

Index

- Aberth, O., 34, 122, 133, 146, 147, 155
absolute value, 9
accurate dot product, 28
addition of intervals, 10, 11
 associativity, 31
 commutativity, 31
additive identity element, 31
Alefeld, G., 17, 76
Archimedes' method, 1, 4
associative laws, 31
atomic energy lower bounds, 158
automatic differentiation, 109, 129, 137
 backward mode, 141
 forward mode, 141

backward mode, automatic differentiation,
 141
Banach spaces, 128
BARON, 82, 167
barycentric coordinates, 145
Berz, M., 147, 155
binary arithmetic, IEEE, 23
box, 15
branch-and-bound algorithm, 82
branching, 62

C-XSC, 28
cancellation law, 33
Cartesian product, 173
Center for Reliable Engineering Comput-
 ing, 169
centered form, 67
chaos, 158
chemical engineering, 163
chemical kinetics equilibrium, 163
closed interval, 2, 7
clustering problem, 83

code list, 65
codomain, 174
commutative laws, 31
complement, 172
complex eigenvalues, 170
complex roots, 170
composition, 174
computational differentiation, 109
computational graph, 65
computer assisted proofs, 157
computer graphics, 169
computing with sets, 10, 15, 113
constraint propagation, 115, 168
continuous function, 51
convergent sequence, 51
COSY, 147
Cset arithmetic, 114

Darboux integrals, 146
degenerate interval, 7
difference of intervals, 10, 11
differential equation, 149
direct method, 88
directed roundings, 16
discontinuous flag, 123
disjoints sets, 172
division of intervals, 10, 13
domain
 of function, 174
dot product, accurate, 28
double-bubble conjecture, 158

Einarsson, B., 158
electrical engineering, 170
empty set, 171
enclosure, 2
 tightness of, 2

- endpoints, 7
- epsilon inflation, 83, 120
- equality of intervals, 7
- equivalence class, 173
- equivalence relation, 173
- error-squaring property, 107
- excess width, 55
- exponential function, 39, 40
- extended arithmetic, 16
- extended interval arithmetic, 110
- extension, 42, 174

- feasibility test, 160
- feasible point, 159
- feasible solution, 165
- Feigenbaum constant, 158
- FILIB++, 28
- finite convergence, 58, 60, 107
- finite element method, 168
- fixed-point theorem, 116
- forest planning, 158
- formula, 42
- forward mode, automatic differentiation, 141
- function(s), 174
 - codomain, 174
 - composition of, 55, 174
 - continuous, 51
 - domain, 174
 - exponential, 39, 40
 - extension, 174
 - identity, 175
 - image, 174
 - interval extension of, 42, 45
 - interval-valued, 37
 - invertible, 175
 - logarithmic, 40
 - monotonic, 39, 50
 - natural interval extension, 47
 - nonmonotonic, 40
 - one-to-one, 174
 - onto, 174
 - preimage, 174
 - range, 174
 - rational interval, 46
 - restriction, 174
 - square root, 40
 - unary, 64
- Fundamental Theorem of Interval Analysis, 47, 53, 86

- Gauss–Seidel method, interval, 96
- Gaussian elimination, interval, 100
- Gaussian quadrature, verified, 145
- global optimization, 82
- global optimizing point, 165
- global optimum, 165
- GlobSol, 41, 127, 163, 164, 167
- gravitational constant, 170

- Hankel matrices, 103
- Hansen, E., 16, 68, 73, 82, 91, 96, 127, 168
- Hansen–Sengupta method, 96
- Hargreaves, G., 27
- Hass, J., 157
- heat convection, 158
- Herzberger, J., 17, 76
- historical references, 16

- IA, 22
- iCOs, 167, 168
- identity element
 - additive, 31
 - multiplicative, 31
- identity function, 175
- IEEE binary arithmetic, 23
- ill-conditioned system, 90
- image, 175
 - of function, 174
- inclusion isotonicity, 35, 46, 55, 150
- indirect method, 88
- initial value problem, 151
- inner product, 15
- Institute of Reliable Computing, 17
- integral, 129, 131
- integral equation, 149
- intersection, 8, 172
- interval addition, 10, 11
- interval arithmetic, 10
 - inclusion isotonicity, 34
 - outwardly rounded, 22

