INDEX

absorbing state, 21
acceptance probability, 57, 169
acceptance-rejection method, 55, 61, 66
affine transformation, 14
alias method, 54
announcing schedule, 189
antibiotic
  estimator, 122
  random variables, 120
aperiodic state, 21
arrival rate, 17
associated stochastic process, 249
asymptotic optimality, 28
asymptotic variance, 104
Barker's algorithm, 198
batch means method, 105, 106, 122
Bayes' rule, 2, 181
Bayesian statistics, 181, 196
Bernoulli
  approximation, 18, 43
  conditional distribution, 316
  disruption problem, 324
  distribution, 5, 63
  process, 8, 18
  sequence, 8, 18
beta distribution, 5, 77
  generation, 62, 75
bias, 114
binomial distribution, 3, 5, 8, 16, 64
generation, 63
  normal approximation to, 16, 64
  Poisson approximation to, 18
birth and death process, 25, 103
Boltzmann distribution, 179
bootstrap method, 113
bottleneck element, 151
bounded relative error, 28
Box–Müller method, 59
bridge network, 98, 115, 121
buffer allocation problem, 269
Burg cross-entropy distance, 32
burn-in period, 194
Cauchy distribution, 77
CE method, 249
central limit theorem, 15, 100
  for random vectors, 16
choice of measure, 132
choice of variable, 149
choice point, 182
Chebyshev inequality, 7
Cholesky decomposition, 15, 39, 67, 315
coin flip experiment, 1, 3, 8, 41, 181, 250, 252
cointegrated random variables, 120
complement, 1
complexity theory, 28
composition method, 54, 77
counter simulation, 81
concave function, 35, 37
conditional
  expectation, 8
  Monte Carlo, 119, 125
  pdf, 8
  probability, 2

confidence interval, 27, 100, 104, 115, 219, 243
  Bayesian, 182
CONTRAF model, 158
continuous optimization, 268
control variable, 123
convex
  function, 35
  program, 37
  set, 35

convolution, 127
cooling scheme, 192
correlation coefficient, 9, 42
  multiple, 124
  coupling from the past, 193
covariance, 9
  function, 104, 172, 194
  matrix, 10, 11, 14, 42, 124
  properties, 9
Cramér-Rao inequality, 34
cross-entropy (CE), 31, 136
  algorithm
    estimation, 238, 239
    optimization, 251, 253
  method, 136, 235
crude Monte Carlo (CMC), 27, 28, 120, 132
cumulant function, 318
cumulative distribution function (cdf), 4
cut vector, 128
cycle
  regenerative, 107
data augmentation, 180
degeneracy
  of likelihood ratio estimator, 133, 249
degree, 265
delta method, 233
detailed balance equations, 23, 168
dimension matching, 187
Dirac measure, 249
direct estimator, 213, 222
discrete uniform distribution, 5, 75
discrete-event dynamic system (DEDS), 84
discrete-event simulation (DES), 81, 87, 201
discrete-event static system (DESS), 84
disjoint events, 1
disruption problem, 324
distinct representatives, 311
distribution
  Bernoulli, 5, 63, 316
  bin, 5, 62, 75, 77
  binomial, 3, 5, 8, 16, 63, 64
  Boltzmann, 179
  Cauchy, 77
  continuous, 4
  discrete, 4, 53
  discrete uniform, 5, 75
  empirical, 114
  Erlang, 61
  exponential, 5, 14, 42, 58, 64
  exponential family, 317
  extreme value, 76
  gamma, 5, 14, 42, 60, 62, 77
  geometric, 5, 64
  Laplace, 76
  location-scale, 76
  normal, 5, 14, 42, 59, 67
  Pareto, 5, 76
  Poisson, 5, 17, 64
  shifted exponential, 133
  uniform, 5, 51, 68
  Weibull, 5, 75
distributional parameters, 202
divergence measures, 32
dominating density, 131
duality, 34, 37
  gap, 37
  strong, 38
  weak, 37
dynamic simulation, 84, 97, 101
efficient score, 33
elite samples, 239
empirical distribution, 114
entropy, 29
  conditional, 30
  cross-, 33
  differential, 29
  joint, 29
  maximum, 36
  minimum, 39
  relative, 31
  Shannon, 29
event, 1
  elementary, 2
  list, 85
  simulation, 85, 87
time, 85
expectation, 6
  properties, 9
  vector, 10, 11, 14
exponential
distribution, 5, 14, 42, 64
generation, 58
  truncated, 77
family, 33, 138, 163, 317
twist, 311, 319
exponential-time estimator, 23
extended Kalman filter, 324
extreme value distribution, 76
feasible region, 35
finite support distribution, 139
Fisher information, 33
function  
$C^1$, 34  
$C^2$, 34

