

# *General Index*

- acceptance window, 563  
acoustic model, 231  
adjacency list, 109  
agglutinative language, 176  
algebraic power series, 537  
algorithm  
    ACYCLICMINIMIZATION, 34  
    ADDTOTRIE, 17  
    AUTOMATAPRODUCT, 39  
    AUTOMATAUNION, 38  
    AUTOMATONLETTER, 38  
    AUTOMATONSTAR, 39  
    BORDER, 8  
    BORDERSHARP, 97  
    CHECKSIMPLE, 499  
    CIRCULARMIN, 14  
    CLONE, 133  
    CLOSURE, 510  
    COMPOSETRANSDUCERS, 44  
    CONVEX, 500  
    DOMINANTEIGENVALUE, 73  
    ENCODEMAP, 516  
    ENTROPY, 90  
    EPSILON, 58  
    EVALEXP, 56  
    EVALFACT, 56  
    EVALTERM, 56  
    EXTENSION, 133  
    FASTFIND, 118  
    FIRST, 59  
    FLORENTINEREJECTION, 503  
    FOLLOW, 60  
    FOOTPRINTER, 253  
    FORBIDDENWORDS, 152  
    HOPCROFTMINIMIZATION, 31  
    ISACCEPTED, 23  
    ISINTRIE, 17  
    ISSUBWORD, 11  
    K-REPETITIONS, 468  
    LCP, 48  
    LCS, 13  
    LCSLENGTHARRAY, 12  
    LENGTHSOFFACTORS, 156  
    LLTABLE, 62  
    LONGEST-PREFIX-EXTENSION,  
        441  
    LONGESTCOMMONPREFIX, 7  
    LONGESTCOMMON-  
        PREFIXARRAY, 51  
    LONGESTPREFIXINTRIE, 17  
    LRPARSE, 67  
    LYNDONFACTORIZATION, 15  
    MAXIMAL-REPETITIONS, 447  
    MISMATCH-RIGHT-  
        REPETITIONS, 465  
    MISMATCH-RIGHT-SUBRUNS,  
        469  
    MOOREMINIMIZATION, 28  
    NAIVESTRINGMATCHING, 10  
    NEXT, 21–23, 48  
    NFATODFA, 24  
    NORMALIZETRANSDUCER, 51  
    PROCESS-BLOCK, 467  
    RANDMAP, 511  
    RANDPERM, 494  
    REMOVEFROMTRIE, 18  
    RIGHT-LOCAL-SQUARES, 459  
    RIGHT-REPETITIONS, 444

- algorithm (*cont.*)
  - RUNS-THIRD-STAGE, 472
  - SEARCHFACTOR, 11
  - SLOWFIND, 109
  - SLOWFIND-BIS, 110
  - SLOWFINDC, 117
  - SMILE, 258
  - SPELLER, 251
  - STAIRCASE, 496
  - SUFFIXAUTOMATON, 132
  - SUFFIXTREE, 116
  - SUFFIXTRIE, 109
  - SUFFIXTRIE-BIS, 111
  - TOSEQUENTIALTRANSDUCER, 49
  - UNIMODAL, 498
  - VITERBI, 98
  - WEIGHTED-COMPOSITION, 213
  - WEIGHTED-DETERMINIZATION, 218
  - ZLDECODING, 87
  - ZLENCODING, 86
- alignment, 188, 189
- alphabet, 3
  - DNA alphabet, 270
  - alphabetic order, 5
  - ambiguity
    - lexical, 173
  - amino acid, 271
  - animal, 492
  - approximate eigenvector, 73
  - approximate repetition, 461
  - approximate square, 461
  - Arnoux–Rauzy word, 575
  - asymptotic equirepartition property, 85
- autocorrelation
  - polynomial, 93, 278, 311, 361, 402, 415
  - set, 361
- automatic sequence, 524
- automaton, 19
  - complete, 21
  - deterministic, 20
  - finite, 21
- literal, 20
- minimal, 27
- of analyses, 198
- path, 19
- state, 19
- trim, 19
- unambiguous, 19
- weighted, 212
- basis, 260, 261, 267
- beam search, 234
  - synchronous, 234
- Bernoulli distribution, 75
- Bernoulli source, 356
- best approximations, 564
- beta
  - expansion, 572, 577
  - integers, 573
  - transformation, 572, 577
- bimachine, 103, 192
- bounded remainder
  - letter, 570
  - set, 571
- capacity
  - ( $l, k$ ) sequences, 393
- Carlitz formal power series, 541
- cascade transduction, 186
- Catalan number, 70, 484
- central limit theorem, *see* Gaussian approximation
  - exact string matching, 370
  - generalized pattern matching, 389
  - reduced string matching, 379
  - self-similar pattern matching, 415
  - subsequence pattern matching, 402
- cepstra, 232
  - delta, 232
  - delta–delta, 232
- cepstral coefficients, 232
- cepstrum, 232
- character
  - encoding, 165
- Chen–Stein method, 339

