

Index

- Ackoff, R., 6, 26
 Acme Manufacturing, 320–322
 spreadsheet model, 321
 activity, 371–375
 adding a new activity, 229–232
 definition, 229
 pricing out, 230–231
 aggregate production planning problems, *see*
 production planning problems
 algorithms, 10
 analog models, 6
 AnimalP, 213, 245–247, 294, 305
 annuity, 119
 Answer Report (Solver), 51
 antiderivative, 393
 Arnold, L., 356n
 array of constraint coefficients, 43
 auditing problem
 model formulation, 124–125
 problem statement, 124
 spreadsheet model (alternate form), 126
 spreadsheet model (standard form), 126
- backlogged demand, 175
 Banks, J., 672n
 Bayes' Rule, 385–388, 475, 524
 example, 387–388
 formula, 386
 Bell, D., 525n
 Belles and Baubles Trinket Company, 306–310
 determining the trinket demand function,
 308–309
 impact of marginal production cost, 309–310
 Bernoulli random variable, 394
 definition, 389
 value generation, 626
 BGT Candy Company, 70–77
 Answer Report, 234
 model, 74
 model formulation, 71–73
 optimal solution, 74–77
 problem statement, 70–71
 sensitivity analysis, 234–240
 Sensitivity Report, 235
 spreadsheet model, 75
 bidding for salvage rights, *see SS Kuniang case*
 Bierman, H., 525n
 bin values, *see* histogram
 binary variables, 314, 318–322
 contingent decision variables, 319–320
 either/or constraints, 320–321
 mutually exclusive decision variables, 318–319
 using in Solver, 316
 binding constraint, 202
 binomial random variable, 389–390, 394, 596,
 606–607
 definition, 389
 Bistro 220, 594–599
 CRYSTAL BALL model, 606–613
 distribution of daily net contribution, 614
 evaluation of the summary, 603
 generating daily total net contribution, 596
 replicating the experiment, 597–599
 spreadsheet model, 596
 summarizing the values of the replications,
 603
 Blair, C., 168n, 525n
 blending problems, 3, 95
 bond portfolios, 344
 model, 349
 spreadsheet model, 348
 Bonini, C., 525n
 Book Browser decision problem, 451–453
 decision tree, 453
 payoff table, 452
 Botkin, D., 356n
 boundary of a constraint, 202
 break-even analysis, 20
 Budnik, F., 168
 Bunch O'Munchies, 180–189
 general model, 189
 general problem, 188–192
 general spreadsheet model, 192
 single-site model, 183
 single-site purchasing problem, 182–185
 single-site spreadsheet model, 184
 two-site model, 192
 two-site problem, 185–187
 two-site spreadsheet model, 192
 bundle pricing problem, 322–328
 bundles of constraints, 38, 49
- Camm, J., 356n
 capital budgeting problems, 3, 95, 113–124
 examples
 Global Investment Company, 114–115
 optimization criteria
 discounted sum of cash flows, 120
 terminal net worth, 116
 Captain Wise's packing problem
 formulation, 107–109
 generalization, *see* Belles and Baubles
 Trinket Company
 model, 108

