

Index

- active constraint, 125
 - correct identification, 113
- active set, 92
- active set methods, 196
- adjustment step, 170
- affine function, 47
- affine hull, 12
- affine set, 11, 31
- algorithm, 1
 - fast, 2
 - finite, 52
- asymptotic linearity, 168
- asymptotic normality, 168

- balanced, 6
- Bartels, 103, 130, 177
- basis, 163
- basis matrix, 96, 131, 162
 - update, 98
- Basis Pursuit Denoising, 220, 225
- bisection, 135, *see* linesearch, 143, 232
 - optimal properties, 136
- Bloomfield, 137
- breakpoint, 59, 63, 125, 148, 163
 - active, 126, 132
 - homotopy, 153

- C++, 179
- canonical form, 91
- censored l_1 problem, 46, 159
- chain rule, 31
- characterization result, 27
- Clarke, 23
- code
 - Augment, 179
 - delete structure functional, 183
 - min_type, 184
 - most_violated, 181
 - Separate, 180
 - code fragment
 - partitioning algorithm, 138
 - collection class, 179
 - compact representation, 196
 - comparison search, 170
 - complementarity, 30
 - strict, 103
 - complementarity condition, 50
 - complexity, 122
 - computational complexity, 2, 172
 - concave, 187
 - condition number, 114, 218
 - cone, 12
 - finitely generated, 13
 - normal, 29
 - pointed, 12
 - polar, 14, 15, 28
 - tangent, 28, 30
 - consistent estimator, 169, 190, 191
 - constraint, 1, 196
 - active, 4, 97
 - bound, 100, 102, 141
 - equality, 1, 32, 100, 222
 - explicit, 29
 - geometry, 3
 - inequality, 1, 32, 39, 133
 - interval, 62, 76
 - linear equality, 59
 - linear inequality, 3, 15
 - nonsmooth, 200
 - redundant, 15
 - constraint qualification, 27
 - constraint set, 3
 - convergence
 - piecewise linear approximation, 140
 - convergence in probability, 168
 - convex
 - body, 12
 - conjugate function, 33, 34, 40, 48, 49, 62

convex (*cont.*)
 function, 39
 minimum, 27
 hull, 6, 10, 48
 polytope, 12
 set, 5
 boundary point, 8
 polyhedral, 12
 sets, representation of, 5
 convex function, 2, 15
 continuous, 17
 separable piecewise linear, 59, 64
 complex structure, 61
 simple structure, 61
 stable, *see* lower semicontinuity, 18
 convexity
 rank regression functional, 167
 crossing point, 134, 169, 170
 closest breakpoint, 135
 cycling, 109

data mining, 197
 Dax, 115
 dead point, 97, 99, 101, 105, 173
 degeneracy, 92, 109, 110, 122, 144, 153, 204, 222
 detection, 112
 minimum step length, 112
 nonrecursive, 112
 rank regression, 178
 recursive method
 implementation, 111
 termination, 111
 at reentrant corner, 85
 resolution, 140
 separable piecewise linear functions, 139
 degenerate, 54
 descent algorithm, 225, 233, 234
 descent direction, 82, 97, 102, 125, 132, 162, 173, 176, 221, 223
 descent edge, 107
 descent method, 96
 descent vector, 130
 design, 167
 design matrix, 43
 diagonal scaling, 225
 difference quotient, 21
 direction
 nonuniqueness, 55, 151, 153
 direction of recession, 11, 12, 20, 51, 178
 line, 11
 directional derivative, 21, 74, 76, 170, 174, 186, 188
 convex, 21
 generalized, 24
 nonintuitive, 24

ordinary, 87
 positively homogeneous, 21, 24
 subadditive, 24
 upper semicontinuous, 24
 downhill, 97
 dual norm, 212
 duality, 39, 55, 61
 dual problem, 39

effective domain, 16
 epigraph, 16
 norm, 12
 polyhedral geometry, 65
 exploratory data analysis, 196, 199
 exposed point, 10
 extreme direction, 11, 51, 70
 extreme point, 10–12, 50, 51, 60, 61, 66, 92
 optimal, 55

factor, 103
 lower triangular, 103
 orthogonal, 103
 upper triangular, 103
 factorization, 177
 orthogonal, 32
 Farkas's Lemma, 14, 15
 feasible, 1
 initial point, 118
 feasible direction, 3, 96
 descent direction, 3
 feasible region, 1, 51
 Fenchel's Duality Theorem, 37
 Fenchel's inequality, 34
 finite descent algorithm, 205
 flat, 11, 17
 full rank, 101
 function
 locally nonconvex, 163
 piecewise linear, 125, 150
 piecewise linear separable
 complex structure, 122
 separable convex, 140
 separable piecewise linear, 122
 simple structure, 122