- chi-square
  - statistic, 276, 277
  - test, 275
- Christol's theorem, 539
- clump, 278, 279
  - k*-clump, 278, 280
  - mixed, 322
  - size of, 278
- codon, 271
- COMBI, 244, 252, 260, 262, 265
- compact suffix automaton, 138
- compaction of trie, 113
- complexity function, 569
- composition
  - filter, 215
  - of weighted transducers, 213, 234
- compound Poisson approximation, 302, 319, 340
- compound words, 172
- confidence interval, 307, 340
- conjugate words, 4, 159
- constant length morphism, 522
- constituent, 204
- context-dependency
  - model, 230
  - n*-phonic model, 230
  - transduction, 230
- context-free grammar, 204, 206
- correlation
  - matrix, 377
  - number, 398
  - polynomial, 324, 377
  - set, 377
- count
  - of clumps, *see* declumped count
  - of overlapping occurrences, *see* word count
  - of renewals, *see* renewal count
- critical factorization theorem, 455
- cut and project scheme, 563
- DAWG, 174
- de Bruijn graph, 229, 335, 382
- declumped count, 279, 298
  - Poisson approximation, 298, 302, 320
- decoder, 234
- delimiter, 168
- delta method, 294, 344
- density, 534
- depth, 416
- deterministic
  - weighted automata, 217
- determinizable
  - weighted automata, 220
- determinization, 181
  - weighted automata, 217
  - weighted transducers, 217, 235
- dictionary, 172
- discrete topology, 521
- distance, 5
  - edit, 6, 243, 262, 264, 266
  - Hamming, 5, 243, 245, 266
  - subword, 6
- distance between occurrences, 282
  - distribution, 283
  - expectation, 284
  - moment-generating function, 284
  - scan, 286
  - variance, 284
- don't care symbol, 241, 242, 244, 259–261
- Dyck language, 53
- dynamical source, 357, 407
- edge label representation, 114
- encoding
  - character, 165
- end position, 122
- error
  - lexical, 176
- exact pattern matching, 359
- exceptional word, 328
- exponent, 431
- factor, 3
  - proper, 3
- failure function, 155, 158
- family of words, 315, 319, 322, 323
  - reduced set, 316
- Fibonacci numbers, 21, 524
- Fibonacci word, 524

- Fibonacci words, 434
- Fine and Wilf's theorem, 432
- fixed point, 522, 524
- FOOTPRINTER, 245, 252, 253, 264, 266
- forbidden word, 152
- fork, 108, 138
- formal Laurent series, 536
- formal power series, 536
- Fourier transform, 232
- Gamma function  $\Gamma(z)$ , 367
- Gaussian approximation, 290, 312, 316, 324, 338
- generalized index, 143
- generalized pattern matching, 375
- generating operator, 359, 407
- Gilbreath's card trick, 25
- Golden mean automaton, 21, 570
- grammar
  - statistical, 227
  - weighted, 227
- graph, 179, 201
- hapax, 170
- head, 107
- hidden Markov model, 231, 235
- hidden patterns, 355, 393
- homography, 173
- Hopcroft's algorithm, 30
- implementation of transition, 109
- incidence matrix, 535, 546
- index, 142
  - index membership, 144
- inflection, 172
- initial prefix, 45
- integer power, 431
- intersection
  - weighted automata, 215
- irreducibility, 384
- iterates of a morphism, 522
- kernel, 526, 527
- KMRC, 246, 266
- Kolmogorov theorem, 78
- lacuna
  - lexical, 176
- language, 362
- language model, 227
  - Katz back-off, 229, 235
- large deviation principle, 309, 345
- large deviations
  - exact string matching, 371
  - generalized pattern matching, 389
  - reduced string matching, 379
  - subsequence pattern matching, 405
- lattice, 198
- lemma, 172
- lexical
  - ambiguity, 173
  - analysis, 165
  - error, 176
  - lacuna, 176
  - tagging, 172
- lexicographic order, 5
- ligature, 165, 168
- likelihood, 273
- literal
  - alignment, 188
- literal automaton, 20
- local grammar, 201
- local limit theorem
  - exact string matching, 370
  - generalized pattern matching, 391
  - subsequence pattern matching, 405
- local period, 455
- longest common
  - factor, 159
  - prefix, 3
  - subword, 3
- longest context, 145
- longest extension functions, 439
- loop, 480
- Markov chain, 75, 198, 269, 271
  - aperiodic, 76
  - embedding technique, 273, 308
  - irreducible, 76
  - maximal order, 291

