

## Bibliography to Volume I

- Aho AV, Corasick MJ (1975) Efficient string matching: an aid to bibliographic search. *Commun. ACM* 18: 333–340
- Aho AV, Ullman JD (1972) The theory of parsing, translation, and compiling, vol. I: parsing. Prentice-Hall, Englewood Cliffs, NJ
- Aho AV, Ullman JD (1973) The theory of parsing, translation, and compiling, vol. II: compiling. Prentice-Hall, Englewood Cliffs, NJ
- Aho AV, Ullman JD (1977) Principles of compiler design. Addison-Wesley, Reading, MA
- Aho AV, Denning PJ, Ullman JD (1972) Weak and mixed strategy precedence parsing. *J. Assoc. Comput. Mach.* 19: 225–243
- Aho AV, Hopcroft JE, Ullman JD (1974) The design and analysis of computer algorithms. Addison-Wesley, Reading, MA
- Aho AV, Hopcroft JE, Ullman JD (1983) Data structures and algorithms. Addison-Wesley, Reading, MA
- Aho AV, Sethi R, Ullman JD (1986) Compilers: principles, techniques, and tools. Addison-Wesley, Reading, MA
- Arbib MA, Kfoury AJ, Moll RN (1981) A basis for theoretical computer science. Springer, New York, Heidelberg, Berlin
- Baase S (1978) Computer algorithms—Introduction to design and analysis. Addison-Wesley, Reading, MA
- Backhouse RC (1979) Syntax of programming languages: theory and practice. Prentice-Hall International, London
- Backus JW (1959) The syntax and semantics of the proposed international algebraic language of the Zurich ACM-GAMM conference. In: *Proc. Internat. Conf. on Information Processing*, June 1959. UNESCO, pp. 125–132
- Bar-Hillel Y, Perles M, Shamir E (1961) On formal properties of simple phrase structure grammars. *Z. Phonetik Sprachwiss. Kommunikationsforsch.* 14: 143–172
- Bauer FL, Eickel J, eds. (1976) Compiler construction: An advanced course, 2nd ed. Springer, Berlin, Heidelberg, New York
- Bauer H, Becker S, Graham SL (1968) ALGOL W implementation. Report CS98, Computer Science Department, Stanford University, Stanford, CA
- Blum N (1982) On the power of chain rules in context-free grammars. *Acta Inf.* 17: 425–433
- Chomsky N (1956) Three models for the description of language. *IRE Trans. Inf. Theory* 2: 113–124
- Chomsky N (1959) On certain formal properties of grammars. *Inf. Control* 2: 137–167
- Chomsky N (1962) Context-free grammars and pushdown storage. Quarterly Progress Report, no. 65, Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, MA
- Chomsky N (1963) Formal properties of grammars. In: *Handbook of Math. Psych.*, vol. 2. Wiley, New York
- Chomsky N, Miller GA (1958) Finite state languages. *Inf. Control* 1: 91–112
- Ciesinger J (1979) A bibliography of error-handling. *ACM SIGPLAN Notices* 14, no. 1: 16–26
- Conway ME (1963) Design of a separable transition-diagram compiler. *Commun. ACM* 6: 396–408
- Culik K II (1968) Contribution to deterministic top-down analysis of context-free languages. *Kybernetika* 4: 422–431
- DeRemer FL, Pennello TJ (1982) Efficient computation of LALR(1) lookahead sets. *ACM Trans. Program. Lang. Syst.* 4: 615–649