- Captain Wise's packing problem (*cont.*)
 optimal solution, 110
 problem statement, 106–107
 Sensitivity Report, 308
 spreadsheet model, 110, 307
- cardinal versus ordinal values, 436
- Carson, J., 672n
- Cauchy's functional equation, 590n
- cdf (cumulative distribution function), 377, 393
 inverse, 632
- CE (certainty equivalent), 434–435
- Central Limit Theorem, 405
- certainty equivalent (CE), 434–435
 in terms of risk premium, 438
- chi-squared random variable, 633
- column-oriented data table, *see* EXCEL Data Table
- common distributions, 396–404
 table, 406
- conditional expected value, 385
 definition, 385
- conditional probability, 365–367
 definition, 366
- constraint coefficient array, 43
- consumer surplus, 323
- contingency plan, 466
- continuous random variable, 376, 393
- convex function, 450n
- Crabill, T., 592n
- CRYSTAL BALL
 assumption cells, 606–608
 define, 606–608
 built-in function
 CB.Beta, 635
 CB.Binomial, 635
 CB.Custom, 635
 CB.CustomCumul, 635
 CB.Exponential, 635
 CB.ExtremeValue, 635
 CB.ExtremeValue2, 635
 CB.Gamma, 635
 CB.Geometric, 635
 CB.Hypergeometric, 635
 CB.Logistic, 635
 CB.Lognormal, 635
 CB.Lognormal2, 635
 CB.NegBinomial, 635
 CB.Normal, 635
 CB.Pareto, 635
 CB.Poisson, 635
 CB.Triangular, 635
 CB.Uniform, 635
 CB.Weibull, 635
- choosing preferences, 609–610
- decision cells, 607, 609
 define, 609
- forecast cells, 607, 609
 define, 609
- forecast statistics, 614
- gallery of distributions, 609
- installing, 606
- OptQuest module, 610–613
- CTR Company
- Answer Report, 65
 model, 60
 model formulation, 57–60
 problem statement, 56–57
 profit spreadsheet model, 66
 Sensitivity Report, 245
 spreadsheet model, 61
 spreadsheet model formulation, 60–62
- cumulative distribution function (cdf), 377, 393
 inverse,
 curse of dimensionality, 790
- cutting stock problems, 5, 157
 Wisconsin Paper Company, 166
- decision calculus, 7
- decision criteria, 423–426
- decision maker (DM), 421
- decision making under uncertainty, 420
 non-probabilistic methods, 422–428
 probabilistic methods, 428–432
- decision models, 30
 formulation, 30
 general structure, 31
- Decision Models in Practice
 decision tree (bidding for salvage rights), 503–508
 integer linear program (bond portfolios), 344–349
 integer linear program and queues (scheduling police patrols), 574–579
 linear program (disentangling bankruptcies), 135–139
- decision problems
 graphical representation of types, 94
 role of uncertainty, 420
- decision process
 additional elements, 455–456
 elements, 421
- decision theory, 421
- decision tree, 13, 456
 construction guidelines, 459–460
 decision node, 456–457
 evaluating new information, 472–479
 event node, 456
 exponential utility, 489–497
 folding back, 461–465
 optimal strategy, 466, 479–481
 “pay-as-you-go” node valuation, 461–463
 example, 464
 rules, 463
 sensitivity analysis, 487–489, 494–497
 “settle-up-at-termination” node valuation, 463–465
 example, 465
 rules, 465
 terminal node, 456
 TreePlan, *see* TreePlan
 value of a node, 461–462
- decision variables, 31, 35
- definitional variable, 129
- demand function, 23
- designing queueing systems, 555–570
 approximate methods, 559–566

- average rate at which system incurs cost, 558
- choosing number of servers, 558–559
- controlling the rate of service, 556–570
- deterministic model, 560–562
 - applicability, 561–562
 - example, 561
 - formula for total profit rate, 560
- equilibrium model, 565–566
- graph of service and waiting cost, 558
- under the independence assumption, 562–565
 - example, 563–565
 - optimal number of servers with Poisson arrivals, 563, 566
- diminishing marginal returns, 170
- property of optimal value functions, 296
- directed arcs, 102
- directed graph, 456 *See also* Rent-a Hauler, directed graph
- discount factor, single-period, 119
- discounted sum of cash flows, 120
- discrete-event simulation, 623–625
 - designing a simulation experiment, 623–625
 - model components, 624
- discrete random variable, 376
 - common distributions, 389–393
 - table, 394–395
- discrete uniform random variable, 644 *See also* EXCEL, functions, **RANDBETWEEN**
 - value generation, 625–626
- disentanglement problem, 137
- disentangling bankruptcies, 137
- DM (decision maker), 421
- dominated decisions, 423
- Driver's License Examination Center simulation
 - Model worksheet, 637
 - Parameters worksheet, 637
 - problem statement, 622
 - Repetitions worksheet, 638
 - spreadsheet model, 636–644
- dual prices, *see* shadow prices
- duality, 273–288
 - dual linear program, 276
 - primal problem, 273
 - primal–dual pairs, 279–281
 - relation between primal–dual payoffs, 281–282
 - shadow prices and dual variables, 283–284
- dummy demand node, 103
- Dyer, J., 525n
- dynamic models, 96–97