- order, 271, 275, 329  
parameters, *see* transition matrix  
phase, 272  
reversed chain, 273  
stationary distribution, 271  
Markov source, 357, 366  
martingale, 291, 345  
matrix  
    aperiodic, 71  
    irreducible, 71  
    nonnegative, 71  
    positive, 71, 535  
    primitive, 71  
    stochastic, 535  
maximal repetition, 432  
memoryless source, 356  
    biased, 356  
    unbiased, 356  
Meyer set, 563  
minimal  
    weighted automata, 223  
minimal automaton, 27  
minimal forbidden word, 152  
minimization  
    weighted automata, 223  
    weighted transducers, 235  
MITRA-COUNT, 244, 252, 255,  
    264–266  
MITRA-DYAD, 257, 267  
MITRA-GRAF, 246, 255–257, 264  
model, *see* probabilistic model  
model set, 563  
Möbius, 567  
moment-generating function, 284,  
    343  
moments  
    exact string matching, 366  
    generalized subsequence  
        problem, 411  
    subsequence pattern matching,  
        400  
Moore's algorithm, 28  
morphic, 524  
morphism, 522  
    of constant length, 522  
    of Pisot type, 570, 576  
uniform, 522, 524  
unimodular, 576  
network expression, 241–249,  
    251–265, 267  
basis, 260, 261, 267  
simple, 241–245, 247–249,  
    251–256  
tandem, 261–264  
with spacers, 241, 256–260  
NEWAUTOMATON, 109  
NEWSTATE, 109  
normal approximation, *see*  
    Gaussian approximation  
number of factors, 147  
occurrence, 277, 278  
distance, *see* distance between  
    occurrences  
overlap, *see* period  
phased, 296  
probability, 279  
waiting time, 347  
output of state, 109  
overlap, 546  
overlapping occurrences, 277  
    clump, *see* clump  
paperfolding word, 526, 528  
path, 19, 492  
    successful, 19  
period, 4, 277  
    minimal, 4  
    principal, 277, 279  
Perron–Frobenius theorem, 70, 380,  
    386, 535  
perturbed symmetry, 526  
phase, 296, 332  
phone, 227, 230  
    context-dependent, 230  
phoneme, 230  
Pisot number, 546  
Poisson approximation, 287, 297,  
    313, 319, 325, 336, 339  
POIVRE, 244, 247, 252, 260, 262,  
    264–266

- polygon, 492
- polyomino, 493
- position tree, 112
- PRATT, 244, 259, 260, 265, 267
- prefix, 3
  - proper, 3
- prefix automaton, 570
- prefix distance, 7
- prefix order, 4
- primitive pattern, 384
- primitive word, 4, 543
- primitively-rooted square, 431
- primitivity, 384
- probabilistic model, 270
  - hidden Markov model, 269
  - Markov model, *see* Markov chain
- probability measure, 78
- probability of occurrence, 534
- pronunciation model, 230, 235
- Prouhet–Thue–Morse word, 525
- p*-value, 310, 328, 373
- pyramid, 501
- quasi-square, 448
- quorum, 244, 246, 247, 249–251, 253–255, 258, 260, 262, 264, 266
- radix order, 5
- rare word assumption, 297
- rational
  - function, 41, 99, 103
  - nonnegative, 99
  - relation, 41
- Rauzy
  - fractal, 552
  - norm, 558
- recognizable set, 19
- recognized set, 19
- recursive transition network, 203
- reduced pattern matching, 376
- redundancy, 175
- regular set, 19
- relation, 40
  - composition, 40
  - rational, 41
- relatively dense, 563
- renewal, 278, 281
- renewal count, 281, 311
  - competing, 323
  - expectation, 311
  - Gaussian approximation, 312
  - Poisson approximation, 313
- repeat with fixed gap, 450
- repeat with fixed gap word, 454
- repetition, 431
- right context, 121
- right position, 122
- root, 278
  - principal, 278
- rotation of a word, 159
- RTN, 203
  - parameterized, 205
- Rudin–Shapiro word, 525, 528
- SATELLITE, 262–264, 267
- score, 294, 328
- self-similar pattern matching, 413
- semi-pyramid, 501
- semiring, 211
  - Boolean, 211
  - log, 211, 238
  - probability, 211
  - tropical, 211
- sequence
  - DNA sequence, 270, 328
- sequential
  - function, 45
  - transducer, 45
- set
  - recognizable, 21
- shortest context, 146
- shuffle, 25
- sibling
  - states, 220
- $\sigma$ -additive, 77
- $\sigma$ -algebra, 77
- simultaneous combination, 188
- slitplane, 488
- SMILE, 244, 257–260, 264, 265, 267