Gauss–Newton method, 211
 generalized directional derivative, 86
 generalized gradient, *see* subdifferential, 25, 30, 73, 85, 161, 186, 187
 of component functions, 87
 mean value theorem, 26
 upper semicontinuous, 25
 generalized stationary point, 86
 global convergence, 216
 global minimum, 27
 Golub, 103, 130, 177

- Gram–Schmidt orthogonalization
 - modified, 226
- group of ties, 179
- Hald data set, 232
- halfspace, 7
- hard case, 173
- hemstitching, 143
- Hoare, 133
- homotopy, 3, 58, 122, 147, 156
 - downdate step, 209
 - piecewise linear, 206
 - properties, 210
 - starting values, 210
 - update step, 207
- homotopy algorithm, 225, 232
- Householder transformation, 208
- Hubble data, 171
- Huber, 38
- hyperplane, 6, 122
 - separating, 14
 - supporting, 8, 12, 33
 - nonvertical, 18–20
 - vertical, 19
- implementation, 172
- indicator function, 35
- intercept, 149, 167
- interior, 6
- Iowa wheat data, 234
- Jordan elimination, 92
- k-step estimator, 172
- Klee, 12
- Kuhn–Tucker conditions, 30, 40, 41, 49, 96, 102, 113, 116, 154, 200, 212
 - partitioned form, 201
- Kuhn–Tucker multiplier, 53, 127, 198, 219
- l_1 estimation, 45
- l_1 fitting, 4
- l_1 problem, 61, 69, 144
- Lagrangian, *see* duality, 39, 53, 196, 198, 202, 219, 229, 236
- Lasso, 196, 200, 218–220, 222, 225–227, 233
- lc-feasibility, 200, 207
- lc-feasible, 203, 221, 222
- least squares, 46, 101
- limiting behavior
 - regression quantiles, 153
- limiting distribution, 168
- linear inequalities, 196
- linear model, 43, 46, 166
- linear program, 154
- linear programming, 3, 43, 44, 50
 - dual problem, 54
 - uniqueness, 54
 - initial scaling, 114
 - primal problem, 54
 - nonuniqueness, 54
 - random problems, 113
 - regression quantiles, 148
- linear space, 11
- linear subproblem, 211
 - conditioning, 218
- linesearch, 3, 62, 91, 122, 129, 142, 177, 188, 203
 - alternative to, 198
 - Lagrangian function, 231, 237
 - no termination
 - locally nonconvex function, 163
 - secant algorithm, 232
- list, 179
- local linearization, 222
- locally convex, 90
- locally Lipschitz, 17
- lower semicontinuous, 17, 40
- mathematical programming, 1
- median, 4, 61, 145
- methods, 179
- minimum
 - global minimum, 2
 - local minimum, 2
- multiplier
 - estimate, 105
- multiplier condition, 33
 - linear equality constraints, 31, 32
 - local minimum, 89
 - regression quantiles, 149
- multiplier equation, 154
- multiplier relation, 4, 30
- multiplier vector, 4, 52, 61, 97, 106, 117, 130, 132, 152, 176
 - tentative, 110, 203, 223
- uniqueness, 55
- negative curvature, 88
- negative curvature direction, 188
- nonconvex problem
 - redescending scores, 47
- nondegeneracy, 126
- nondegeneracy assumption, 98, 99, 132, 170
- nondegenerate, 45, 79, 82
- nonsingular, 98
- norm, 6, 35
 - directional derivative, 22
 - dual, 23
 - generalized Schwartz inequality, 23
 - self dual, 216
- normalized steepest edge, 114
- number of constraints, 65

- objective function, 1, 4
 - separable, 44
 - support vector, 236
- optimal trajectory, 206
- optimal vertex, 82
- optimality conditions, 39, 127
- optimization, 1
 - constrained, 1, 26
 - unconstrained, 1, 26
- optimum
 - nonunique, 83
 - uniqueness, 83
- origin, 80, 171, 174
- orthogonal transformation, 92
- Osborne–Watson Lemma, 215