- Deussen P (1979) One abstract accepting algorithm for all kinds of parsers. In: Maurer H (ed.) *Automata, Languages and Programming. Sixth Colloquium, Graz, July 1979*. Springer, Berlin, Heidelberg, New York, pp. 203–217 (Lecture notes in computer science, vol. 71)
- Earley J (1968) An efficient context-free parsing algorithm. Thesis, Carnegie-Mellon University, Pittsburgh, PA
- Earley J (1970) An efficient context-free parsing algorithm. *Commun. ACM* 13: 94–102
- Ehrenfeucht A, Zeiger P (1976) Complexity measures for regular languages. *J. Comput. Syst. Sci.* 12: 134–146
- Eve J, Kurki-Suonio R (1977) On computing the transitive closure of a relation. *Acta Inf.* 8: 303–314
- Even S (1980) *Graph algorithms*. Computer Science Press, Rockville, MD
- Evey RJ (1963) Applications of pushdown-store machines. In: *Proc. AFIPS Fall Joint Computer Conference*. AFIPS Press, Montvale, NJ, pp. 215–227
- Fischer MJ (1969) Some properties of precedence languages. In: *ACM Symp. on Theory of Computing*. ACM, New York, pp. 181–190
- Floyd RW (1963) Syntactic analysis and operator precedence. *J. Assoc. Comput. Mach.* 10: 316–333
- Garey MR, Johnson DS (1979) *Computers and intractability: a guide to the theory of NP-completeness*. Freeman, San Francisco
- Geller MM, Hunt HB III, Szymanski TG, Ullman JD (1977) Economy of description by parsers, DPDA's, and PDA's. *Theor. Comput. Sci.* 4: 143–153
- Ginsburg S (1966) *The mathematical theory of context-free languages*. McGraw-Hill, New York
- Ginsburg S, Greibach SA (1966) Deterministic context-free languages. *Inf. Control* 9: 620–648
- Goldstine J, Price JK, Wotschke D (1982) A pushdown automaton or a context-free grammar—which is more economical? *Theor. Comput. Sci.* 18: 33–40
- Graham SL (1970) Extended precedence languages, bounded right context languages and deterministic languages. In: *11th Annual IEEE Symp. on Switching and Automata Theory, 1970*. IEEE, New York, pp. 175–180
- Graham SL (1971) *Precedence languages and bounded right context languages*. Thesis, Department of Computer Science, Stanford University, Stanford, CA
- Graham SL, Harrison MA, Ruzzo WL (1980) An improved context-free recognizer. *ACM Trans. Program. Lang. Syst.* 2: 415–462
- Gray JN, Harrison MA (1969) Single-pass precedence analysis. In: *10th Annual IEEE Symp. on Switching and Automata Theory, 1969*. IEEE, New York, pp. 106–117
- Gray JN, Harrison MA (1972) On the covering and reduction problems for context-free grammars. *J. Assoc. Comput. Mach.* 19: 675–698
- Greibach SA (1965) A new normal form theorem for context-free phrase structure grammars. *J. Assoc. Comput. Mach.* 12: 42–52
- Gries D (1971) *Compiler construction for digital computers*. Wiley, New York
- Haines LH (1965) *Generation and recognition of formal languages*. Thesis, Massachusetts Institute of Technology, Cambridge, MA
- Hammond K, Rayward-Smith VJ (1984) A survey on syntactic error recovery and repair. *Comput. Lang.* 9: 51–67
- Harrison MA (1978) *Introduction to formal language theory*. Addison-Wesley, Reading, MA
- Heilbrunner S (1981) A parsing automata approach to LR theory. *Theor. Comput. Sci.* 15: 117–157
- Hopcroft JE (1971) An  $n \log n$  algorithm for minimizing the states in a finite automaton. In: Kohavi Z (ed.) *The Theory of Machines and Computations*. Academic Press, New York, pp. 189–196
- Hopcroft JE, Ullman JD (1969) *Formal languages and their relation to automata*. Addison-Wesley, Reading, MA
- Hopcroft JE, Ullman JD (1979) *Introduction to automata theory, languages, and computation*. Addison-Wesley, Reading, MA
- Huffman DA (1954) The synthesis of sequential switching circuits. *J. Franklin Inst.* 257: 3–4, 161–190, 275–303
- Hunt HB III (1979) Observations on the complexity of regular expression problems. *J. Comput. Syst. Sci.* 19: 222–236
- Hunt HB III, Rosenkrantz DJ, Szymanski TG (1976) On the equivalence, containment, and covering problems for the regular and context-free languages. *J. Comput. Syst. Sci.* 12: 222–268