- economic order quantity (EOQ), 660
- economics of decision making, *see* sensitivity analysis
- elements of probability, 359–365
 - events, 360
 - complement, 360
 - intersection, 360
 - mutually exclusive, 360
 - null, 360
 - partition, 361
 - simple, 360
 - union, 360
 - probability functions, 362
 - properties, 362
 - probability measures, *see* probability functions
 - random experiment
 - examples, 360
 - sample space, 359
- Elimam, A., 168n
- empirical random variable, 628–631
 - value generation, 629–631
 - formula, 631
- Engelbrecht-Wiggans, R., 168n, 312n
- EOQ (economic order quantity), 660
- EPPI, *see* expected payoff with perfect information
- Erlang distribution, 407
- Erlang's loss formula, 550
- Essex Oil Company, 497–503
 - computing EVPI, 503
 - decision tree with information, 500
 - initial decision tree, 498
 - revised decision tree with information, 502
- EVPI, *see* expected value of perfect information
- EXCEL
 - AI cell addressing, 674–675
 - add-ins
 - CRYSTAL BALL, *see* CRYSTAL BALL
 - TREEPLAN.XLA, 466
 - See also* TreePlan
 - adding columns, 67
 - adding rows, 68
 - array (matrix) formulas, 678–684
 - bin range, bin values, 696–698
 - cell addressing, 674–675 *See also* EXCEL, AI
 - cell addressing and R1C1 cell addressing
 - cell names, 675–677 *See also* invalid cell names
- Data
 - Table, 20, 597, 601, 689–693
 - Table (Two-Way), 691–693
- Edit
 - Copy-Paste Special-Values, 601, 605
 - Fill, 598
 - Fill-Series, 647, 698
 - Insert-Name-Create, 676
 - Insert-Name-Define, 675–677
 - Insert-Name-Paste-Paste List, 676
- Edit Formula window, 676
- Format
 - Row-Hide, 601, 617
 - Row-Unhide, 617
 - Sheet-Rename, 45
- functions
 - AND, 649, 685–686
 - BETADIST, 633
 - BETAINV, 633
 - BINOMDIST, 390, 391, 394
 - CHIDIST, 633
 - CHIINV, 633
 - COUNTIF, 416, 417, 599, 641, 642
 - CRITBINOM, 394, 596, 633
 - EXPONDIS, 400

EXCEL, functions (*cont.*)

- FDIST, 633
- FINV, 633
- GAMMADIST, 401, 633
- GAMMAINV, 633, 639
- HLOOKUP, 577, 645–647, 693–695
- HYPERGEOMDIST, 395
- IF, 480, 488, 618, 619, 626, 634, 639–641, 649, 686–689, 701
- INT, 619, 620, 626, 645
- LN, 633–638
- LOGINV, 633
- LOGNORMDIST, 633
- MAX, 484, 618, 639, 640
- MDETERM, 680, 700, 701
- MIN, 648
- MINVERSE, 680, 683, 700, 701
- MMULT, 679–681, 683, 684
- MOD, 645–647
- NORMDIST, 402, 403, 406, 417, 633
- NORMINV, 406, 497, 633, 645, 646
- NORMSDIST, 404, 405, 633, 644
- NORMSINV, 633, 644
- NOT, 685, 686
- NPV, 119, 120
- OR, 686
- POISSON, 392, 394, 539, 553, 564
- PV, 17, 18, 119, 168
- RAND, 394, 395, 399, 406, 407, 416, 596, 597, 600, 605, 619, 625, 626, 628–634, 638–640, 645
- RANDBETWEEN, 600, 626
- SQRT, 403, 405, 414, 597, 634, 650
- SUM, 17, 18, 579, 678
- SUMIF, 576, 641
- SUMPRODUCT, 43, 44, 61, 65, 414, 681
- TDIST, 633
- TINV, 633
- TRANSPOSE, 681–684
- VLOOKUP, 564, 618, 630, 631, 693–695
- hiding rows, 601, 696
- invalid cell names, 677
- logical condition, 684
- logical function, 684
- logical operators, 685
- matrix (array) formulas, 678–684
- Name Box window, 675, 676
- nested functions, 678
- R1C1 cell addressing, 675
- recalculation control, 605–606
- renaming a worksheet, 45
- replacing formulas with values, 602–603
- Sensitivity Report, *see* sensitivity analysis, Sensitivity Report
- Standard Form Template, 67–68
- Tools
 - CRYSTAL BALL *see* CRYSTAL BALL
 - Data Analysis–Descriptive Statistics, 603
 - Data Analysis–Histogram, 604, 695–700
 - Goal Seek, 20, 21
 - Solver, *see* Solver
 - TreePlan, *see* TreePlan
- two-way data table, 598, 691–693
- workbooks
 - AcmeMan.xls, 321
 - Ale.xls, 336
 - Auditor.xls, 125
 - Belle&Bauble.xls, 308
 - BGTLP.xls, 74
 - Bid(Discrete).xls, 318
 - Bid1.xls, 135
 - Bid2.xls, 135
 - BOM.xls, 181, 185, 189
 - BondModel.xls, 349
 - Bundle.xls, 328
 - CaptWise.xls, 110
 - CostEx.xls, 687
 - Crash.xls, 139
 - CTRLP.xls, 62
 - CTRProfit.xls, 64
 - CutStock.xls, 101
 - DTable.xls, 689
 - EqSolver.xls, 676, 678, 683
 - EssexOil-Info.xls, 499
 - EssexOil.xls, 498
 - Gambler.xls, 179
 - GameMagic-Info.xls, 487
 - GameMagic.xls, 464, 476–477
 - GameMagicRisk.xls, 491–492, 496
 - Global.xls, 117, 121
 - GMEPPI.xls, 484
 - HighMargin.xls, 172
 - Histogram.xls, 696
 - HOE8-1.xls, 416
 - InvBack.xls, 176
 - Inventory.xls, 645
 - Invest.xls, 99
 - Kanondell.xls, 652
 - Kuniang.xls, 508
 - LeaseBuy.xls, 13, 21
 - License.xls, 636
 - LotsaPasta.xls, 198, 215
 - LumpSumInvest(Opt).xls, 620
 - LumpSumInvest.xls, 616
 - MachShop.xls, 315
 - MicroWorks.xls, 45, 53
 - OverBk(Manual).xls, 595, 597
 - Overbooking.xls, 606
 - Patrol.xls, 575
 - Precision.xls, 130
 - Putter.xls, 251
 - Queue.xls, 547–549, 551, 552, 554–557, 575
 - Rent.xls, 104
 - Replicate.xls, 600
 - River.xls, 343
 - Servers.xls, 564
 - Staff.xls, 112
 - StdFormTemplate.xls, 67
 - Triangle.xls, 634
 - Weed.xls, 255
- expected loss decision criterion, *see* expected regret decision criterion
- expected payoff with perfect information (EPPi), 433, 482–483
 - computed in a decision tree, 485
- expected regret decision criterion, 430–431