- solid, 130  
source  
    memoryless, 356  
spacer, 241, 256, 257, 259, 260,  
    265, 267  
spectral decomposition, 388  
spectrum, 335  
speech, 196, 226  
speech recognition, 226  
    statistical formulation, 226  
SPELLER, 244, 249, 251, 252, 255,  
    257–260, 263–266  
square, 431  
square-free number, 568  
state, 19  
    initial, 19  
    terminal, 19  
state diagram, 19  
statistical  
    grammar, 227  
statistical grammar  
    Katz back-off, 229  
    n-gram model, 228  
Stein’s method, 338, 340  
step, 480  
stochastic matrix, 535  
string matching  
    exact, 354, 359  
    generalized, 354, 375, 382  
    reduced, 376  
    self-similar, 413  
structured motif, 347  
Sturmian word, 524  
subsequence pattern matching, 355,  
    393  
    generalize, 355  
    generalized, 407  
subsequential  
    weighted automata, 219  
subsequential  
    weighted automata, 217  
substitution matrix, 535  
substitutive, 524  
subword, 3  
suffix, 3  
    proper, 3  
suffix array, 163  
suffix automaton, 121, 127  
suffix function, 123  
suffix link, 110, 130  
suffix link function, 110  
suffix paths, 131  
suffix tree, 113, 248, 249, 251, 259,  
    266  
suffix trie, 107, 416  
syntactic  
    table, 205  
syntactic congruence, 122  
syntactic equivalence, 121  
  
table  
    syntactic, 205  
tag, 171  
tail, 108  
TARGETSTATE, 109  
terminal  
    function, 45  
Thue–Morse word, 77, 525,  
    528  
token, 168  
topological entropy, 82  
topology, 521  
total variation distance, 339  
transducer, 41  
    p-sequential, 173  
    alignment, 188  
    ambiguous, 173, 180  
    finite, 166  
    generalized sequential, 181  
    literal, 42, 166  
    sequential, 45, 167  
    subsequential, 103  
    synchronous, 42, 166  
    weighted, 212  
transduction, 166  
    cascade, 186  
transition matrix, 271, 535  
    eigenvalue, 272  
    estimation, 273  
transliteration  
    ambiguous, 168  
    unambiguous, 166

- Tribonacci
  - morphism, 546
  - normal representation, 548
  - sequence, 548
  - word, 525, 546
- trie, 416, 423
- twinning property, 47
- twins
  - property, 220
  - states, 220
- two-level morphology, 191
- uniform balance, 570
- uniform morphism, 522, 524
- unique ergodicity, 87
- vector
  - nonnegative, 70
  - positive, 70
- Viterbi
  - algorithm, 98, 234
  - approximation, 211, 233, 234
- waiting time, 359, 374
- walk, 480
  - reverse, 480
  - length of a, 480
  - self-avoiding, 492
- WEEDER, 246, 266
- weight pushing, 220, 235
  - weighted automata, 220
- weighted automata
  - deterministic, 217
  - determinizable, 220
  - intersection, 215
- minimal, 223
- minimization, 223
- subsequential, 219
- subsequential, 217
- weight pushing, 220
- weighted transducers
  - composition, 213, 234
  - determinization, 217
  - minimization, 223
- Wielandt function, 72
- WINOWER, 246, 247, 254, 255, 264, 266
- word
  - conjugate, 4
  - Dyck, 482
  - linguistic, 172
  - Motzkin, 485
  - palindrome, 4
  - period, 4
  - primitive, 4
  - reversal, 4
- word bag model, 199
- word count, 279
  - asymptotic variance, 294
  - compound Poisson
    - approximation, 302, 306, 307, 322
  - distribution, 289
  - expectation, 290
  - Gaussian approximation, 290, 316
  - variance, 290
- Z-score, 373
- Ziv–Lempel encoding, 86
- Ziv–Lempel factorization, 86