**gamma**  
distribution, 5, 14, 42, 62, 77  
generation, 60  
function, 5  
Gaussian distribution, 59  
generalized Markov sampler, 184, 198  
geometric distribution, 5  
generation, 69  
GI/G/1 queue, 106, 108, 112, 123, 124, 227  
Gibbs sampler, 167, 175–177, 189, 198  
global balance equations, 23, 26  
global minimizer, 55  
gradiant, 34, 45, 135  
gradiant descent, 212  
gradiant estimation, 213  

Hammersley points, 263  
flamensley-Cliford, 194  
Hastings' algorithm, 198  
heavy-tai distribution, 244  
Hessian matrix, 34, 35  
hidden Markov model (HMM), 144, 323  
hide-and-seek, 192  
hit-and-run, 174, 175, 192  
hit-or-miss method, 164  

importance sampling, 119, 131, 136, 206, 235  
density, 131  
optimal, 132  
dynamic, 141  
estimator, 132  
dequential, 141  

inclusion-exclusion principle, 311  

independence, 3  
of events, 3  
of random variables, 8, 9  
independence sampler, 169  

independent and identically distributed (iid), 9  
index set, 7  
initial distribution, 19, 20  
instrumental density, 131, 168  
intersection, 1  
inventory model, 108, 113  
inverse-transform estimator, 213, 223  
inverse-transform method, 51, 58, 65, 75, 76, 120, 148  
irreducible Markov chain, 21  
ising model, 178  

Jacobi matrix, 13  
Jensen's inequality, 31  
joint  
cdf, 7  
distribution, 7, 11  
pdf, 7  

Kalman filter, 324  
Karush-Kuhn-Tucker (KKT) conditions, 37, 38  
Kolmogorov's criterion, 24, 26  
Kullback-Leibler distance, 31  
Kullback-Leibler distance, 136  

Lagrangian  
dual function, 37  
dual program, 37  
function, 36  
method, 36  
multiplier, 36, 130  

Laplace  
distribution, 76  
transform, 73  

large deviations rate function, 329  

law of large numbers, 15, 160  

law of total probability, 7  
likelihood, 32, 239  
Bayesian, 181  
likelihood ratio, 132, 206, 236  
estimator, 132, 236  

limiting distribution, 21, 109  
of Markov chain, 21  
of Markov jump process, 26  

Lindley equation, 117, 123, 124  
linear congruential generator, 59  
linear program, 35, 38  
linear transformation, 11  
nlocal balance equations, 23, 26, 73, 108, 197  
local minimizer, 34  
location-scale family, 76  
logarithmic efficiency, 28  

M/M/1 queue, 45  
M/M/1 queue, 25, 101, 103, 106, 116  

majorizing function, 55  
marginal pdf, 7  

Markov chain, 19, 44, 107, 112, 229  
classification of states, 20  
generation, 72  
limiting behavior, 21  
Markov chain Monte Carlo (MCMC), 167, 184  
Markov inequality, 7  
Markov jump process, 19, 24, 127  
generation, 73  
limiting behavior, 25  
Markov process, 18, 44, 72  
Markov property, 18, 24  

Matlab, 31  
max-cut problem, 253  
with r partitions, 258  
maximum entropy, 36  
maximum likelihood estimate, 32  
estimator, 32, 239  
mean square error, 114  

joint normal distribution, 14, 42
memoryless property, 42
Metropolis-Hastings algorithm, 167–169, 189, 198
minimal cut set, 128
minimal path set, 162
minimization vs. maximization, 251
minimum CE (MinxEnt), 39, 297
mixture pdf, 77
mode, 182
model, 82
moment generating function, 318
Monte Carlo simulation, 82
multiplicative congruential generator, 50
multivariate normal distribution, 14
generation, 67
mutual information, 31
natural exponential family, 318
neighborhood structure, 170
Neymann χ² goodness-of-fit measure, 32
node placement, 266
nominal parameter, 134, 140, 243
normal distribution, 5, 14, 67
generation, 59
objective function, 35
one-step-look-ahead, 286
optimization, 34
CE method for, 249
combinatorial, 249
constrained, 35
continuous, 249
convex, 34
order statistics, 11, 52
parallel computing, 84
parametric MinxEnt (PME), 301
Pareto distribution, 5, 76
partition, 2
partition problem, 259
Pearson χ² discrepancy measure, 32, 163
perfect sampling, 192
performance function, 98
long-run average, 112
steady-state, 112
permanent, 311
permutation counting, 312
generation, 74
permutation flow shop problem, 273
permutation Monte Carlo, 127
phi-divergence, 32
Poisson
disruption problem, 182
distribution, 5, 17
generation, 64
process, 16, 18, 43
generation, 70
nonhomogeneous, 71
zero inflated model, 197
polynomial-time estimator, 28
positive definite matrix, 34
positive semidefinite matrix, 10, 35, 42
posterior pdf, 181
Potts model, 178, 179
predictive pdf, 197
prior pdf, 181
improper, 196
probability, 2
probability collective, 275
probability density, 4
function (pdf), 4
probability generating function, 13
probability mass function (pmf), 4
product rule, 2, 19, 41, 66
program evaluation and review technique (PERT), 99, 115
proposal density, 55, 131, 168
pseudorandom number, 50
push-out estimator, 213, 214, 223
quadratic program, 35
quantile, 100
queens problem, 191
queueing network, 87, 125, 177, 195
rand (matlab), 51
random
experiment, 1
number generation, 49
permutation, 74
sample, 98, 131
weighted, 132
sum, 126
tour, 75
variable, 3
functions of, 10
vector, 7, 11
generation, 65
walk, 19, 22, 44, 72, 143
on an n-cube, 73
random walk sampler, 170, 171
randomized algorithm, 289
Rao-Blackwellization, 125
rare event, 27, 236
probability, 136
rarity parameter, 239, 253
ratio estimator, 110, 132
recurrent state, 21
reference parameter, 134, 137
regenerative simulation, 107, 225
relative error, 27, 28, 101
relative time variance, 122
reliability, 98, 115
variance reduction, 126
renewal process, 70
repairman problem, 91
replication-deletion method, 107
resampling, 114
response surface, 206
retrospective test, 82
reversibility, 23
reversible jump sampler, 186
root finding, 245
Rosenbrock function, 273

event
mean, 98
space, 1
variance, 100, 114
sample average approximation, 212
sampling
uniform, 170, 289
score function (SP), 33, 135
k-th order, 204
method, 203
screening method, 151
for rare events, 245
seed, 50
sensitivity analysis, 201, 203, 225
sequential importance sampling (SIS), 141
Shannon entropy, 36
SIMULA, 90
simulated annealing, 189, 191
simulation, 81, 83
classification, 84
clock, 85
discrete-event, 201
dynamic, 101, 201
event-oriented, 88, 89, 91
finite horizon, 101
models, 82
process-oriented, 88, 93
rate-event, 236
regenerative, 111
static, 98, 201
steady-state, 101, 103, 105, 110
simulation-based optimization, 211
slice sampler, 185
smoothed updating, 251
squared coefficient of variation, 27, 28
standard deviation, 6
standard likelihood ratio (SLR), 136
standard normal distribution, 14
standardization, 14
state space, 7
static simulation, 84, 97, 98
stationary distribution, 103
of Markov chain, 23
of Markov jump process, 26
stationary stochastic process, 23, 103
steady-state, 101
stochastic approximation, 212
stochastic counterpart method, 215
optimization, 212
stochastic process, 7, 97
regenerative, 107
stationary, 23
stochastic shortest path, 123, 124, 140, 218, 236, 243
stopping criterion, 256, 270
for CR, 252
stratified sampling, 120
structural parameters, 202
structure function, 98
sum rule, 2
Swendsen-Wang algorithm, 180
system, 82
state, 97
systematic sampling, 131
total queue, 87
target pdf, 55
tilting vector, 134
time-homogeneous
Markov chain, 19
Markov jump process, 24
trajectory generation
random walks, 255
random partitions, 260
TSP, 266
transform
Laplace, 13
moment generating function, 318
transform likelihood ratio (TLR), 148, 150, 244
transformation rule, 13
transient state, 21
transition
graph, 19
matrix, 19
k-step, 20
probability, 19
rate, 24
rate graph, 25
traveling salesman problem (TSP), 189, 198, 260
trust region, 211
twisting parameter, 319
two-opt, 190
unbiased estimator, 26
uniform
distribution, 5, 51
over hypersphere, 69
over simplex, 68
sampling, 170, 289
union, 1
uniqueness property
of transforms, 13
variance, 6, 42
asymptotic, 104
properties, 9
reduction, 119
variance minimization (VM), 132, 253
waiting time, 117, 123, 124, 227
weak duality, 37
Weibull distribution, 5, 75
weighted sample, 132
estimator, 132