- equivalent to expected value criterion, 431
- expected utility decision criterion, 437–438
- expected utility of the lottery, 435
- expected value
 - definition (continuous random variable), 396
 - definition (discrete random variable), 378
 - of a function of a random variable, *see* Law of the Unconscious Statistician
 - properties, 378
- expected value decision criterion, 430
 - equivalent to expected regret criterion, 431
- expected value of perfect information (EVPI), 432–434
 - equals minimum expected regret, 434
 - in decision trees, 482
 - in the Essex Oil Company case, 503
- expected value of sample information (EVSI), 481–484
 - definition, 481
- exploitable decision, 244–245
- exponential distribution, *see* exponential random variable
- exponential random variable, 399–400, 406, 536–537, 633
 - cumulative distribution function, 536, 633
 - definition, 399
 - memoryless property, 536–537
 - value generation, 633
- exponential utility function, 389, 440–443 *See also* decision tree, exponential utility
 - certainty equivalent, 441, 490
 - measure of risk aversion, 441, 489
- extreme points, 207

- F* random variable, 633
- Farm Implement Company
 - integer LP model, 316–318
 - integer LP spreadsheet model, 317
 - model formulation, 132–135
 - problem statement, 131–132
 - spreadsheet model with Supplier 1, 134
 - spreadsheet model without Supplier 1, 136
- FIFO (first-in, first-out), *see* queues, queue discipline
- fixed charge, 313
- fixed charge problems, 313–315
 - example, *see* Mercury Machine Shop
- Fundamental Theorem of Calculus, 393

- gambler's problem, 176–179
 - model, 180
 - spreadsheet model, 180
- Game Magic, Inc., 454–466
 - basic decision tree, 465
 - decision tree with expected utility payoffs, 490–494
 - expected utility decision criterion, 490–494
 - modified decision tree, 478
- gamma function, 407, 419n
- gamma random variable, 400, 406, 633
 - definition, 400
- generating values of random variables, 625–635
 - Bernoulli, 626
 - discrete uniform, 625–626
 - empirical, 629–631
 - exponential, 633
 - inverse transform method, *see* inverse transform method
 - triangular, 626–628
 - uniform (*a*, *b*), 625
- geometric random variable, 395
 - definition, 390
- GI/G/s (approximate analysis), 566
- Girgis, M., 168n
- Global Investment Company
 - discounted cash flow model formulation, 120–122
 - discounted cash flow spreadsheet model, 121
 - model formulation, 115–117
 - problem statement, 114–115
 - terminal net worth model, 118
 - terminal net worth spreadsheet model, 118
- Grassman, W., 591n

