
Index

- 1-simplex, 178
- 3-dimensional grid graph, 249
- Abs**, 43
- Acyclic graphs, 294
- AcyclicQ, 25, 26, 285, 288
- Add-on package
 - Arrow, 208
 - Graphics, Polyhedra, 118
 - Statistics, DiscreteDistributions, 262
- AddEdge, 14
- AddEdges, 12, 14, 193
- AddVertex, 14
- AddVertices, 14
- Adjacency lists, 10, 15, 179, 186
- Adjacency matrices, 10, 179, 226
 - circulant graphs, 245
 - powers, 333
 - spanning trees, 339
 - square, 266
- Adjacent transposition graph, 54, 68
- Ahlgren, S., 135
- Aho, A., 287, 354
- Ahuja, R. K., 342
- Aigner, M., 175
- Algorithm, 31
- Algorithmic graph theory, 322
- Algorithms, 49
 - Bellman-Ford, 328
 - biconnected components, 287
 - bipartite matching, 345
 - breadth-first search, 277
 - chromatic polynomial, 308
 - coloring, 310
 - connected components, 283
 - depth-first search, 281
 - Dijkstra, 323
 - edge coloring, 314
 - Eulerian cycles, 298
 - Floyd-Warshall, 330
 - girth, 295
 - Hamiltonian cycles, 300
 - isomorphism, 366
 - K-connectivity, 289
 - Kruskal, 336
 - maximal matching, 343
 - maximum clique, 316
 - maximum independent set, 318
 - minimum spanning trees, 336
 - network flow, 340
 - orienting graphs, 286
 - planarity, 371
 - shortest paths, 323
 - stable matchings, 350
 - strong connectivity, 284, 285
 - topological sorting, 352
 - transitive closure, 353
 - Transitive reduction, 354
 - traveling salesman, 303
 - vertex coloring, 310
 - vertex cover, 317, 349
 - weak connectivity, 284
 - weighted matching, 349
- All, 312
- All-pairs shortest paths, 323
 - algorithms, 330
 - isomorphism testing, 366
- AllPairsShortestPath, 31, 252, 330
- Alphabet, 88
- Alphabetical order, 58
- Alternating group, 110
- AlternatingGroup, 6, 110
- AlternatingGroupIndex, 6
- And, 49
- Andrews, G., 143
- AnimateGraph, 19, 21
- Animating a graph, 212
- Antichain, 358, 361
- Antisymmetric, 30
- AntiSymmetricQ, 26
- Appel, K., 306
- Append, 41, 45, 46
- AppendTo, 45
- Apply, 46, 48
- ApproximateVertexCover, 31
- Approximation algorithms, 71
 - Metric traveling salesman, 304
- Arc, 178
- Arguments, 42
- Arora, S., 305, 316
- Around the world game, 302
- Array notation, 45, 55
- Arrows, 208
- Articulation vertex, 25, 287
- ArticulationVertices, 25, 27, 287
- Ascending sequences, 74

- Associativity, 110
- Atallah, M., 70
- Augmenting paths, 340
- Auslander, L., 371
- Automorphism group, 131
- Automorphisms, 111
- Automorphisms, 27
- Back edges, 294
- Background, 16
- Backtrack, 9, 311, 320
- Backtracking, 310
 - Hamiltonian cycles, 300
 - isomorphism, 366
 - traveling salesman, 303
 - vertex coloring, 310
- Balanced parentheses, 162
- Ball, W., 302
- Battle, J., 371
- Behzad, M., 267
- Beineke, L., 242
- Bell numbers, 154
- Bell, E. T., 154
- BellB, 9, 154
- Bellman, R., 328
- Bellman-Ford algorithm, 323, 328
 - asymptotic running time, 329
- BellmanFord, 31
- Best first search, 323
- BFS, 277
- BFS numbers, 277
- Biconnected components, 287
- Biconnected graph, 25, 108
- BiconnectedComponents, 25, 27, 287
- BiconnectedQ, 26, 108, 287
- Biconnectivity, 292
- Biggs, N., 269, 297
- Bijection
 - binary strings, 76
 - compositions, 147
 - cycle representation, 100
 - index, 74
 - inversion vectors, 69
 - involutions, 105, 163, 167
 - pairs of tableaux, 166
 - partitions, 143
 - permutations, 59
 - RGFs, 159
 - set partitions, 159
 - subsets, 76
 - trees, 258, 339
 - Young tableaux, 162, 163
- Bijjective proof, 173
- Binary relations, 64, 269
 - equivalence, 115
 - partial orders, 352
 - reflexive, 115
 - symmetric, 115
 - transitive, 115
- Binary representation, 76
- BinarySearch, 5
- BinarySubsets, 6, 77, 89
- Bindings, 49
- Binomial, 44, 49, 84, 183
- Binomial coefficients, 83
 - Catalan numbers, 169
 - compositions, 146
 - Gauss, 49
 - lattice paths, 334
 - middle, 44
- Binomial distribution, 78, 262
- Binomial numbers, 153
- Biparential heaps, 169
- Bipartite graphs, 96, 246, 279
 - cliques, 316
 - coloring, 306
 - grid graphs, 250
 - hypercubes, 252
 - scheduling, 315
- Bipartite matching, 340, 345, 346, 373
- BipartiteMatching, 29, 31, 276, 346
- BipartiteQ, 26, 306
- Birkhoff, G., 307
- Bjorner, A., 248
- Block-cutpoint graph, 288
- Bollobás, B., 247, 263
- Bondy, J., 293, 301
- Book embeddings, 227
- Boolean algebra, 357
- Boolean operators, 49
- BooleanAlgebra, 24, 358
- Box, 17
- Branch, 178
- Brandstadt, A., 70
- Breadth-first search, 277
- Breadth-first traversal, 24, 332

- BFS numbers, 277
- distances, 277
- girth, 295
- parent pointers, 277
- shortest paths, 323
- tag, Edge, 278
- tag, Level, 278
- tag, Tree, 278
- BreadthFirstTraversal, 24, 31, 277
- Brelaz, 31
- Brelaz's algorithm, 313, 320
- Brelaz, D., 313
- BrelazColoring, 31, 313
- Bridgeless graphs, 286
- Bridges, 286
 - Fleury's algorithm, 298
 - Konigsberg, 297
 - orienting graphs, 286
 - planarity testing, 371
- Bridges, 27, 287
- Broder, A., 61
- Brooks, R., 312
- Buckley, F., 245
- Bugs, 50
- Bumping procedure, 163, 170
- Burnside's lemma, 116
- Business world, 332
- Butterfly, 273
 - recursive structure, 254
- ButterflyGraph, 10, 11, 24, 253, 278, 281
- C language, 44, 46
- C/C++, 95, 225
- Cage graph, 21
- CageGraph, 21, 24
- Cai, J., 371
- Calendar, 302
- Canfield, R., 175
- Canonical cycle structure, 94, 100
- Capobianco, M., 231, 273
- CAR, 45
- Cartesian products, 239, 253, 269
- CartesianProduct, 24, 239
- Catalan numbers, 169
- Cauchy-Frobenius lemma, 116
- Cayley graphs, 271
- Cayley, A., 258
- CDR, 45
- Ceiling, 43
- Center, 218, 332
- Center, 17
- Chaiken, S., 339
- Chain, 361
- ChangeEdges, 14
- ChangeVertices, 14, 214
- Character strings, 88
- Chartrand, G., 243, 267, 302
- Chase, P., 68
- Chemical compounds, 109
- Chessboard, 250
- Chinese postman problem, 298
- Christofedes, N., 305
- Chromatic number, 216, 276, 306
 - girth, 312
- Chromatic polynomial, 307
- ChromaticNumber, 27, 312
- ChromaticPolynomial, 26, 27, 308
- Chung, F., 227
- Chvatal, V., 301
- ChvatalGraph, 24
- Circulant graphs, 214, 245
 - cycle, 248
 - Harary graph, 292
 - k-partite, 274
- CirculantGraph, 19, 20, 24, 214, 222, 245, 273
- Circular embedding, 22, 188, 213, 227
- CircularEmbedding, 213
- CircularVertices, 19
- Circumference, 296
- Class, 170
- Claw, 242
- Clear, 43, 48
- Clique, 71, 316
 - chromatic number, 312
 - Turán graph, 247
- CliqueQ, 26
- Closure, 110
- CoarserSetPartitionQ, 9
- CodeToLabeledTree, 24, 259
- Coefficients, 309
- Cofactor, 339
- Cofactor, 9, 339
- Colbourn, C., 339
- Color degree, 313
- Coloring graphs, 306
- Combination locks, 299

- Combinations, 3, 54, 76
- Combinatorial explosion, 76
- Combinatorial Gray codes, 68
- Commutative operation, 240
- Compilation, 353
- Compiler optimization, 306
- Complement
 - complete graph, 245
 - connectivity, 284
 - sum, 238
 - vertex cover, 317
- Complement, 46
- Complete k -ary tree, 207
- Complete bipartite graphs, 319
 - construction, 246
 - edge chromatic number, 314
 - Hamiltonian, 300
 - join, 239
 - regular, 268
 - star, 249
 - vertex connectivity, 292
- Complete directed acyclic graph, 353
- Complete graphs, 182, 198, 214, 269
 - chromatic polynomial, 308
 - coloring, 312
 - construction, 244
 - degree sequence, 266
 - examples, 186
 - intersection, 237
 - properties, 247, 319
- Complete k -ary Tree, example, 232
- Complete k -partite graphs, 246
 - coloring, 313
 - construction, 246
 - vertex cover, 317
- Complete subgraph, 316
- CompleteBinaryTree, 24
- CompleteGraph, 10, 11, 24, 182, 186, 240, 268, 298, 312, 326, 338, 356
- CompleteKaryTree, 24, 188, 232
- CompleteKPartiteGraph, 24, 298, 303, 308, 313
- CompleteQ, 26, 198, 238
- Compositions, 7, 134
 - Gray code, 147
 - random, 146
- Compositions, 7, 8, 147
- Computer networks, 248, 287
- Conditional statements, 49
- Connected components, 222, 234
 - chromatic polynomial, 308
- ConnectedComponents, 24, 27, 246, 255, 283
- ConnectedQ, 24, 26, 283
- Connectivity, 276
 - directed graphs, 284
 - random graphs, 320
 - strong, 284
 - weak, 284
- ConstructTableau, 9, 164, 174
- Contiguous subsequence, 172
- Contract, 13
- Contract, 13, 14, 231, 254
- Contraction, 227, 231, 308
- Convex polyhedra, 370
- Corneil, D., 366
- Cos, 43
- Cosh, 59
- CostOfPath, 31
- Count, 50, 265
- Counting
 - combinations, 76
 - compositions, 146
 - De Bruijn sequences, 299
 - derangements, 106
 - dice, 109, 117
 - inversions, 71
 - involutions, 105
 - K -subsets, 83
 - necklaces, 117
 - partitions, 174
 - permutations by cycle, 103
 - runs, 75
 - set partitions, 153
 - spanning trees, 339
 - subsets, 76
 - Young tableaux, 168
- Cover number, 318
- Coxeter, H., 302
- CoxeterGraph, 24
- Cross edges, 253
- Cube
 - geometric, 370, 371
 - power, 334
 - vertex symmetries, 122
- Cube symmetries, 109
- CubeConnectedCycle, 24
- Cubic graphs, 112, 289, 290, 298

- CubicalGraph, 24, 31
- Cut, 290, 292
- Cut point, 287
- Cycle, 248
 - chromatic polynomial, 308
 - connectivity, 292
 - line graph, 242
 - noninterval graphs, 319
 - spanning trees, 339
- Cycle, 24, 239, 308
- Cycle index, 122
- Cycle structure, 92, 93
- CycleIndex, 6, 122
- Cycles, 214
- Cycles, 6
- Cycles in permutations, 93, 104
- CycleStructure, 6
- Cyclic, 6
- Cyclic graphs, 294
- Cyclic group, 110
- CyclicGroup, 6, 110
- CyclicGroupIndex, 6, 124

- DAGs, 295, 352
- Data structures, 179, 335
- Day, R., 339
- De Bruijn sequence, 299
- De Bruijn, N., 299
- DeBruijnGraph, 20, 24, 282, 298
- DeBruijnSequence, 6, 299
- Decrement operators, 44
- Default embedding, 15
- Degree, 65
- Degree matrix, 339
- Degree sequence, 265
 - Eulerian graphs, 297
 - isomorphisms, 364
- Degree set, 274
- Degrees, 27, 71
- DegreeSequence, 27, 266
- DegreesOf2Neighborhood, 27
- DeleteCycle, 14
- DeleteEdge, 14, 24
- DeleteEdges, 14
- DeleteFromTableau, 9, 165
- DeleteVertex, 14
- DeleteVertices, 13, 14
- Depth-first search, 277
- Depth-first traversal, 24, 285, 294, 304
 - back edges, 281
 - cross edges, 282
 - DFS tree, 281
 - forward edges, 282
 - tag, Edge, 282
 - tag, Tree, 282
- DepthFirstTraversal, 24, 31
- Derangement graph, 107
- DerangementQ, 5, 107
- Derangements, 104, 106
- Derangements, 5, 107
- Dereferencing, 43
- Descents, 89
- Det, 44
- Determinant, 339
- DFS tree, 281
- Diagonal matrix, 339
- Diameter, 332
 - cycle, 334
- Diameter, 27, 256, 332, 369
- Dice, 109
- Difference, graphs, 238
- Digits, 76
- Dihedral, 6
- Dihedral group, 110
- DihedralGroup, 6, 110
- DihedralGroupIndex, 6
- Dijkstra, 31, 324
- Dijkstra's algorithm, 323
 - asymptotic running time, 329
 - disconnected graphs, 327
- Dijkstra, E., 324
- DilateVertices, 19, 219
- Dilworth's theorem, 361
- Dilworth, R., 361
- Directed, 17
- Directed acyclic graphs, 295, 352
- Directed graphs, 198
- Disconnected graphs, 268, 308
- Disk, 17
- Distances
 - breadth-first search, 277
- Distances, 27
- Distinct parts, 168
- Distinct parts, partition, 174
- DistinctPermutations, 5
- Distribution, 9, 146, 158, 252

- Distribution, uniform, 61, 78, 87, 170
- Divide, 43
- Divisibility relation, 353, 355, 361
- Divisors, 45, 124
- DivisorSigma, 174
- Divorce digraph, 374
- Dixon, J., 110
- Do, 46, 48
- Documentation, 41
- Dodecahedral graph, 17
- DodecahedralGraph, 17, 20, 24, 31, 329
- Dodecahedron, 302, 370
- DominatingIntegerPartitionQ, 8
- DominationLattice, 8
- Dot, 45
- Dots, 143, 146
- Drawing graphs, 111, 181
- Drop, 45
- Druffel, L., 366
- Dual graph, 249
- Durfee square, 173
- DurfeeSquare, 8
- Dynamic programming, 154
 - Eulerian numbers, 75
 - shortest paths, 330
 - Stirling numbers of the first kind, 103
- Dynamic scoping, 43
- E, 107
- Eades, P., 221
- Eccentricity, 218, 332
- Eccentricity, 27, 332
- Eco, U., 247
- Edge, 178
 - chromatic number, 314
 - coloring, 314
 - connectivity, 233, 289
 - contraction, 231
 - insertion, 193
 - interchange operation, 274
- Edge lists, 179, 182
- Edge transitive, 132
- Edge-disjoint paths, 322
- Edge-transitive, 116
- EdgeChromaticNumber, 27
- EdgeColor, 17
- EdgeColoring, 27, 314
- EdgeConnectivity, 25, 27, 233, 289, 320
- EdgeDirection, 17
- EdgeLabel, 17
- EdgeLabelColor, 17
- EdgeLabelPosition, 17
- Edges, 64
- Edges, 12, 14, 182
- EdgeStyle, 16, 17, 180
- EdgeWeight, 17, 331
- Edmonds, J., 298, 340
- Eggleton, R., 108, 274
- Eigenvalues, 44
- Element, 9
- Embeddings
 - complete k-partite graphs, 247
 - convex, 370
 - hypercube, 273
 - misleading, 243
 - product, 240
- Empty graph, 195, 245
 - chromatic polynomial, 308
 - join, 239
- Empty graphs, 198
- EmptyGraph, 24
- EmptyQ, 26, 198, 238
- EncroachingListSet, 5
- Equal, 49
- Equivalence classes, 109, 115, 364
- EquivalenceClasses, 6
- EquivalenceRelationQ, 26
- Equivalences, 27, 364
- Erdos, P., 172, 262, 263, 266, 312
- Error checking, 193
- Ervin, V., 306
- Euclidean, 31, 326
- Euclidean graphs, 374
- Euler function, 124
- Euler's formula, 370, 371
- Euler's Pentagonal Theorem, 141
- Euler, L., 135, 297
- Eulerian
 - cycles, 298
 - function, 124
 - graphs, 242, 243, 297
 - numbers, 75, 90
- Eulerian, 9, 75
- EulerianCycle, 25, 27, 298
- EulerianQ, 26, 297
- EulerPhi, 124

- Even cycles, 307
- Even partitions, 174
- Even permutations, 96
- Even, S., 342, 371
- EvenQ, 47, 49
- ExactRandomGraph, 24, **264**
- Exercises, 89, 131, 173, 226, 273, 319
- Expand, 309
- ExpandGraph, 24
- Extensible languages, 43
- ExtractCycles, 31, 296
- Extracting connected components, 284
- Extremal graph theory, 247, 292

- Factor, 309
- Factor of a graph, 343
- Factorial, 44
- FactorInteger, 45
- Falling factorial function, 308
- False, 47
- Fault-tolerance, 287
- Feedback shift registers, 299
- Ferrers diagrams, 143, 174
- FerrersDiagram, 7, 8
- Fibonacci heaps, 327
- FindCycle, 31, **294**
- FindSet, 9, **336**
- FiniteGraphs, 2, 24
- First, 45
- FirstLexicographicTableau, 9
- Fixed points, 4, 93, 104–106
- Flatten, 45
- Fleischner, H., 334
- Fleury's algorithm, 298
- Floor, 43
- Flow problems, 322
- Floyd, R., 330
- Floyd-Warshall algorithm, 330
- Folded-up butterfly, 254
- FoldList, 49, 96
- Folkman graph, 116
- FolkmanGraph, 24, 116
- For, 46, 48
- Force-directed algorithms, 221
- Ford, L., 289, 328, 340
- Format, 179
- Fortran, 46
- Foucault's Pendulum, 247

- Four color problem, 301, 306, 320
- FranklinGraph, 24
- Franzblau, D., 168
- Frederickson, G., 329
- Fredman, M., 327, 338
- Free trees, 258
- FromAdjacencyLists, 15, 225
- FromAdjacencyMatrix, 15, 225
- FromCycles, 5, **95**, 132
- FromInversionVector, 5, **69**
- FromOrderedPairs, 15, 225
- FromUnorderedPairs, 15, 225
- Frucht graph, 112
- Frucht, R., 112
- FruchtGraph, 24
- Fulkerson, D., 266, 274, 289, 340
- Function, 47
- Functional graphs, 270
- FunctionalGraph, 24

- Gale, D., 350
- Gallai, T., 266, 318
- GAP, 112
- Gardner, M., 109
- Garey, M., 71, 335, 354
- Gassner, B., 74
- Gauss, C., 49
- Generalized Petersen graph, 215
- GeneralizedPetersenGraph, 24, 215
- Generating functions, 72, 173
- Generation
 - combinations, 83
 - complete graphs, 245
 - connected components, 283
 - cycles, 248
 - Derangements, 107
 - dice, 109
 - grid graphs, 249
 - hypercubes, 251
 - involutions, 105
 - K-set partitions, 150
 - K-subsets, 83
 - Model 2 random graphs, 264
 - partitions, 135
 - permutations, 56
 - Random k-subsets, 87
 - random permutations, 60
 - random subsets, 78

- regular graphs, 268
- RGFs, 160
- set partitions, 150
- stars, 248
- strings, 88
- subsets, 76, 81
- trees, 258
- wheels, 249
- Young tableaux, 163, 167
- Generators, 271
- Geodesic, 340
- Geometric transformations, 219
- GetEdgeWeights, 12
- GetVertexWeights, 12
- Giant cycles, 101
- Gilbert, E., 80
- Girth, 295
 - chromatic numbers, 312
- Girth, 27, 320
- Golomb, S., 299
- Gomery, R., 342
- Good, I., 299
- Gottlieb, C., 366
- Gould, R., 313
- Graham, R., 44, 103, 335
- Graph, 178
- Graph, 45
- Graph connectivity, 24
- Graph cycle structure, 24
- Graph editor, 225
- Graph embeddings, 181
- Graph isomorphism, 111, 190
- Graph operation
 - contract, 231
 - difference, 238
 - intersection, 237
 - join, 238
 - product, 239
 - sum, 238
 - union, 235
- Graph product, 273
- Graph theory, 24
- GraphBase, 224
- GraphCenter, 27, 218
- GraphComplement, 24
- GraphDifference, 24
- Graphic degree sequences, 274
- Graphic sequences, 266
- Graphical enumeration, 260
- GraphicQ, 26, 266
- Graphics primitives, 200
- GraphIntersection, 24, 237, 273, 274
- GraphJoin, 24, 239, 268, 274
- GraphOptions, 12
- GraphPolynomial, 27, 129
- GraphPower, 24, 333
- GraphProduct, 19, 24, 224, 274
- Graphs, 64
 - adjacent transpositions, 54, 68
 - biconnected, 108
 - coloring, 306
 - complement, 317
 - connectivity, 283
 - cycles of, 24
 - embedded, 11
 - embeddings, 240
 - internal representation, 179
 - matching, 343
 - product, 251
- GraphSum, 24
- GraphUnion, 24, 273, 274, 284, 308, 327
- Gray codes, 68
 - compositions, 147
 - involutions, 105
 - K-subsets, 85
 - partitions, 138, 174
 - permutations, 64
 - set partitions, 152
 - subsets, 78, 251
- Gray, F., 78
- GrayCode, 5
- GrayCodeKSubsets, 6, 86, 90
- GrayCodeSubsets, 6, 79
- GrayGraph, 6
- Greedy algorithm, 306
- GreedyVertexCover, 31
- Grid graphs, 249
 - 3-dimensional, 249
 - embedding, 273
 - independent sets, 318
 - powers, 334
- GridGraph, 13, 21, 24, 182, 210, 214, 284, 307, 325, 329, 330
- GrotztschGraph, 24
- Group
 - action, 113