- properties of, 31
- interval dependency, 38, 42
- interval division, 10, 13
- interval enclosure, 135
- interval extension, 42, 45
 - Lipschitz, 53
- interval Gauss–Seidel method, 96
- interval Gaussian elimination, 100
- interval hull, 8
- interval integral, 129
- interval majorant, 149
- interval matrices, 16, 85
 - midpoint, 85
 - norm, 85
 - width, 85
- interval multiplication, 10, 12
- interval operator, 149
- interval polynomial enclosure, 135
- interval subtraction, 10, 11
- interval vector(s), 14
 - intersection of, 14
 - membership in, 14
 - midpoint, 14
 - norm, 15
 - set containment, 14
 - width, 14
- interval(s), 7
 - absolute value of, 9
 - addition of, 11
 - closed, 2, 7
 - degenerate, 7
 - division of, 13
 - endpoints, 7
 - equality of, 7
 - intersection of, 8
 - midpoint of, 3, 9
 - multiplication of, 12
 - negative, 10
 - negative of, 12
 - order relations for, 9
 - positive, 10
 - product of, 10, 12
 - quotient of, 10, 13
 - reciprocal of, 13
 - subdistributive law for, 32
 - subtraction of, 10, 11
 - sum of, 10, 11
 - symmetric, 33
 - union of, 8
 - width of, 3, 9
- interval-valued function, 37
- INTLAB, 4, 22, 41, 70, 74, 87, 101, 118
 - references, 27
 - representation
 - infimum-supremum, 22
 - midpoint-radius, 25
 - significant digits, 25, 26
 - uncertainty, 26, 59
- inverse, 175
- isometric embedding, 53
- isometry, 53
- Jacobian matrix, 116
- Jaulin, L., 162
- Jouanolou foliation, 158
- K. A. M. bounds, 158
- Kahan arithmetic, 16, 113
- Kahan, W., 16
- Kantorovich theorem, 127
- Kearfott, R. B., 168
- Kepler’s conjecture, 157
- Krawczyk method, 17, 91, 92, 116
- Krawczyk, R., 17
- Kreinovich, V., 195
- Kulisch, U., 17, 28
- Lake Constance currents, 158
- lattice theory, 156
- least squares problems, 158
- limit, 51
- Lin, Y., 163
- Lipschitz condition, 53
- logarithmic function, 40
- long accumulator, 28
- Lorenz attractor, 157, 158
- Makino, K., 155
- Mathematics Research Center, 17
- Mayer, G., 103
- mean value extension, 69
- mean value form, 69

- mechanical engineering, 170
- metric, 52
- metric space, 52
- midpoint, 3, 9, 14, 85
- midpoint test, 160
- mignitude, 87
- molecular models, 163
- monotonic function, 39, 50
- monotonicity test form, 75, 76
- Monte Carlo method, 100
- Moore, R. E., 16, 107, 113, 120, 128, 156, 161, 162
- MPFI, 28
- Muhanna, R. L., 169
- Mullen, R. L., 169
- multiple integral, 145
- multiplication of intervals, 10, 12
 - associativity, 31
 - commutativity, 31
- multiplicative identity element, 31
- multivariate interval Newton method, 123

- natural interval extension, 47
- negative interval, 10
- negative of interval, 12
- Neumaier, A., 17, 83, 168
- Newton's gravitational constant, 170
- Newton's method, 105
 - geometric interpretation, 107
- Nickel, K., 16
- norm, 15, 85
- number pair extension, 5
- Numerica, 168

- Oishi, S., 28
- operator equation, 149
- operator overloading, 70
- optimal outward rounding, 22
- optimization, 159
- optimizing point, global, 165
- order relations, 9
- ordered pair, 5
- Orr-Sommerfeld equations, 158
- outward rounding, 20
 - optimal, 22
- parameter, 2
- parameter estimation, 161, 170
- partial differential equations, 156
- partial ordering, 10, 173
- partition, 173
- PDE, 156
- persymmetric matrices, 103
- photoelectron spectroscopy, 161
- polynomial enclosure, 141
- polynomial integration, 133
- positive interval, 10
- preimage, 174, 175
- product of intervals, 10, 12
- PROFIL/BIAS, 28
- propagation of uncertainties, 20

- quadratic convergence, 118
- quotient of intervals, 10, 13

- range, 174
- rational interval function, 46
- Ratschek, H., 68, 168
- reciprocal of interval, 13
- recursion, 3
- refinement, 55, 64
- relation, 173
 - antisymmetric, 173
 - equivalence, 173
 - on a set, 173
 - reflexive, 173
 - symmetric, 173
 - transitive, 173
- restriction, 174
- robotics, 162
- robust control, 162, 170
- Rohn, J., 103
- Rokne, J., 17, 168
- roundoff error, 3
- Rump, S. M., 17, 27, 120, 158

- safe starting interval, 121
- semidefinite programming, 166
- sequence(s)
 - convergent, 51
 - limit, 51
 - nested, 58
- set(s), 171

- complement, 172
 - difference, 173
 - disjoint, 172
 - elements, 171
 - empty, 171
 - equality, 172
 - intersection, 172
 - members, 171
 - notation, 171
 - subset of, 172
 - union, 172
- simplex, 145
- Skelboe–Moore algorithm, 77
- slope, 72
- slope form, 72, 73
- small divisors in Hamiltonian dynamics, 158
- SPICE, 158
- splitting, 56
- square root function, 40
- stability of matter, 158
- Stadtherr, M. A., 163
- structural engineering, 168
- Sturm–Liouville problem, 158
- subdistributive law, 32
- subset, 172
 - proper, 172
- subset property, 45
- subtraction of intervals, 10, 11
- sum of intervals, 10, 11
- symmetric interval, 33
- symmetric matrices, 103
- Szpiro, G. G., 157
- Taylor arithmetic, 147, 163
- Toeplitz matrices, 103
- transitive relation, 9
- Tucker, W., 157
- turbine eigenfrequencies, 158
- unary function, 64
- uniform subdivision, 55
- union, 8, 172
- united extension, 38, 54
 - subset property of, 45
- Walster, G. W., 16, 82, 127, 168
- width, 3, 9, 14, 85
 - excess, 55
- wrapping effect, 155
- Wright, S., 100