- half-planes, 202
- Hall, Monty, 663, 673n
- Hausman, W., 525n
- Hess, J., 356n
- heuristic rules, 620
- hiding rows in EXCEL, *see* EXCEL, hiding rows
- High Margins, Inc.
 - model, 173
 - problem statement, 170–172
 - spreadsheet model, 173
- Hillier, F., 322, 356n
- histogram, 603–605, 695–700
 - bin values, 696–698
- HTML files
 - CarsGalore.html, 247
 - Dog.html, 247
 - Lawn.html, 247
 - LotsaPasta.html, 213, 294, 305
 - Simpson.html, 2
 - ZeroSP.html, 223
- hypergeometric random variable, 395

- iconic models, 6
- increasing marginal returns, 440, 450n
- influence diagrams, 11–13, 31
 - arrows, 11
 - directed arcs, 11
 - nodes, 11
 - oval, 11
 - rectangular, 11
 - rounded-corner rectangular, 11
 - optimization problems, 31
 - structure, 12
- integer linear programs
 - definition, 313
 - examples, *see* bond portfolios, Micro Wholesale, Red Triangle Ale Company, river crossing problem, and scheduling police patrol cars
 - Solver to solve, 315–316

- intersection of sets, 204
 inventory, 127
 example, 687–689
 inventory balance equation, 129, 175, 183, 185, 189, 332–333, 649
 inventory models, *see* Bunch O'Munchies, multi-period inventory simulation, Precision Products, and Red Triangle Ale Company
 reasons for holding, 128
 inventory ordering policy
 (s,S) type, 644
 inventory position, 649
 formula, 649
 inverse of the cumulative distribution function, 632
 inverse transform method, 632–634
 iso-cost (iso-profit) lines, 205
 iso-profit (iso-cost) lines, 205
 determining their slope, 209
 issue t bonds, 347
- Java applets, 213
 joint distribution, 381
 joint probability, 363, 381
 table, 370–371
 Jones, C., 213
- Kanondell Bicycle Company simulation, 652–659
 Kendall, D., 530n
 Kolesar, P., 592n
 Kotob, S., 168n
- Law of the Unconscious Statistician, 379
 Law of Total Probability, 367–368
 lease/buy problem
 influence diagram, 12, 19
 sensitivity analysis, 19–23
 spreadsheet model, 13–19
 Lieberman, G., 322, 356n
 likelihood probability, 473
 no information case, 485
 perfect information case, 484
 linear programming. *see* linear programs
 linear programs
 alternate format, 125–126
 classification scheme, *see* linear programs, problem types
 components of optimal plans
 optimal decisions, 207
 SOBC (set of binding constraints), 207
 value of the optimal solution, 207
 constructing spreadsheet models, 41–45
 corner points, 207
 deterministic, 94
 dual, *see* duality
 errors
 no solution, 69
 nonlinearity, 68
 unbounded solution, 69
 feasible region, 201, 204
 formulation, 34–40
 formulation aids, 59–60
 formulation errors, 68–70
 graphical methods, 201–207
 finding an optimal solution, 204–207
 graphical representation, *see* linear programs, graphical methods
 integer versus non-integer solutions, 54–56
 multiple optimal solutions, 210
 objective criterion, 34
 optimal plans, 207
 optimal solution, 206
 primal problem, *see* duality, primal problem
 problem types, 94–97
 transshipment problems, 185
 value of the optimal solution, 51
 variables that are unrestricted in sign, 50
 with nonlinear objective functions, 171
 Lippman, S., 471n
 Little's Law, 533, 545
 Little, J., 7, 26
 Lognormal random variable, 633
 loss, *see* regret
 Lotsa Pasta Company
 Answer Report, 199
 general problem, 291–300
 graph of an optimal value function, 305
 optimal labor hours, 299–300
 optimal profit function, 295
 optimal value function for wheat macaroni profit margin, 305
 graphical solution, 200–207
 model, 199
 model formulation, 198
 optimal plan, 208
 problem statement, 198
 sensitivity analysis, 208–232
 Sensitivity Report, 209, 228, 333
 spreadsheet model, 199
 lottery, 435
 LP (linear program), *see* linear programs
 LP Standard Form, 41
 benefits, 45
 limitations, 45
 lump-sum investment simulation, 613–621
- marginal probability, 605 *See also*
 unconditional probability
 max–min problems, 286
 maximax decision criterion, 424
 maximin decision criterion, 423
 McLeavey, D., 168
 mean (of a random variable), *see* expected value
 mean standard error, 643
 memoryless property of a random variable, 536–537
 equivalence to exponential random variables, 537
 Mercury Machine Shop, 313–315
 model, 314
 spreadsheet model, 316
 Micro Wholesale, 322–328
 model, 326–327
 spreadsheet model (left-half), 329

- spreadsheet model (right-half), 330
- Microworks, Inc.
 - Answer Report, 52
 - model, 40, 42
 - model formulation, 33–41
 - problem statement, 31–34
 - spreadsheet model, 42
- minimax decision criterion, 423
- minimax regret decision criterions, 424
- minimum decision criterion, 424
- model decision criterion, 429
 - shortcomings, 429
- models
 - analog, 6
 - categories, 6
 - construction, 8
 - evaluating and testing solutions, 8
 - iconic, 6
 - implementing the solution, 8
 - overview, 8
 - solution determination, 8
 - stages of development, 8
 - symbolic, 6
- Mojena, R., 168
- Monte Carlo simulation, *see* simulation
- Morahan, T., 525n
- multi-period inventory simulation, 644–652
- multi-server exponential queues, *see* queues, M/M/s
- multiple optimal solutions
 - in linear programs, 210
- net cash flow, 116
- network flow problems, 4, 96
 - example
 - Rent-a-Hauler Company, 102–106
- New York City police patrol case, *see* scheduling police patrol cars
- nonlinear objective function, 171
- non-probabilistic models (in decision making under uncertainty), 422–428
- normal random variable, 401, 406
 - definition, 401
 - properties, 402
- objective function, 31
- opportunity cost, 239 *See also* shadow price
- opportunity loss, 425
- optimal contingency plan, 479–481
- optimal objective function value, *see* linear programs, value of the optimal solution
- optimal plans
 - in linear programs, *see* linear programs, optimal plans
- optimal solution
 - to a linear program, 206
- optimal value functions
 - for objective function coefficients, 300–305
 - example, *see* Belles and Baubles Trinket Company
 - graphical analysis, 301–305
 - properties, 305
 - for RHS values, 291–300
 - definition, 294
 - general properties, 298
 - general shapes, 299
 - graphical analysis, 294–295
 - properties, 295–297
 - Solver, 297
 - utilization, 298–300
- optimality of consuming versus saving, 122–124
 - examples, 123–124
 - sufficient condition, 122
- optimization model, 8
- ordinal versus cardinal values, 436
- overbooking cost, 594
- overbooking problem, *see* Bistro 220
- P–K (Pollaczek–Khintchine) formula, 555
- payoff matrix, 422
- pdf (probability density function), 376, 396
- piecewise linear, 170
 - property of optimal value function, 295–296
- pmf (probability mass function), 376
- Poisson arrivals, *see* queues, Poisson arrivals
- Poisson random variable, 391–392, 394, 538
 - definition, 391
- Pollaczek–Khintchine (P–K) formula, 555
- portfolio selection problems, 97
 - examples
 - Western Trust, 97–99
- post-optimality analysis, *see* sensitivity analysis
- posterior probability, 366, 475–476
- precedence diagram, 13
- Precision Products
 - model formulation, 129–130
 - problem statement, 128
 - Sensitivity Report, 241
 - Sensitivity Report (standard form), 242
 - spreadsheet model, 131
 - spreadsheet model (alternate form), 240
 - spreadsheet model (standard form), 242
 - with backlogging, 174–176
 - model, 176
 - spreadsheet model, 177
- present value, 119 *See also* EXCEL, functions, NPV; PV
- principle of complementary slackness, *see* sensitivity analysis, complementary slackness
- Principle of Irrelevant Alternatives, 426
- prior probability, 366, 474–476
- probabilistic methods (in decision making under uncertainty), 428–432
- probabilistic models, 420
- probability density function (pdf), 376, 396
- probability distribution, 376
 - Bernoulli, 394
 - beta, 633
 - binomial, 390, 391, 394
 - chi-squared, 633
 - discrete uniform, 395
 - empirical, 628
 - Erlang, 407
 - exponential, 399–400, 406, 536–537, 633
 - extreme value, 635
 - F, 633