- Hunt HB III, Szymanski TG, Ullman JD (1974) Operations on sparse relations and efficient algorithms for grammar problems. In: 15th Annual IEEE Symp. on Switching and Automata Theory, October 1974. IEEE, New York, pp. 127–132
- Hunt HB III, Szymanski TG, Ullman JD (1977) Operations on sparse relations. *Commun. ACM* 20: 171–176
- Ichbiah JD, Morse SP (1970) A technique for generating almost optimal Floyd-Evans productions for precedence grammars. *Commun. ACM* 13: 501–508
- Johnson DB, Sethi R (1975) Efficient construction of LL(1) parsers. Technical Report no. 164, Computer Science Department, Pennsylvania State University, University Park, PA
- Johnson DB, Sethi R (1976) A characterization of LL(1) grammars. *BIT* 16: 275–280
- Johnson WL, Porter JH, Ackley SI, Ross DT (1968) Automatic generation of efficient lexical analyzers using finite state techniques. *Commun. ACM* 11: 805–813
- Kasami T (1965) An efficient recognition and syntax algorithm for context-free languages. Scientific report AFCRL-65-758, Air Force Cambridge Research Laboratory, Bedford, MA
- Kfoury AJ, Moll RN, Arbib MA (1982) A programming approach to computability. Springer, New York, Heidelberg, Berlin
- Kleene SC (1956) Representation of events in nerve nets and finite automata. In: *Automata studies*. Princeton Univ. Press, Princeton, NJ, pp. 3–42
- Knuth DE (1965) On the translation of languages from left to right. *Inf. Control* 8: 607–639
- Knuth DE (1967) Top-down syntax analysis. Lecture Notes, International Summer School on Computer Programming, Copenhagen
- Knuth DE (1971) Top-down syntax analysis. *Acta Inf.* 1: 79–110
- Knuth DE, Morris JH Jr, Pratt VR (1977) Fast pattern matching in strings. *SIAM J. Comput.* 6: 323–350
- Korenjak AJ, Hopcroft JE (1966) Simple deterministic languages. In: 7th Annual IEEE Symp. on Switching and Automata Theory, October 1966. IEEE, New York, pp. 36–46
- Kurki-Suonio R (1966) On top-to-bottom recognition and left recursion. *Commun. ACM* 9: 527–528
- Kurki-Suonio R (1967) A note on LL(1) Languages. International Summer School on Computer Programming, Copenhagen
- Kurki-Suonio R (1969) Notes on top-down languages. *BIT* 9: 225–238
- Lesk ME (1975) LEX—a lexical analyzer generator. CSTR 39, Bell Laboratories, Murray Hill, NJ
- Lewis HR, Papadimitriou CH (1981) Elements of the theory of computation. Prentice-Hall, Englewood Cliffs, NJ
- Lewis PM II, Rosenkrantz DJ (1971) An ALGOL compiler designed using automata theory. In: *Proc. Symp. on Computers and Automata*, Polytechnic Institute of Brooklyn, NY, pp. 75–88 (Microwave research institute symposia series, vol. 21)
- Lewis PM II, Stearns RE (1966) Syntax-directed transduction. In: 7th Annual IEEE Symp. on Switching and Automata Theory, October 1966. IEEE, New York, pp. 21–35
- Lewis PM II, Stearns RE (1968) Syntax-directed transduction. *J. Assoc. Comput. Mach.* 15: 465–488
- Lewis PM II, Rosenkrantz DJ, Stearns RE (1976) Compiler design theory. Addison-Wesley, Reading, MA
- Lucas P (1961) Die Strukturanalyse von Formelübersetzern. *Electron. Rechenanlagen* 3: 159–167
- McKeeman WM, Horning JJ, Wortman DB (1970) A compiler generator. Prentice-Hall, Englewood Cliffs, NJ
- McNaughton R (1982) Elementary computability, formal languages, and automata. Prentice-Hall, Englewood Cliffs, NJ
- McNaughton R, Yamada H (1960) Regular expressions and state graphs for automata. *IEEE Trans. Electronic Computers* 9: 39–47
- Meyer AR, Fischer MJ (1971) Economy of description by automata, grammars and formal systems. In: 12th Annual IEEE Symp. on Switching and Automata Theory, October 1971. IEEE, New York, pp. 188–190
- Meyer AR, Stockmeyer LJ (1972) The equivalence problem for regular expressions with squaring requires exponential space. In: 13th Annual IEEE Symp. on Switching and Automata Theory, October 1972. IEEE, New York, pp. 125–129
- Moore EF (1956) Gedanken experiments on sequential machines. In: *Automata Studies*. Princeton Univ. Press, Princeton, NJ, pp. 129–153

- Myhill J (1957) Finite automata and the representation of events. In: WADD TR-57-624, Wright Patterson AFB, OH, pp. 112–137
- Naur P et al. (1960) Report on the algorithmic language ALGOL 60. *Commun. ACM* 3: 299–314, revised in *Commun. ACM* 6: 1–17
- Nerode A (1958) Linear automaton transformations. *Proc. Am. Math. Soc.* 9: 541–544
- Nijholt A (1983) Deterministic top-down and bottom-up parsing: historical notes and bibliographies. Mathematical Centre, Amsterdam
- Oettinger A (1961) Automatic syntactic analysis and the pushdown store. In: *Structure of Language and Its Mathematical Concepts*. Proc. 12th Symposium on Applied Mathematics. American Mathematical Society, Providence, RI, pp. 104–129
- Pair C (1964) Arbres, piles et compilation. *Revue Francaise de Traitement de l'Information* 7: 199–216
- Parikh RJ (1966) On context-free languages. *J. Assoc. Comput. Mach.* 13: 570–581
- Rabin MO, Scott D (1959) Finite automata and their decision problems. *IBM J. Res.* 3: 115–125
- Rosenkrantz DJ (1967) Matrix equations and normal forms for context-free grammars. *J. Assoc. Comput. Mach.* 14: 501–507
- Rosenkrantz DJ, Stearns RE (1970) Properties of deterministic top-down grammars. *Inf. Control* 17: 226–256
- Salomaa A (1969) *Theory of automata*. Pergamon Press, New York
- Salomaa A (1973) *Formal languages*. Academic Press, New York
- Savitch WJ (1982) *Abstract machines and grammars*. Little, Brown, Boston
- Schmidt EM (1978) Succinctness of descriptions of context-free, regular, and finite languages. DAIMI PB-84, Department of Computer Science, University of Aarhus, Denmark (also: Thesis, Cornell University, Ithaca, NY)
- Schützenberger MP (1963) On context-free languages and pushdown automata. *Inf. Control* 6: 246–264
- Sippu S (1982) Derivational complexity of context-free grammars. *Inf. Control* 53: 52–65
- Sippu S, Soisalon-Soininen E (1985) On the use of relational expressions in the design of efficient algorithms. In: Brauer W (ed.) *Automata, Languages and Programming*. Twelfth Colloquium, Nafplion, Greece, July 1985. Springer, Berlin, Heidelberg, New York, Tokyo, pp. 456–464 (Lecture notes in computer science, vol. 194)
- Stearns RE, Hunt HB III (1981) On the equivalence and containment problems for unambiguous regular expressions, grammars, and automata. In: 22nd Annual Symp. on Foundations of Computer Science, October 1981. IEEE, New York, pp. 74–81
- Stockmeyer LJ, Meyer AR (1973) Word problems requiring exponential time. In: 5th Annual ACM Symp. on Theory of Computing, April-May, 1973. ACM, New York, pp. 1–9
- Tarjan RE (1972) Depth-first search and linear graph algorithms. *SIAM J. Comput.* 1: 146–160
- Thompson K (1968) Regular expression search algorithm. *Commun. ACM* 11: 419–422
- Valiant LG (1975) General context-free recognition in less than cubic time. *J. Comput. Syst. Sci.* 10: 308–315
- Waite WM, Goos G (1984) *Compiler construction*. Springer, New York, Berlin, Heidelberg, Tokyo
- Warshall S (1962) A theorem on Boolean matrices. *J. Assoc. Comput. Mach.* 9: 11–12
- Wirth N (1968) PL-360: A programming language for the IBM 360 computers. *J. Assoc. Comput. Mach.* 15: 37–54
- Wirth N, Weber H (1966) Euler—a generalization of ALGOL and its formal definition. *Commun. ACM* 9: 13–23 (part 1), 89–99 (part 2)
- Wood D (1969a) A note on top-down deterministic languages. *BIT* 9: 387–399
- Wood D (1969b) The theory of left factored languages, part I. *Comput. J.* 12: 349–356
- Wood D (1970) The theory of left factored languages, part II. *Comput. J.* 13: 55–62
- Wood D (1971) A further note on top-down deterministic languages. *Comput. J.* 14: 396–403
- Wood D (1987) *Theory of computation*. Harper & Row, New York, NY
- Younger DH (1967) Recognition and parsing of context-free languages in time  $n^3$ . *Inf. Control* 10: 189–208

# Index to Volume I

- Acceptance
  - in a finite automaton 72
  - in a pushdown automaton 155, 160
  - in a RAM 14, 20
- Accepting computation
  - of a finite automaton 72
  - of a pushdown automaton 155
  - of a RAM 14
- Accepting configuration
  - of a finite automaton 72
  - of a pushdown automaton 155
- Accessible state 74
- Ackley, S. I. 114
- Action of a pushdown automaton 154
- Acyclic graph 4
- Adjacency matrix 61
- adjoins** relation 186, 191
- Aho, A. V. 35, 64, 113, 114, 151, 214, 215
- Alphabet 11
- Ambiguous context-free grammar 122
- Ambiguous finite automaton 73
- Ambiguous language description 70
- Ambiguous pushdown automaton 155
- Ambiguous regular expression 70
- Ambiguous regular grammar 83
- Ancestor node 4
- Antisymmetric relation 2
- Applicable rule 24
- Applicable rule string 25
- Arbib, M. A. 35
- Arc 3
- $\alpha$ -trans** relation 89
- Augmented grammar 174
- Automaton
  - ambiguous finite 73
  - ambiguous pushdown 155
  - completely specified finite 109
  - deterministic finite 87
  - deterministic pushdown 155
  - $\epsilon$ -free finite 75
  - finite 72
  - minimal finite 100, 110
  - nondeterministic finite 87
  - nondeterministic pushdown 155
  - normal-form finite 75
  - pushdown 154
  - reduced finite 74
  - unambiguous finite 73
  - unambiguous pushdown 155
- Baase, S. 64
- Backhouse, R. C. 215
- Backus, J. W. 151
- Backus–Naur form 151
- Bar-Hillel, Y. 113
- Basis of a monoid 8
- Bauer, F. L. 215
- Bauer, H. 215
- Becker, S. 215
- begins** relation 186
- Bijection 5
- Binary string 11
- Blum, N. 151
- BNF 151
- Boolean matrix 31
- Bottom-up parser 160
- Bounded stack 207
- Breadth-first order 60
- Canonical two-form grammar 133
- Cantor's diagonal argument 6
- Cardinal number 5
- Cardinality of a set 5
- Character 11
- Chomsky, N. 113, 136, 151, 214
- Chomsky normal-form grammar 136
- Ciesinger, J. 215
- Closed language family 68
- Closed monoid 7
- Closure of a relation 2, 3
- Closure of a set under a relation 3
- Cocke, J. 151, 169
- Cocke–Kasami–Younger algorithm 151
- Complement of a decision problem 15
- Completely specified finite automaton 109
- Complexity
  - of a derivation 29
  - of a language recognizer 20
  - of a pushdown automaton 160
  - of a RAM 19

- of a transformation 20
- of deriving in a grammar 136–137
- Composition of relations 2
- Computable function 14
- Computation
  - of a finite automaton 72
  - of a pushdown automaton 155
  - of a RAM 13
- Computational complexity 19
- Concatenation 9
- Configuration
  - of a finite automaton 72
  - of a pushdown automaton 154
  - of a RAM 12
- Connected component 39
- Containment problem 91
- contains** relation 131
- Context-free grammar 115
- Context-free language 117
- Context-free language recognition 144
- Conway, M. E. 215
- Corasick, M. J. 114
- Correct prefix property 207
- Correctly halting pushdown automaton 155
- Correctly halting RAM 13
- Correctly terminated computation of a RAM 13
- Cost criterion 19
- Countable set 5
- Countably infinite set 5
- Culik, K. 215
- Current input symbol 155
- Cycle 4
- Cyclic graph 4
  
- Dead state 74
- Decidable decision problem 15, 21
- Decision problem 14, 15
- Default action 210
- Denning, P. J. 215
- Denumerable set 5
- Depth-first order 39
- Depth-first traversal 37, 39
- DeRemer, F. L. 64
- Derivation
  - in a grammar 117
  - in a rewriting system 25
- Derivation tree 116–117
- Derivational complexity 136
- Derives relation 24, 25
- Descendant node 4
- Descriptive power 70–71
- Deterministic finite automaton 87
- Deterministic language 158
- Deterministic pushdown automaton 155
- Deterministic RAM 13
- Deterministic space 21
  
- Deterministic time 21
- Deterministic workspace 21
- Deussen, P. 35
- Diagonal argument 6, 17
- Diagonal matrix 32
- Directed graph 3
- Directly derives relation 25
- Directly leftmost derives relation 119
- Directly rightmost derives relation 119
- Disjunctive normal-form 106
- Domain
  - of a relation 1
  - of a relational expression 54
  
- Earley, J. 151, 169
- Edge 3
- Effectively closed language family 68
- $\varepsilon$ -free context-free grammar 130
- $\varepsilon$ -free finite automaton 75
- Ehrenfeucht, A. 113
- Eickel, J. 215
- Empty string 9
- empty-trans** relation 76, 89
- Encoding
  - of a relation 37
  - of a rewriting system 28
  - of a string 11
- End marker 154
- ends** relation 186
- enter**( $a$ ) 39
- Entering edge 3
- Enumeration 33
- $\varepsilon$ -position 143
- Equivalence class 4
- Equivalence
  - induced by a finite automaton 110
  - induced by a language 110
  - of language descriptions 69
- Equivalence problem 91
- Equivalence relation 4
- Equivalent state 111
- Error configuration
  - of a finite automaton 72
  - of a pushdown automaton 155
  - of a RAM 13
- Error detection 185
- Error handling 196
- Error recovery 212
- $\varepsilon$ -rule 130
- Eve, J. 64
- Even, S. 64
- Evey, R. J. 214
- exit**( $a$ ) 39
  
- Father node 4
- Final configuration of a RAM 13
- Final stack contents 154

- Final state 72
- Finite automaton 72
- Finite index 110
- Finite sequence 9
- Finite set 5
- Finite string 9
- Finite-machine program 72
- FIRST function 174
- first-of** relational expression 186
- Fischer, M. J. 113, 214, 215
- Floyd, R. W. 215
- FOLLOW function 174
- follows** relational expression 187, 191
- Free generation 8
- Free monoid 8
- Frontier of a derivation tree 147
- Function 5
  - defined by a transformation 14
  - defined on a graph 48
- Garey, M. R. 35
- Geller, M. M. 214
- General string 116
- General symbol 116
- Generator of a monoid 8
- Ginsburg, S. 151, 214
- Goldstine, J. 214
- Goos, G. 35, 151, 215
- Graham, S. L. 151, 215
- Grammar
  - ambiguous context-free 122
  - ambiguous regular 83
  - $\S$ -augmented 174
  - canonical two-form 133
  - Chomsky normal-form 136
  - context-free 115
  - $\epsilon$ -free context-free 130
  - Greibach normal-form 169
  - invertible 205
  - left-linear 83
  - left-recursive 149, 182
  - linear context-free 150
  - reduced context-free 130
  - regular 83
  - right-linear 83
  - simple 170
  - simple precedence 204
  - SLL( $k$ ) 178
  - strong LL( $k$ ) 178
  - unambiguous context-free 122
  - unambiguous regular 83
  - weak precedence 213
- Graph 3
- Gray, J. N. 151
- Greibach normal-form grammar 169
- Greibach, S. A. 169, 214
- Gries, D. 215
- Group 32
- guess** instruction 13
- Haines, L. H. 214
- Halting
  - of a pushdown automaton 155
  - of a RAM 13
- Halting problem 16
- Hammond, K. 215
- Harrison, M. A. 35, 114, 151, 214
- has-first-pos** relation 192
- has-last-pos** relation 192
- has-lookahead** relational expression 192
- has-rule** relation 192
- Hasse diagram 31
- Heilbrunner, S. 151
- Homomorphism 10
- Hopcroft, J. E. 35, 64, 113, 114, 151, 215
- Horning, J. J. 215
- Huffman, D. A. 113
- Hunt, H. B. III 64, 97, 113, 214, 215
- Ichbiah, J. D. 215
- Identity of a semigroup 7
- Identity relation 2
- Image of a set under a relation 2
- Immediate right recursion 211
- Inaccessible state 74
- Incorrectly halting pushdown automaton 155
- Incorrectly halting RAM 13
- Incorrectly terminated computation of a RAM 13
- Induced depth-first traversal 39
- Induced equivalence 110
- Induced monoid 7
- Induction 26
- ineq** relation 111
- Inequivalence problem 91
- Infinite sequence 6
- Infinite set 5
- Infinite string 6
- Inherently ambiguous context-free language 70, 122
- Initial configuration
  - of a finite automaton 72
  - of a pushdown automaton 155
  - of a RAM 12
- Initial stack contents 154
- Initial state 72
- Injection 5
- Input alphabet 72, 154
- Instance of decision problem 15
- Instantaneous description
  - of a finite automaton 72
  - of a pushdown automaton 154
  - of a RAM 12

- Interpretation in a lexical description 99
- Inverse
  - of a relation 2
  - of an element of a monoid 32
- Invertible grammar 205
- Irreflexive partial order 4
- Isomorphic monoids 11
- Isomorphic sets 5
- Isomorphism 11
- Item core of a grammar 190
  
- Johnson, D. B. 215
- Johnson, D. S. 35
- Johnson, W. L. 114
  
- Kasami, T. 151, 169
- Kfoury, A. J. 35
- Kleene, S. C. 68, 113
- Knuth, D. E. 114, 215
- Korenjak, A. J. 215
- Kosaraju, R. 64
- Kurki-Suonio, R. 64, 215
  
- Language
  - accepted by a finite automaton 72
  - accepted by a pushdown automaton 155
  - accepted by a RAM 14
  - accepted by a state 111
  - associated with a decision problem 15
  - context-free 117
  - denoted by a regular expression 67
  - deterministic 158
  - generated by a context-free grammar 117
  - generated by a regular grammar 83
  - generated by a sentential form 117
  - inherently ambiguous context-free 70, 122
  - over an alphabet 11
  - prefix-free 108
  - recursive 14
  - recursively enumerable 14
  - regular 68
  - simple 170
  - $SLL(k)$  178
  - strong  $LL(k)$  178
- Language description 65
- Language recognizer 14
- Leaf node 4
- Leaving edge 3
- Left parse 160
- Left parser 160, 161
- Left quotient 108
- Left sentence 120
- Left sentential form 119
- Left-hand side of a rule 24
- Left-linear grammar 83
- Leftmost derivation 119–120
- Leftmost derives relation 118–119
- left-of** relation 147
- Left-recursive grammar 149, 182
- Left-recursive nonterminal 148, 182
- Lesk, M. E. 114
- Letter 11
- Lewis, H. R. 35, 114
- Lewis, P. M. II 151, 214, 215
- Lexical analyzer 100
- Lexical description 98
- Lexically correct description 98
- Linear context-free grammar 150
- Linear order 4
- Live state 74
- $LL(1)$  parser 173
- Logarithmic cost criterion 19
- Logarithmic cost space complexity 20
- Logarithmic cost time complexity 19
- Logarithmic cost workspace complexity 19
- Lookahead string 174–175
- Lookahead symbol 169, 200
- Lookback symbol 199, 200
- Looping configuration 182
- Looping pushdown automaton 155
- Looping RAM 13
- Lucas, P. 215
  
- Mapping 5
- Mathematical induction 26
- Maximal element 4
- Maximum 4
- McKeeman, W. M. 215
- McNaughton, R. 113, 114
- Membership problem
  - for context-free languages 144
  - for regular languages 91
- Meyer, A. R. 113, 214
- Miller, G. A. 113
- Minimal element 4
- Minimal finite automaton 100, 110
- Minimum 4
- Mirror image of a string 10
- Moll, R. N. 35
- Monoid 7
- Monoid homomorphism 10
- Monoid isomorphism 11
- Moore, E. F. 113
- Morris, J. H. Jr. 114
- Morse, S. P. 215
- Myhill, J. 110, 113
- Myhill-Nerode theorem 110
  
- Naur, P. 151
- Nerode, A. 110, 113
- $N$ -fold product of a relation 2
- Nijholt, A. 215
- Node 3



- No-instance 15
- Noncontainment problem 91
- Nondenumerable set 5
- Nondeterministic finite automaton 87
- Nondeterministic pushdown automaton 155
- Nondeterministic RAM 13
- Nondeterministic space 21
- Nondeterministic time 21
- Nondeterministic workspace 21
- Non- $\epsilon$ -position 143
- Nonregular language 80
- Nonterminal alphabet 83, 115
- Norm
  - of a context-free grammar 117
  - of a rewriting system 28
  - of a string 11
- Normal-form finite automaton 75
- