Table of Contents

Introduction 1
Chapter 1 Fundamentals 3
1.1 Sets 3
1.2 Functions 5
1.3 Relations 7
1.4 Equivalence Relations 9
1.5 Partial Orders 11
1.6 Lattices 13
1.7 Boolean Algebra 15
1.8 Combinatorial Principles 17
1.9 Binomial Coefficients 19
1.10 Pigeonhole Principle 21
1.11 Inclusion-Exclusion 23
1.12 Generating Functions 25
1.13 Recurrence Relations 27
1.14 Graphs 29
1.15 Trees 31
1.16 Spanning Trees 33
1.17 Minimum Spanning Tree 35
1.18 Shortest Path 37
1.19 Dijkstra's Algorithm 39
1.20 Bellman-Ford Algorithm 41
1.21 Floyd-Warshall Algorithm 43
1.22 Topological Sort 45
1.23 Strongly Connected Components 47
1.24 Bipartite Graphs 49
1.25 Matching 51
1.26 Hamiltonian Paths 53
1.27 Eulerian Paths 55
1.28 Planar Graphs 57
1.29 Euler's Formula 59
1.30 Kuratowski's Theorem 61
1.31 Chromatic Number 63
1.32 Greedy Algorithms 65
1.33 Dynamic Programming 67
1.34 Memoization 69
1.35 Divide and Conquer 71
1.36 Binary Search 73
1.37 Sorting Lower Bound 75
1.38 Merge Sort 77
1.39 Quicksort 79
1.40 Heapsort 81
1.41 Priority Queue 83
1.42 Binary Heap 85
1.43 Fibonacci Heap 87
1.44 Disjoint Set Union 89
1.45 Path Compression 91
1.46 Union by Rank 93
1.47 Hash Table 95
1.48 Collision Resolution 97
1.49 Open Addressing 99
1.50 Chaining 101
1.51 Universal Hashing 103
1.52 Perfect Hashing 105
1.53 Bloom Filter 107
1.54 Cuckoo Hashing 109
1.55 Consistent Hashing 111
1.56 Rolling Hash 113
1.57 Rabin-Karp Algorithm 115
1.58 Knuth-Morris-Pratt Algorithm 117
1.59 Z-Algorithm 119
1.60 Suffix Array 121
1.61 Suffix Tree 123
1.62 Longest Common Subsequence 125
1.63 Longest Common Substring 127
1.64 Edit Distance 129
1.65 Levenshtein Automata 131
1.66 Knapsack Problem 133
1.67 Subset Sum 135
1.68 Partition Problem 137
1.69 Bin Packing 139
1.70 Job Scheduling 141
1.71 Interval Scheduling 143
1.72 Weighted Interval Scheduling 145
1.73 Activity Selection 147
1.74 Huffman Coding 149
1.75 Canonical Huffman Code 151
1.76 Arithmetic Coding 153
1.77 Run-Length Encoding 155
1.78 Burrows-Wheeler Transform 157
1.79 Move-to-Front Transform 159
1.80 Lempel-Ziv 77 161
1.81 Lempel-Ziv 78 163
1.82 Lempel-Ziv-Welch 165
1.83 Deflate 167
1.84 Gzip Header 169
1.85 Zlib Header 171
1.86 Adler-32 173
1.87 Cyclic Redundancy Check 175
1.88 Hamming Code 177
1.89 Reed-Solomon Code 179
1.90 Convolutional Code 181
1.91 Viterbi Algorithm 183
1.92 Turbo Code 185
1.93 Low-Density Parity-Check Code 187
1.94 Polar Code 189
1.95 Shannon Entropy 191
1.96 Mutual Information 193
1.97 Channel Capacity 195
1.98 Shannon-Fano Coding 197
1.99 Kraft Inequality 199
1.100 Prefix Code 201
1.101 Uniquely Decodable Code 203
1.102 Asymmetric Numeral Systems 205
1.103 Range Coding 207
1.104 Dictionary Coding 209
1.105 Sliding Window 211
1.106 Lazy Matching 213
1.107 Hash Chain 215
1.108 Binary Tree Traversal 217
1.109 Preorder Traversal 219
1.110 Inorder Traversal 221
1.111 Postorder Traversal 223
1.112 Level Order Traversal 225
1.113 Morris Traversal 227
1.114 Threaded Binary Tree 229
1.115 Binary Search Tree 231
1.116 Insertion 233
1.117 Deletion 235
1.118 Successor 237
1.119 Predecessor 239
1.120 Lowest Common Ancestor 241
1.121 Binary Lifting 243
1.122 Heavy-Light Decomposition 245
1.123 Centroid Decomposition 247
1.124 Euler Tour Technique 249
1.125 Segment Tree 251
1.126 Lazy Propagation 253
1.127 Fenwick Tree 255
1.128 Range Query 257
1.129 Point Update 259
1.130 Coordinate Compression 261
1.131 Sparse Table 263
1.132 Mo's Algorithm 265
1.133 Square Root Decomposition 267
1.134 Persistent Data Structure 269
1.135 Path Copying 271
1.136 Fat Node 273
1.137 Node Copying 275
1.138 Persistent Array 277
1.139 Persistent Stack 279
1.140 Persistent Queue 281
1.141 Persistent Deque 283
1.142 Persistent Union-Find 285
1.143 Persistent Segment Tree 287
1.144 Persistent Binary Search Tree 289
1.145 Persistent Hash Table 291
1.146 Trie 293
1.147 Compressed Trie 295
1.148 Radix Tree 297
1.149 Suffix Trie 299
1.150 Suffix Automaton 301
1.151 Aho-Corasick Automaton 303
1.152 Failure Function 305
1.153 Dictionary Matching 307
1.154 Wildcard Matching 309
1.155 Regular Expression Matching 311
1.156 Finite Automaton 313
1.157 Deterministic Finite Automaton 315
1.158 Nondeterministic Finite Automaton 317
1.159 Epsilon Closure 319
1.160 Subset Construction 321
1.161 Minimization 323
1.162 Hopcroft Minimization 325
1.163 Brzozowski Minimization 327
1.164 Regular Expression Derivative 329
1.165 Thompson Construction 331
1.166 Glushkov Construction 333
1.167 Pattern Matching Machine 335
1.168 Longest Prefix Suffix 337
1.169 Manacher's Algorithm 339
1.170 Palindromic Tree 341
1.171 Eertree 343
1.172 Aho-Corasick Failure Link 345
1.173 Dictionary Compression 347
1.174 Grammar Compression 349
1.175 Repair Algorithm 351
1.176 Sequitur Algorithm 353
1.177 Lempel-Ziv-Welch Decompression 355
1.178 Bit Stream Reader 357
1.179 Bit Stream Writer 359
1.180 Varint Encoding 361
1.181 Zigzag Encoding 363
1.182 Delta Encoding 365
1.183 Frame of Reference Encoding 367
1.184 Bit Packing 369
1.185 Simd Decoding 371
1.186 Vectorized Decoding 373
1.187 Streaming Decoder 375
1.188 Chunked Encoding 377
1.189 Checksum Verification 379
1.190 Corrupt Input Handling 381
1.191 Fuzzing Harness 383
1.192 Property Test Generator 385
1.193 Golden Test Vector 387
1.194 Benchmark Harness 389
1.195 Profiling Hot Path 391
1.196 Memory Allocation Pattern 393
1.197 Zero Copy Parsing 395
1.198 Borrowed Slice Lifetime 397
1.199 Error Recovery Strategy 399
1.200 Conclusion 401