- probability distribution (*cont.*)
 gamma, 400, 406, 633
 geometric, 390, 395
 hypergeometric, 395
 logistic, 635
 lognormal, 633
 normal, 401, 406
 pareto, 635
 Poisson, 391–392, 394, 538
 standard normal, 404, 405, 633, 646
 Student's t , 633
 table of properties of some discrete random variables, 394–395
 triangular, 406
 uniform (a, b), 396–399, 406
 Weibull, 635
- probability mass function (pmf), 376
- probability tree diagram, 364
 event (chance) nodes, 363
 terminal nodes, 363
- problem formulation, 8
- product mix problems, 3, 95
 examples
 Captian Wise's packing problem, 106
 Lotsa Pasta, 198
- production plan, 60
- production planning problems, 4, 96, 127
 examples
 Precision Products, Inc., 128
 with backlogging, 174
- quantity discounts, 13
- queueing models, *see* queues
- queues
 average number of busy servers, 533
 average rate of the arrival process, 538
 balking, 529
 calling population, 528
 comparison of waiting times in M/M/s queues, 570–574
 controlling the service rate
 examples, 567, 569–570
 descriptive phase of analysis, 528
 design phase, *see* designing queueing systems
 design phase of analysis, 528
 designing queueing systems, *see* designing queueing systems
 deterministic examples, 530–535
 effective arrival rate, 550
 graphic of a typical system, 526
 inter-arrival times, 537
 jockeying, 529
 Kendall notation, 530
 Little's Law, *see* Little's Law
 M/G/1, 554–557
 example, 555–557
 worksheet in Queue.xls, 555–557
 M/G/∞, 552–553
 example, 553
 worksheet in Queue.xls, 552
 M/G/s/s, 550
 example, 551–552
 worksheet in Queue.xls, 551
- M/M/1, 535–546
 balance equations, 542
 computing operating characteristics, 539–541, 544–546
 computing steady-state probabilities, 541–543
 example, 543–544
 operating characteristics, 544–546
 probability that the system is empty, 543
 steady-state probabilities, 543
 transition diagram, 541
- M/M/s, 546–549
 choosing number of servers, 558–559
 example, 548
 operating characteristics, 547
 probability that the system is empty, 547
 worksheet in Queue.xls, 547, 548
- M/M/s (finite source), 553–554
 example, 553–554
 worksheet in Queue.xls, 554
- M/M/s/K, 549, 552
 example, 550
 worksheet in Queue.xls, 549
- model components, 528–535
 operating characteristics, 535
- Poisson arrivals, 537–538
 equivalent to exponential interarrival times, 539
- queue discipline, 529
 reneging, 529
 steady state, 531
 steady state versus transient analysis, 535
- random experiment
 definition, 359
- random number generator, *see* generating values of random variables
- random variable
 continuous, 376, 393
 definition, 393
 discrete, 376
 marginal distribution, 382
- Raturi, A., 356n
- recalculation control in EXCEL, 605–606
- Red Triangle Ale Company, 328–339
 constraints, 332–337
 objective function, 335–336
 optimal solution, 340
 spreadsheet model (left half), 338
 spreadsheet model (right half), 339
- reduced cost, 226–232
 as a shadow price, 231–232
 comparing marginal revenue to marginal cost, 230–231
 definition, 228
 interpretations, 228
- redundant constraints, 109–110
- regret, 425
- regret matrix, 525
- Rent-a-Hauler Company, 102–106
 data, 103
 directed graph, 103
 model, 105

- spreadsheet model, 105
- replacing formulas with values in EXCEL, 602, 603
- reservation value, 322
- return on investment (ROI), 654
- revised probability, *see* posterior probability
- Rider, K., 592n
- risk averse decision maker, 439
- risk lover decision maker, 440
- risk neutral decision maker, 439
- risk premium (RP), 438
 - definition, 438
- river crossing problem, 339–344
 - model, 345–346
 - optimal solution, 347
 - spreadsheet model, 344
- ROI (return on investment), 654
- RP (risk premium), 438

- safety stock, 181
- Sasieni, M., 6, 26n
- scheduling police patrol cars, 574–579
 - determining a optimal schedule, 578–579
 - integer linear program, 578
 - spreadsheet model in PatrolOpt.xls, 580
 - determining requirements, 574–578
 - spreadsheet model in Patrol.xls, 576
- sensitivity analysis
 - 100% Rule for changes in objective function coefficients, 215
 - 100% Rule for changes in right-hand-side values, 225
 - allowable range of objective coefficient values, 212
 - BGT example, 234–240
 - changing more than one objective function coefficient, 215–216
 - changing objective function coefficients, 208–216
 - changing right-hand-side values, 216–226
 - complementary slackness, 222
 - economic significance, 223
 - large changes, 291–305
 - methods
 - “snapshot” (local) method, 197
 - using Solver’s Sensitivity Report, 197
 - multiple optimal solutions, 233
 - reduced cost, *see* reduced cost
 - Sensitivity Report, 212–213
 - allowable changes in objective function coefficients, 212–213
 - comparing reports, 540–543
 - shadow price, *see* shadow price
 - “What if . . .” analysis, 197
- set of binding constraints (SOBC), 207
- set of feasible decisions, 31
- set-up cost, 516 *See also* fixed charge problems
- shadow price, 219–223
 - definition, 219
 - sign, 221–222
 - slope of an optimal value function, 297
- shareware program, 466
- simulation
 - constructing a simulation model, 595
 - discrete-event, *see* discrete-event simulation
 - experiment, 595–597
 - generating values of random variables, *see* generating values of random variables using data tables to replicate experiments, 600–603
 - sink nodes, 103
 - Smith, V., 529n
 - SOBC (set of binding constraints), 207 *See also* linear programs, components of optimal plans, SOBC
 - identified in Answer Report, 208
- Solver
 - adding constraints, 48–50
 - adding integer restrictions, 55
 - adding sign restrictions, 50
 - Answer Report, 51
 - Assume Non-Negative, 48
 - binary variable specification, 316
 - By Changing Cells, 47–48
 - Constraints Add window, 49
 - dialog box, 47, 50, 64, 75
 - installing, 46
 - Options window, 48
 - Results box, 51
 - Target Cell, 47
 - using, 46–51
- source nodes, 103
- spreadsheet models
 - single source of data, 15
 - structure, 9, 10
- SS Kuniang case, 503–508
 - decision tree, 506, 507
- staff scheduling problems, 3, 96
 - examples
 - University Computing Center, 111
- standard deviation, 380
 - definition, 380
- standard error of the mean, 643
- Standard Form, *see* LP Standard Form
- Standard Form Template, *see* EXCEL, workbooks, StdFormTemplate.xls
- standard normal random variable, 404–405
- states of the world, 421
- static models, 96–97
- stationary system, 531
- statistical dependence
 - events, 371
- statistical independence
 - of events, 371
 - condition, 371
 - of random variables, 381
- steady state
 - in queueing models, 531
 - in simulation models, 623
- Student’s *t* random variable, 633
- symbolic models, 7

- TANSTAAFL, 481
- terminal net worth, 116

- time value of money, *see* discount factor, single-period
- total discounted sum of payoffs, 120
- traffic intensity, 543
- transient (non-stationary) system, 531
- transportation problems, 96
 - dynamic, 180
 - examples
 - auditing, 124
 - Bunch O'Munchies, 180
- transshipment nodes, 103
- transshipment problems, 185
- TreePlan, 466–472
 - building a new decision tree, 467–470
 - copy and paste subtrees, 469–470
 - data storage convention, 467
 - modifying a decision tree, 468–470
 - node valuation convention, 467
 - printing hints, 470–471
 - redrawing the decision tree, 468–469
 - Tools menu, 466
 - using exponential utility function, 490–494
- triangular random variable, 406
 - cumulative distribution function, 627
 - graph of distribution function, 628
 - symmetric, 622–628
 - value generation, 628
 - value generation, 626–628
- Tsubakitani, S., 356n
- two-way data table, 598, 691–695

- uncapacitated minimal cost network flow problem, 106
- unconditional probability, 370
- uniform (0,1) random variable, 396–399
 - cdf, 397
 - expected value, 398
 - pdf, 397
 - useful property, 398, 629
 - variance, 398
- uniform (a,b) random variable, 398–399
 - expected value, 398
 - generating in EXCEL, 399, 625
 - value generation, 399, 625
 - variance, 399
- University Computing Center staffing problem model, 113
 - model formulation, 112–113
 - problem statement, 111
 - spreadsheet model, 114
- utility and preference, 434–443
- utility function, 435–437, 489
 - constructing, 436–437
 - diminishing marginal returns, 439–440
 - exponential, *see* exponential utility function
 - properties, 435
 - utility of a payoff, 435

- value of information, 432–434
 - in decision trees, *see also* expected value of perfect information, expected value of sample information
- variance, 379
 - definition, 379

- Walker, W., 592n
- Walls, M., 525n
- Western Trust portfolio investment problem model, 99
 - model formulation, 97
 - problem statement, 97
 - spreadsheet model, 100
- Whitin, T., 127, 168n
- Wisconsin Paper Company
 - data, 101
 - problem statement, 100
 - spreadsheet model, 102