduced densities, 511; <i>see</i> normalized inclusive
precision, 579, 585	densities
precision parameter, 318	reduced factorial moments
primary vertex reconstruction, 490	normalized factorial moments, 511
prior, 286	regularization function, 598
prior probability, 31	resolution, 585
priors	robustness function ξ , 623
informative, 291	robustness measure ξ , 626
noninformative, 291	run test, 272

- sagitta
 - definition, 414
- sample
 - biased, 142
 - probability sample, 142
 - random, 142
 - unbiased, 142
- sampling, 143
 - efficiency, 143
- scalar product method, 566
- score, 168
- semi-inclusive cumulants, 514
- Shannon's entropy
 - information entropy, 300
- Shannon–Jaynes entropy, 302
- significance level, 255
- skewness, 46
 - left-skewed, 46
 - right-skewed, 46
- slow control data, 460
- Snedecor's F distribution, 131
- sparsification, 460
- specific energy loss, 425
- spectator nucleons, 402
- spherical coordinates, 396
- split tracks, 417
- standard deviation (σ), 44
- standard event plane (EP) method, 562
- standard normal distribution, 38
 - definition, 120
- standard uniform distribution, 107
- standardized moment, 45
- statistic
 - function, 145
- statistical estimator bias, 580
- statistical independence, 21, 56
- statistical test
 - χ^2 , 268
 - bias, 262
 - binomial, 263
 - consistency, 261
 - discovery, 264
 - Gaussian, 265
 - goodness-of-fit, 268
 - histograms compatibility, 272
 - Kolmogorov–Smirnov, 273
 - most powerful test, 261
 - Neyman–Pearson, 276
 - Neyman–Pearson formulation, 277
 - optimization, 276
 - Poisson, 264
 - power, 258
 - run test, 272
 - Student's t , 266
 - uniformly most powerful test, 261
 - steepest descent method, 352
 - Stirling factorial formula, 96
 - straight line fit, 193
 - errors, 195
 - formula, 195
 - Student's t test, 266
 - Student's t -distribution, 126
 - definition, 126
 - derivation, 280
 - moments, 127
 - properties, 127
 - subjective probability, 29
 - summaries of posterior, 293; *see* posteriors
 - TDC
 - calibration, 469
 - ternary plot, 446
 - test bias, 262
 - test power, 258
 - time to digital converter
 - calibration, 469
 - time-based correlation functions, 524
 - track
 - definition, 412
 - track finding
 - road finders, 475
 - track template, 475
 - track following, 475
 - track merging, 621
 - track reconstruction, 472
 - effect of detector materials, 480
 - error propagation, 480
 - hit outlier removal, 488
 - hybrid methods, 489
 - measurement model, 480
 - track model, 479
 - track parameterization, 477
 - track splitting, 621
 - track template method, 473
 - transformation method, 648; *see* pseudorandom numbers
 - transition radiation, 425
 - transverse momentum, 392
 - trigger
 - minimal bias, 142
 - uniform deviate method, 647; *see* pseudorandom numbers
 - uniform distribution, 106
 - definition, 106
 - moments, 107
 - properties, 107
 - random number generation, 108
 - uniformly most powerful test, 261
 - unimodal distribution, 42

variance	histogramming finder method, 492
calculation, 45	linear vertex finding, 493
definition, 44	mapping finder method, 492
estimator, 154	topological vertex finders, 495
mean square error (MSE),	vertex finding, 491
155	vertex fitting, 495
vertex	
definition, 412	weighing method generator, 660; <i>see</i> pseudorandom
vertex reconstruction	numbers
Billoir vertex fitting, 495	weighing techniques, 626
cluster finding methods, 491	weighted averages ($\mathbb{W}\mathbb{A}$), 207
divisive clusterizer, 493	world average, 208