- axioms, 110
- generators, 271
- homomorphism, 113
- identity element, 110
- inverse element, 110
- isomorphism, 111
- order, 110
- theory, 92
- GTL, 225
- Gupta, H., 142
- Gupta, R., 314
- Gusfield, D., 374
- Gwyther, A., 142
- Hakan, W., 306
- Hakimi, S., 266
- Hall's marriage theorem, 345
- Hall, J., 315
- Hall, M., 69
- Hall, P., 345
- Hamilton, Sir William, 302
- Hamiltonian cycles, 26, 108, 300
 - backtracking, 320
 - biconnectivity, 334
 - circumference, 296
 - derangement graph, 108
 - dodecahedron, 302
 - grid graphs, 250
 - hypercube, 79, 251
 - NP-completeness, 298
 - set partitions, 152
 - Tutte graph, 301
- Hamiltonian cycles, 67
- Hamiltonian graphs
 - biconnectivity, 289
 - bipartite, 300
 - hypercube, 251
 - line graphs, 243
 - squares, 334
 - transpositions, 67, 68
- Hamiltonian paths, 302
 - transposition graph, 67, 68
- HamiltonianCycle, 26, 27, 79, 211, 250
- HamiltonianPath, 302
- HamiltonianQ, 26, 108
- Han, X., 371
- Harary, 24, 292
- Harary graph, 292
- Harary, F., 178, 241, 243, 245, 260, 292, 371
- Hardy, G., 135
- Harmonic numbers, 102
- Hartline, J., 315
- Hasse diagram, 30, 356
- HasseDiagram, 24, 30
- Havel, V., 266
- Head, 180
- HeadCenter, 208
- Heap's algorithm, 62, 90
- Heap, B., 62
- Heap, biparential, 169
- Heapify, 5
- HeapSort, 5
- HeawoodGraph, 24
- Hell, P., 335
- Help, 41
- HerschelGraph, 24
- Heuristics
 - circular embedding, 227
 - coloring, 313
 - isomorphism, 366
 - maximum clique, 316
 - rooted embedding, 217
 - spring embedding, 221
 - traveling salesman, 305
- Hidden cycle representation, 100
- HideCycles, 5, 100
- Hierholzer, C., 298
- Highlight, 19, 21, 211
- HighlightedEdgeColors, 17
- HighlightedEdgeStyle, 17
- HighlightedVertexColors, 17
- HighlightedVertexStyle, 17
- Highlighting a graph, 211
- Hochbaum, D., 71
- Hoffman, A., 274
- Holyer, I., 315
- Homeomorphism, 370
- Homomorphic groups, 113
- Hook length formula, 8, 168
- Hooke's law, 19, 221
- Hopcroft, J., 280, 287, 346, 371
- Hospitals, 350
- Hosseini, S., 306
- Hu, T., 342
- Hyperbolic cosine, 59
- Hypercube, 22

- Hypercube, 11, 21, 24, 79, 208, 211, **251**, 254, 302, 312, 314, 359
- Hypercubes, 251, 273
 - edge connectivity, 290
 - embedding, 273
 - Gray code, 79
- Hypercubic networks, 250
- Hypotraceable graph, 303
- Icosahedral graph, 26
- IcosahedralGraph, 24, 26, 31
- Icosahedron, 370
- Identical graphs, 363
- IdenticalQ, 26, 292, 356, 363
- Identity operation, 70, 93, 237
- Identity permutation, 56, 72, 93, 104, 131
- IdentityMatrix, 44
- IdentityPermutation, 5, **56**
- If, 49
- Imperative languages, 49
- Improving embeddings, 219
- In-degree, 297, 356
- Incidence matrices, 191, 226
- IncidenceMatrix, 15, **191**
- Inclusion, 357
- Increasing subsequence, 170
- Increment operators, 44
- InDegree, 27, **297**
- Independence number, 318
- Independent set, 316, 318, 335
- IndependentSetQ, 26, **318**
- Index, 5, **73**
- Index, permutation, 73
- Induced subgraph, 273
- InduceSubgraph, 13, 14, 24, 29, 255, 284, 287
- Infinity, 46
- InitializeUnionFind, 9, **336**
- InsertIntoTableau, 9, **164**
- Insertion, Young tableaux, 163, 170
- Integer partitions, 99, 135
- Interconnection networks, 250
- Interlocking bridges, 371
- Interns, 350
- Intersection, 46
- Intersection graphs, 240
- Intersection, graphs, 237
- IntervalGraph, 24, 319
- Invariants, 276
- Invariants, 31
- Inventory of orbits, 127
- Inverse permutation, 56, 167
 - inversions, 72
 - involution, 104
- InversePermutation, 4, 5, **56**, 98, 107, 167
- Inversion poset, 30, 269
- Inversion vectors, 69, 89, 90
- InversionPoset, 5, 30
- Inversions, 69, 89
- Inversions, 4, 5, 71, **71**
- InvolutionQ, 5, **104**
- Involutions, 93, 104, 132, 167
- Involutions, 5
- Irrational numbers, 44
- Irving, R., 374
- Isaacson, J., 313
- Isomers, 109
- Isomorphic groups, 111
- IsomorphicQ, 26, 190, 239, 240, 242, 255, 257, **367**
- Isomorphism, 242, 363
- Isomorphism, 27, 366
- IsomorphismQ, 26, **367**
- Jackson's theorem, 108
- Jackson, B., 108
- Janson, S., 263
- Java, 95, 225
- Jerrum, M., 61
- Jeurissen, R., 306
- Johnson, D., 71, 335
- Johnson, E., 298
- Johnson, S., 68
- Johnson-Trotter algorithm, 68
- Join, 45, 46
- Join, graphs, 223, 238, 249
- Josephus, 5
- Junction, 178
- Junction points, 371
- K-connectivity, 289, 291, 292, 340
- K-edge-connectivity, 289
- K-factor, 343
- K-partite graphs, 246
- K-regular graph, 108
- K-set partitions, 150
- K-subsets, 76, 83, 90
 - compositions, 147
 - construction, 83

- odd graphs, 269
- Kainen, P., 306
- Kaliningrad, 297
- Kamada, T., 221
- Karger, D., 233, 338
- Karlin, A., 315
- Karp, R., 309, 340, 346
- Kawai, S., 221
- Kirchhoff, G., 339
- Klein, P., 329, 338
- Klingsberg, P., 147
- Knight's tour, 302
- KnightsTourGraph, 24, 302
- Knuth, D., 44, 71, 72, 74, 103, 105, 153, 163, 166, 168, 299
- Koch, J., 306
- Kodama, Y., 371
- Konigsberg, 297
- Kratsch, D., 70
- Krishnamurthy, V., 109
- Kruskal's algorithm, 335
- Kruskal, J., 335
- KSetPartitions, 9, 150
- KSubsetGroup, 6
- KSubsetGroupIndex, 6
- KSubsets, 5, 6, 83
- Kuratowski's theorem, 370
- Kuratowski, K., 370
- Kwan, M., 298

- Labeled trees, 258
- LabeledTreeToCode, 24, 258
- Large, 17
- Last, 45
- LastLexicographicTableau, 9
- Latin square, 113
- Lawler, E., 303
- Laye, R., 173
- Layton, W., 306
- Leaves, 14
- Leda, 225
- Left-to-right minima, 100
- Leighton, T., 227, 250
- Length, 45
- Lenstra, J., 303
- Level set, 357
- LeviGraph, 24
- Levin, L., 363

- Lewis, D., 307
- Lewis, P., 304
- Lexicographic order, 58
 - backtracking, 311
 - compositions, 147
 - K-subsets, 83
 - partitions, 135
 - permutations, 56, 58
 - RGFs, 160
 - strings, 88
 - subsets, 81
 - Young tableaux, 167
- LexicographicPermutations, 5, 58, 90
- LexicographicSubsets, 6, 82
- Lin, S., 305
- Line, 178
- Line graphs, 226, 240, 273
 - coloring, 314
 - total graph, 273
- Linearity of expectation, 102
- LinearProgramming, 373
- LineGraph, 20, 24, 241
- Lipton, R., 111
- Lisp, 45
- List construction operations, 48
- List manipulation, 45
- ListGraphs, 6, 265
- ListNecklaces, 6
- Lists, 45
 - adjacency, 10
- Litow, B., 306
- Liu, C., 143
- Lloyd, E., 297
- Lloyd, L., 225
- LNorm, 31
- Loading graphs, 224
- Longest increasing subsequence, 71, 170
- LongestIncreasingSubsequence, 5, 8, 71, 171
- LoopPosition, 17
- Lovasz, L., 312, 343
- Lower bound, 312
- LowerLeft, 17
- LowerRight, 17
- Lucas, E., 298
- Luczak, T., 263
- Luks, E., 363
- Lund, C., 316

- M, 11, 12, 27, 71, 182

- MacMahon, P., 73, 142
- Magma, 112
- MakeDirected, 14
- MakeGraph, 22, 24, 29, 30, 66, 85, 107, 174, 352
- MakeSimple, 14, 254
- MakeUndirected, 14, 210
- Male-optimal marriage, 351
- Malkawi, M., 306
- Manacher, G., 70
- Manber, U., 47
- Mannila, H., 71, 74
- Manvel, B., 313
- Map, 46, 49
- MapAt, 50
- Marble, G., 313
- Marriage problem, 345
- Matchings, 343
- Mathematica, 54
 - arrays, 45, 55
 - Background, 16
 - calling a function, 42
 - Cancel, 73
 - Coefficient, 73
 - compilation, 57
 - Compile, 57
 - CompiledFunction, 57
 - conditionals, 49
 - conventions, 43
 - data types, 44
 - defining a function, 42
 - dereferencing, 43
 - efficiency, 47, 331
 - Expand, 73
 - Flatten, 95
 - FromCycles, 95
 - Graphics'Arrow', 200
 - GraphicsArray, 210
 - GraphicsSpacing, 210
 - iteration, 46
 - Kernel, 95
 - Kernel, 200
 - Line, 200
 - linear programming, 373
 - lists, 45
 - manual, 41
 - mapping functions, 46
 - mathematical operations, 43
 - NestList, 57
 - number-theoretic functions, 45
 - numbers, 44
 - packed arrays, 61
 - Plot, 16
 - Point, 200
 - Product, 73
 - recursion, 47
 - RotateRight, 95
 - scoping, 43
 - side effects, 45
 - Sort, 95
 - statements, 43
 - timing, 58
 - Transpose, 95
- Matrices, 45
 - adjacency, 10
 - multiplication, 45
- Matrix operations, 44
- MatrixQ, 49
- Matroid, 335
- Matula, D., 313
- Maubach, J., 306
- Max, 46
- Maximal matching, 29
- MaximalMatching, 27, 29, 373
- Maximum change order, 67, 107
- Maximum clique, 27, 71
- Maximum degree, 265
- Maximum flow, 322
- Maximum matchings, 29, 343
- MaximumAntichain, 27, 361
- MaximumClique, 27, 71, 320
- MaximumIndependentSet, 27, 318
- MaximumSpanningTree, 27, 336
- McAndrew, M., 274
- McGeeGraph, 24
- McPherson, J., 306
- Measures of order, 71, 74
- MemberQ, 49
- Men of Mathematics, 154
- Menger's theorem, 287, 291
- Menger, K., 291
- Meredith graph, 219, 303
- Meredith, G., 303
- MeredithGraph, 24, 219, 303, 317
- Meserve, B., 371
- Metric function, 304
- Metric traveling salesman problem, 304

- Middle binomial coefficients, 44
- Miller, J., 142
- Min, 46
- Minimum change order
 - compositions, 147
 - partitions, 174
 - permutations, 62
- Minimum cut, 233
- Minimum degree, 265
- Minimum spanning trees, 28
 - Euclidean, 374
 - path, 374
 - TSP, 304
 - United States, 224
 - variants, 335
- Minimum weight matching, 305
- MinimumChainPartition, 27, 361
- MinimumChangePermutations, 3, 5, 63, 64
- MinimumSpanningTree, 27, 28, 336, 373
- MinimumVertexColoring, 27, 211, 216, 310
- MinimumVertexCover, 27, 317
- Minor, 339
- Misleading embeddings, 242, 243
- Mitchell, J., 305
- Mod, 44
- Module, 42
- Molecules, 132
- Molluzzo, J., 231
- Monotone graph property, 262
- Mortimer, B., 110
- Motwani, R., 316
- Mukhopadhyay, A., 374
- Multigraphs, 198
 - degree sequences, 267
 - Konigsberg, 297
- MultipleEdgesQ, 26, 198
- Multiplication
 - associative, 56
 - noncommutative, 55
 - permutations, 55
- Multiplication table, 112
- Multiplication, matrix, 45
- MultiplicationTable, 6, 112
- Multiplicative inverse, 56, 104
- Multisets, 58, 68
- Munro, I., 169
- Murty, U., 293
- Mycielski graph, 216
- MycielskiGraph, 24, 312, 313
- N, 44
- N-cube, 251
- N-dimensional Hypercube, 79
- Nash-Williams, C., 243, 303
- Nauty, 225
- Necklace problem, 110, 127
- NecklacePolynomial, 6
- Necklaces, 109
- Negative, 49
- Negative cycles, 328–330
- Neighborhood, 31
- Nel, L., 339
- NestList, 81, 222, 254
- Network, 323
- Network flow, 340
 - connectivity, 289
 - linear programming, 373
 - matching, 346
- NetworkFlow, 29, 31, 276, 320
- NextBinarySubset, 6, 77
- NextComposition, 8, 148
- NextGrayCodeSubset, 6, 81
- NextKSubset, 6, 83
- NextLexicographicSubset, 6
- NextList, 232
- NextPartition, 8, 137
- NextPermutation, 5, 57, 90
- NextString, 90
- NextSubset, 6
- NextTableau, 9
- Nijenhuis, A., 61, 87, 144, 167, 168, 170, 174, 258
- Node, 178
- NoMultipleEdges, 31
- Non-planar graphs, 244, 247
- NonLineGraphs, 24
- NoPerfectMatchingGraph, 24, 29, 219
- Normal, 17
- NormalDashed, 17
- North, S., 111
- NoSelfLoops, 31
- Not, 49
- NP-completeness
 - coloring, 308, 315
 - drawing trees, 217
 - Hamiltonian cycles, 298, 300
 - maximum clique, 316

- permutation graphs, 70
 - spanning tree variants, 335
 - traveling salesman, 303
- NthPair, 263
- NthSubset, 6
- Null graph, 245
- Number theory, 135
- Number-theoretic functions, 45
- NumberOf2Paths, 9
- NumberOfCompositions, 9, 146
- NumberOfDerangements, 9, 107
- NumberOfDirectedGraphs, 9
- NumberOfGraphs, 9, 129
- NumberOfInvolutions, 9, 105
- NumberOfKPaths, 9
- NumberOfNecklaces, 9
- NumberOfPartitions, 9, 136, 142
- NumberOfPermutationsByCycles, 9, 103
- NumberOfPermutationsByInversions, 9, 73, 89
- NumberOfPermutationsByType, 9, 99
- NumberOfSpanningTrees, 9, 29, 339
- NumberOfTableaux, 8, 9, 168, 170, 174
- OctahedralGraph, 24, 31
- Octahedron, 370, 371
- Odd cycles, 307, 312
- Odd graphs, 269
- Odd partitions, 174
- Odd permutations, 96
- OddGraph, 24
- OddQ, 42, 49
- On-line help, 41
- One, 31
- Ono, K., 135
- Opsut, R., 306
- Optimum, 31
- Or, 49
- OrbitInventory, 6, 127
- OrbitRepresentatives, 6, 117
- Orbits, 109
- Orbits, 6, 117
- Order
 - group, 110
 - permutations, 131
- Ordered, 6
- OrderedQ, 49
- Ordinary generating functions, 72
- Ore graphs, 301
- Ore, O., 301
- Orientation, 286
- OrientGraph, 24, 25
- Orlin, J., 342
- Out-degree, 297, 356
- OutDegree, 27, 297
- Pages, 227
- Pair groups, 125
- PairGroup, 6
- PairGroupIndex, 6, 125
- Pairwise flows, 342
- Palmer, E., 260
- Papadimitriou, C., 335
- Paradigms, 47
- Parallel computers, 250
- Parameterized graphs, 231
- Parent, 31, 331
- Parent relation, 324
 - breadth-first search, 277
 - depth-first search, 281
 - shortest path, 323
- Parentheses, 162, 169
- ParentsToPaths, 31
- Parity, 369
- Part, 45
- Parter, S., 371
- Partial order, 30, 352
 - antichain, 361
 - chain, 361
 - Dilworth's theorem, 361
- Partial solution, 310
- PartialOrderQ, 26, 30, 352
- Partition, 45, 46, 232, 254, 260, 265, 295
- PartitionLattice, 9
- PartitionQ, 8, 135
- Partitions, 7, 123, 134
 - construction, 135
 - distinct parts, 141, 174
 - Ferrers diagram, 143
 - Gray code order, 138
 - odd parts, 141
 - predicate, 135
 - random, 144
 - representation, 45
 - shape, 162, 168
- Partitions, 7, 8, 99, 136
- PartitionsP, 123

- Pascal's triangle, 153
- Patashnik, O., 44, 103
- Path, 259
- Path, 24, 295
- Path compression, 335
- Pemmaraju, S., 306
- Pentagonal numbers, 141
- Pentagram, 244
- Perfect matching free graph, 219
- Perfect matchings, 29, 343
- PerfectQ, 26
- Permutation generation, 58
 - Johnson-Trotter algorithm, 68
 - lexicographic order, 58
 - maximum change, 67
 - minimum change, 62
 - random, 60
 - unranking, 60
- Permutation graph, 70, 71, 89
- Permutation groups, 110
- Permutation types, 123
- PermutationGraph, 24, 71
- PermutationGroupQ, 6
- PermutationQ, 5, 55
- Permutations, 54, 55
 - construction of, 3
 - cycle structure, 93
 - derangements, 104
 - involutions, 104
 - maximum change order, 107
 - representation, 45
 - scattered subsequences, 170
 - special classes, 104
 - tableaux, 164, 166, 174
 - transposition, 269
 - types, 98
- Permutations, index, 73
- PermutationToTableaux, 166
- PermutationType, 5, 98, 110
- PermutationWithCycle, 5, 96
- Permute, 5, 55, 107
- PermuteSubgraph, 14
- Perturbing embeddings, 220
- Petersen graph, 190, 205, 219, 243, 269
- PetersenGraph, 24, 190, 219, 220, 315
- Pi, 44
- Planar embeddings
 - dual, 249
- Planar graphs, 329
 - coloring, 306
 - dual graphs, 373
 - faces, 373
 - planarity testing, 370
 - platonic solids, 370
- Planarity testing, 226
- PlanarQ, 26, 31, 373
- Plane partitions, 163
- Platonic solids, 31, 109, 131, 329, 370
- PlotLabel, 16
- PlotRange, 17, 85
- Plummer, M., 343
- Plus, 43, 48
- Point, 178
- Polya, 4
- Polyhedra, cube, 118
- Polyhedra, convex, 370
- Polylines, 227
- Polynomial solvability, 110
- Polynomial time, 301
- Polynomials, 122
- Poset, 352
- Position, 50
- Positive, 49
- Postman tour, 298
- Power, 43
- Power of a graph, 333
- Power series expansion, 140
- Precedence relation, 352
- Predicates, 43
- Pregel river, 297
- Prepend, 45
- PrependTo, 45
- Presortedness, 71, 74
- Prim's algorithm, 335, 338, 373
- Prim, R., 335
- Product, 44, 140
- Products, graphs, 239, 249, 251
- Programming languages, 54
- Properties of graphs, 276
- Prufer codes, 258, 273
- Prufer, H., 258
- PseudographQ, 26, 198
- Pseudographs, 198, 267
- Pulse code communication, 78
- Pure functions, 47
- Pólya theory, 4, 92

- Pólya's theorem, 122
Pólya, G., 109
- Quantum physics, 110
- Radial embeddings, 18, 216
RadialEmbedding, 18, 19
Radius, 332
Radius, 27
Rall, D., 108
Ramanujan, S., 135
Random
 compositions, 146
 directed graphs, 264
 edge weights, 326
 embedding, 326
 Euclidean graphs, 374
 graphs, 262
 graphs, degree sequences, 267
 graphs, exact, 264
 K-set partitions, 158
 K-subsets, 87, 262
 number generation, 299
 partitions, 144
 permutation, 89
 permutations, 60
 perturbations, 220
 regular graph, 108
 sampling, 102
 set partitions, 158
 spanning trees, 338
 subgraph, 284
 subsets, 78
 tree, example, 200
 Young tableaux, 170
Random, 43
Random graphs, 234
RandomComposition, 8, 146
RandomGraph, 24, 27, 209, 210, 262, 285, 287
RandomHeap, 5
RandomInteger, 31
Randomized algorithm, minimum cut, 233
RandomKSetPartition, 9, 158
RandomKSubset, 6, 20, 87, 96, 262
RandomPartition, 7, 8, 144
RandomPermutation, 4, 5, 8, 56, 61, 87, 97, 98, 102, 166, 167
RandomRGF, 9
RandomSetPartition, 9, 158
RandomString, 90
RandomSubset, 6, 13, 24, 29, 78, 234, 284
RandomTableau, 8, 9
RandomTree, 11, 14, 18, 24, 211, 217, 218, 260, 290, 295, 296, 307, 313
RandomVertices, 19, 28
Range, 45, 47
RankBinarySubset, 6, 77
Ranked embeddings, 17, 214
 bipartite graphs, 247
 Hasse diagram, 356
Ranked poset, 357
RankedEmbedding, 17, 19, 66
RankGraph, 19, 215
RankGrayCodeSubset, 6, 80
Ranking
 Gray code subsets, 80
 K-set partitions, 155
 K-subset, 84
 permutations, 59
 set partitions, 155
 spanning trees, 339
 subsets, 78
RankKSetPartition, 9, 156
RankKSubset, 6, 84
RankPermutation, 3, 5, 60, 90, 97, 101
RankRGF, 9
RankSetPartition, 9, 156
RankString, 90
RankSubset, 6
Rao, S., 329
Rauch, M., 329
Read, R., 245, 260, 264, 368
ReadGraph, 112
Reading graphs, 224
Real, 44
RealizeDegreeSequence, 24, 25, 274, 294, 312
Recurrence
 Bell numbers, 154
 chromatic polynomial, 308
 derangements, 106
 Eulerian numbers, 75
 involutions, 104
 parentheses, 169
 partitions, 135, 136, 144, 174
 Ranks of set partitions, 155
 Stirling numbers of the first kind, 103
 strings, 88

- subsets, 81
- Recursion, 47
- Recursive structure
 - Butterfly graph, 254
- RecursiveStirling2, 154
- Reductions, 316
- Reflected Gray codes, 78, 89
- Reflexive, 30
- ReflexiveQ, 26
- Regular graphs, 21, 22, 268
 - complete graphs, 266
 - cubic, 289
 - cycle, 248
 - dodecahedron, 302
 - Harary graphs, 293
 - line graphs, 242
- Regular subgraphs, 343
- RegularGraph, 22, 24, 108, 268
- RegularQ, 26, 268
- Reingold, E., 217
- Relation, 64
- RemoveMultipleEdges, 14
- RemoveSelfLoops, 14
- Renyi, A., 262
- Replace, 45
- ReplaceAll, 45
- ResidualFlowGraph, 31
- Rest, 45
- Restricted Growth Functions, RGFs, 159
- Return, 48
- RevealCycles, 5, 100
- Revealing cycles, 100
- Reversals, 148
- Reverse, 45, 46, 93
- Reverse permutation, 72, 171
- ReverseEdges, 14
- RGFQ, 9
- RGFs, 9
- RGFs, lexicographic order, 160
- RGFToSetPartition, 9
- Rinnooy Kan, A., 303
- Roads, 323
- Robbins, H., 286
- Roberts, F., 306
- RobertsonGraph, 24
- Robinson, G., 166
- Robinson-Schensted-Knuth correspondence, 166
- Ronse, C., 299
- Root, 336
- Rooted embeddings, 18, 217
- Rooted trees, 258
- RootedEmbedding, 18, 19, 227, 278, 281
- Rosenberg, A., 227
- Rosenkrantz, D., 304
- RotateLeft, 45, 46
- RotateRight, 45
- RotateVertices, 19, 219, 244
- Rothe, H., 72
- Royle, G., 264
- Rucinski, A., 263
- Runs, 74, 89, 90, 172
- Runs, 5
- Rus, T., 306
- Russia, Kaliningrad, 297
- Ryser, H., 266
- Saaty, T., 306
- Sabidussi, G., 239
- Sachs, H., 369
- Safecracker, 299
- Saia, J., 315
- SamenessRelation, 6
- SameQ, 49
- Sandberg, J., 111
- Satanic symbol, 244
- Savage, C., 139, 174
- Scan, 47, 48
- Scattered subsequences, 170
- Scheduling, 306, 315
- Schensted, C., 166, 170
- Schmidt, D., 366
- Secretary problem, 107
- Sedgewick, R., 56, 62
- Select, 50
- SelectionSort, 5
- Self-complementary graphs, 369
- Self-conjugate partitions, 174
- Self-help, 41
- Self-loops, 198
 - degree sequences, 267
- SelfComplementaryQ, 26, 369
- SelfLoopsQ, 26
- Semirandom graphs, 267, 312
- Sequences, 8
- Series, 140
- Set operations, 46

- Set partitions, 134
 - generation, 150
 - Gray codes, 152
 - test, 149
- Set union, 335
- SetEdgeLabels, 12
- SetEdgeWeights, 12, 28, 187, 326
- SetGraphOptions, 11, 12, 180
- SetPartitionListViaRGF, 9
- SetPartitionQ, 9, **149**
- SetPartitions, 7, 9, **152**
- SetPartitionToRGF, 9
- SetVertexLabels, 12
- SetVertexWeights, 12
- Sewerage, 340
- ShakeGraph, 19, 220, **220**
- Shannon, A., 217
- Shapely, L., 350
- ShapeOfTableau, **162**
- Shift registers, 299
- Shmoys, D., 303
- Shortest cycle, 295
- Shortest paths, 323
 - all-pairs, 323
 - isomorphism, 366
 - minimum spanning trees, 335
 - network flow, 340
 - single-source, 323
 - transpositions, 97
- ShortestPath, 31, 97, 255, 256, 330
- ShortestPathSpanningTree, 28, 31, 329
- ShowGraph, 10, 16, 19
- ShowGraphArray, 2, 10, 19, 21
- Showing an array of graphs, 210
- ShowLabeledGraph, 19
- ShowOpenCube, 109
- Shuffle-exchange graph, 255
 - diameter, 256
- ShuffleExchangeGraph, 24, **255**
- Side effects, 45
- Sign, permutation, 96
- Signature, 96
- SignaturePermutation, 5, 97
- Simple, 14
- Simple, 31
- Simple graphs, 198
- SimpleQ, 26, **198**
- Simplify, 308
- Sin, 43
- Sinclair, A., 61
- Single source shortest-path problem, 323
- Singleton cycles, 93
- Sink, 226
- Sink vertex, 340
- Skeletons of polyhedra, 329
- Skiena, S., 71
- Slater, P., 108
- Small, 17
- SmallestCyclicGroupGraph, 24
- Sort, 45
- Sorting, analysis, 69
- Source vertex, 340
- Spanning tree, 28
- Sparse directed graphs, 285
- Sparse graphs, 186, 300
- Spectrum, 27
- Spencer, J., 263
- Sperner property, 358
- Spine, 227
- Spokes, 249
- Spring embedding, 221
- SpringEmbedding, 19, 22, 24, 66, **221**, 227, 239, 246, 256, 257, 268, 269, 290, 294, 355
- Square
 - adjacency matrix, 266
 - cycle, 248
 - power, 334
- Stable marriage problem, 373
- StableMarriage, 31, **350**
- Standard reflected Gray codes, 78
- Stanford GraphBase, 224
- Stanley, R., 143, 163, 248
- Stanton, D., 100, 143, 174, 269, 358, 360
- Star
 - articulation vertex, 289
 - construction, 248
 - example, 196
 - interval representation, 319
 - join, 239, 249
 - tree, 259
- Star, 12, 24, 179, 186, 232, **248**
- Star graph, 179
- State space, 311
- Static animation of graphs, 210
- Stearns, R., 304
- Steiglitz, K., 335

- Stein, C., 233
- Stirling numbers, 65, 103, 153
 - Second kind, 360
- Stirling, J., 153
- StirlingFirst, 9, 103
- StirlingS1, 103
- StirlingS2, 154
- StirlingSecond, 9, 153
- Straight edges, 253
- Strings, 88, 299
- Strings, 6, 76, 88, 90, 260
- Strong, 31
- Strong connectivity, 284, 297
- Strongly connected graphs, 286
- StronglyConnectedComponents, 27, 373
- Subgraphs, cliques, 247, 312
- Subramanian, S., 329
- Subsets, 54, 76
 - Boolean algebra, 357
 - construction of, 3
 - Gray code, 79
 - lexicographic order, 81
 - representation, 45
- Subsets, 6, 30
- Subtract, 43
- Sudan, M., 316
- Sum, 44, 48
- Sum, graphs, 238
- Supowit, K., 217
- Suwanda, H., 169
- Symmetric group, 110
- SymmetricGroup, 6, 110
- SymmetricGroupIndex, 6, 123
- Symmetries, 92, 111
- Szegedy, M., 316
- Szekeres, G., 172, 274

- Table, 46, 48
- TableauClasses, 9, 171
- TableauQ, 9, 162
- Tableaux, 8, 9
- TableauxToPermutation, 9, 166
- TableForm, 87
- TableForm, 162, 167
- Tait, P., 301
- Take, 45
- Tan, 43
- Tarjan, R., 280, 285, 327, 335, 342, 371
- Tarjan, R. E., 338
- Testing connectivity, 283
- TetrahedralGraph, 24, 31
- Tetrahedron, 370, 371
- TextStyle, 16
- Thick, 17
- ThickDashed, 17
- Thin, 17
- ThinDashed, 17
- Thomassen graph, 219, 303
- Thomassen, C., 303
- ThomassenGraph, 24, 219, 303
- Tilford, J., 217
- Times, 43
- Timing, 47, 58, 80, 87, 125, 154
- ToAdjacencyLists, 15
- ToAdjacencyMatrix, 14, 15, 189, 331
- ToCanonicalSetPartition, 9
- ToCycles, 4, 5, 94, 104, 107
- ToInversionVector, 5, 69
- ToOrderedPairs, 15
- ToOrderedpairs, 184
- Topological sort, 352
- TopologicalSort, 31, 320, 352
- Total graphs, 273
- Totter, H., 68
- Touchdown, 44
- ToUnorderedPairs, 15, 184
- Transformation rules, 45
- Transitive, 30
- Transitive closure, 331, 353
 - inversion poset, 270
 - shortest paths, 330
- Transitive reduction, 354
 - Hasse diagram, 356
- TransitiveClosure, 24, 354, 373
- Transitively orientable, 89
- TransitiveQ, 26
- TransitiveReduction, 24, 30, 355
- Transitivity, 353
- TranslateVertices, 19
- Transmission errors, 78
- Transpose, 143
- Transpose, 45, 46
- TransposePartition, 8, 143
- TransposeTableau, 9, 162
- Transposition graph, 96
- Transpositions, 59, 62

- cycles, 93
- involutions, 104
- permutations, 269
- signatures, 96
- Traveling salesman problem, 303
 - Euclidean, 374
- TravelingSalesman, 31
- TravelingSalesmanBounds, 31
- Tree, 339
 - spanning, 28
- TreeIsomorphismQ, 26
- TreeQ, 26
- Trees, 258
 - chromatic polynomial, 308
 - girth, 296
 - number of edges, 295
 - star, 248
- TreeToCertificate, 27
- Triangle, 248, 295
- Triangle inequality, 28, 304
- TriangleInequalityQ, 26
- Triconnected graphs, 292
- True, 47
- Truncated octahedron, 68
- Turan, 24, 247
- Turan graph, 247, 316
- Turan, P., 247
- Tutte, W., 292, 301
- TutteGraph, 24
- Two-colorable graphs, 246, 306
- Two-dimensional lists, 46
- TwoColoring, 31, 306
- Type, 31
- Types of permutations, 98, 105
- U.S. map, 337
- Ullman, J., 287, 354
- Unary predicates, 49
- Undirected, 17
- Undirected graphs, 198
- UndirectedQ, 26, 198
- Union, 46
- Union, graphs, 235
- Union-find, 335
- UnionSet, 9, 336
- Uniquely3ColorableGraph, 24
- UnitransitiveGraph, 24
- Unlabeled trees, 260
- UnrankBinarySubset, 6, 77
- UnrankGrayCodeSubset, 6, 80
- Unranking
 - Gray code subsets, 80
 - K-set partition, 157
 - K-subsets, 84
 - permutations, 60
 - set partition, 157
 - spanning trees, 339
 - subsets, 78
- UnrankKSetPartition, 9, 157, 173
- UnrankKSubset, 6, 85, 87
- UnrankPermutation, 4, 5, 90
- UnrankRGF, 9
- UnrankSetPartition, 9, 158
- UnrankString, 90
- UnrankSubset, 6
- UnweightedQ, 26, 198
- UpperLeft, 17
- UpperRight, 17
- Urrutia, J., 70
- V, 11, 12, 27, 182
- Vairavan, K., 306
- Valency, 265
- van Rooij, A., 242
- Variable dereferencing, 43
- Vaucher, J., 217
- Vertex, 178
 - coloring, 211, 306, 309
 - connectivity, 289, 292, 340
 - contraction, 231
 - cover, 316, 317
 - degree, 65
 - degrees, 297
 - transformations, 219
- Vertex symmetries, cube, 119
- Vertex transitive, 116, 132
- VertexColor, 17
- VertexColoring, 27, 313
- VertexConnectivity, 25, 27, 291, 320
- VertexConnectivityGraph, 24
- VertexCover, 27
- VertexCoverQ, 26, 317
- VertexLabel, 16, 17
- VertexLabelColor, 17
- VertexLabelPosition, 17
- VertexNumber, 16, 17, 30, 179

- VertexNumberColor, 17
- VertexNumberPosition, 17
- VertexStyle, 16, 17, 180
- VertexWeight, 17
- Vertices, 64
- Vertices, 11, 12, **182**
- Vizing, V., 314
- VLSI layout, 227

- Wachs, M., 248
- Wallis, W., 108
- WaltherGraph, 24
- Warshall, S., 330
- Weak, 31
- Weak connectivity, 284, 297
- WeaklyConnectedComponents, 27
- Weighted
 - edges, 197
 - independent sets, 335
 - matchings, 343
- Weighted graphs, 198
- WeightingFunction, 31
- WeightRange, 31
- Wetherell, C., 217
- Wheel
 - chromatic number, 309
 - connectivity, 292
 - construction, 249
 - eccentricity, 332
 - join, 239
 - properties, 319
- Wheel, 24, 25, 111, 239, **249**
- While, 46, 48
- White, D., 100, 143, 174, 269, 358, 360
- Whitney, H., 242, 291
- Wildcard, 42
- Wilf, H., 61, 67, 72, 87, 138, 144, 167, 168, 170, 174, 242, 258
- Wilkes, J., 315
- Wilson, D., 61
- Wilson, R., 260, 264, 297
- Wolfram, S., 41
- World War II, 297
- Wormald, N., 268
- Writing graphs, 224
- www.combinatorica.com, 225

- Yen's algorithm, 328
- Young tableaux, 7, 134, 135
 - definition, 162
 - insertion operation, 163
 - involutions, 105
 - lexicographic order, 167
 - random, 170
 - representation, 45
 - shape, 162
- Young's lattice, 174

- Zeilberger, D., 168
- Zeno's paradox, 44
- Zoom, 16, 17