- partial pivoting, 92, 99
- partial QR factorization, 227
- partitioning algorithm, 133
- partitioning methods, 169
- PCF, *see* polyhedral convex function, 43
- penalty function, 3
- permutation matrix, 103
- perturbation function, *see* duality, 39, 52
- piecewise linear, 148
- piecewise linear approximation, 124
 - by chords, 124
 - by tangents, 124
- piecewise linear functions, 43
- pivotal value, 48
- pivoting step, 148
- polyhedral constraint function, 219
- polyhedral constraint set, 198
- polyhedral convex function, 3, 12, 77, 91, 196
 - representation by linear inequalities, 198
 - structure functional representation, 221
 - type, 1, 2, 43, 66
- polyhedral function, 43
 - nonconvex, 84
- postoptimality, 121, 122, 147
- problem
 - randomly generated, 141
- programming object, 179
- projected gradient, 91
- projected gradient algorithm, 103
- properties, 179

- quadratic program, 57, 202, 203, 221, 229
- quadratic programming, 39, 102, 116
- quantile parameter, 147
- quantile planes, 148
- quantile regression, 45, 65, 123, 131

- Rademacher, 24, 68
- rank regression, 45, 46, 65, 70, 166
 - signed, 46
 - subdifferential, 79
- rank statistic, 171
- ranking set, 167
- rate of convergence, 3
- redescending condition, 187, 188
- redescending scores, 190
- reduced gradient, 91
- reduced gradient algorithm, 100,
 - 103, 122, 131, 147, 162, 173, 186
 - pivoting step, 151
- reentrant corner, 189
- regression quantiles, 211
- relative boundary, 12
- relative interior, 12
- relaxation method, 217
- residual, 43
- restriction
 - active breakpoints, 139
- robust, 46
- robust estimation, 147

- scale independence, 225
- scores, 166
 - not distinct, 170
- secant algorithm, 135, *see* linesearch,
 - 142, 144, 169, 170, 191
- secant method, 122
- selection rule
 - separable piecewise linear function, 129
- separation, 2
 - theorem, 5
- signed rank regression, 72
 - scores, 72
- sign scores, 169
- simplex algorithm, 100
- simplex method, 91, 123
- simplicial methods, 196
- Slater condition, *see* constraint qualification,
 - 27, 29, 31
- slope, 59, 63
- solution
 - least norm, 56
 - minimum norm, 57
- stable, *see* convex function, 19, 40
- stakloss data set, 156, 190, 237
- stalling, 109
- statistical estimation problems, 43
- steepest descent, 102, 115
 - direction, 216
 - method, *see* Dax, 117
- steepest edge
 - normalized, 107
 - unnormalized, 107
- steepest edge test, 129
- Steiger, 137
- step, 98

- stepwise regression, 196, 199, 217, 225, 234
- structure equations, 66
- structure functional, 66, 68, 72, 170, 174, 176
 - active, 66, 79, 173, 221, 222, 230
 - complete set, 67
 - completeness, 69, 71, 74, 75
 - linear transformation, 71
 - linearly independent, 67
 - nondegenerate, 67
 - origin, 70, 79
 - redundant, 67, 68, 70, 71, 75, 79
 - structure equation, 67, 77
- structure matrix, 174
- subdifferential, 20, 34, 60, 73, 126, 132
 - constraint set, 74, 79, 174
 - defining inequality, 76, 80, 81
 - extreme point, 74
 - extreme points, 22
 - regression quantiles, 149
 - representation, 66
 - of sum, 22
 - support function, *see* directional derivative, 22
- subgradient, 20
 - inequality, 20
- subgradient inequality, 31
- support function, 8, 35, 74
- support vector example, 224
- support vector machine, 199
- support vector method, 220
- supporting hyperplane
 - nonvertical, 16
 - vertical, 16
- tableau, 92, 105, 130, 148, 177
 - downdating, 228
 - up and downdating, 230
- tableau array, 226
- tangent cone, 70
 - extreme direction, 51, 68, 72
- testquant data set, 157
- Theorem
 - characterization, 29
 - duality, 40, 52
 - fundamental on linear inequalities, 13
 - Hahn–Banach, 25
 - Klee representation, 12, 51
 - of the alternative, 13
 - separating hyperplane, 7, 28
- ties, 174
- transformation
 - of structure functionals, 82
- triangle inequality, 6
- trust region, 197, 225
- trust region algorithm, 211
- unbounded, 98, 110
- unbounded direction, 140, 178
- upper semicontinuous, 20, 25
- variable selection, 196, 217, 225
- variance, 168
- vertex
 - separable piecewise linear function, 129
- Visual Basic, 179
- weighted median, 133
- whitecaps data set, 157, 190
- Wilcoxon scores, 45, 166, 190
- Wolfe, 110, 111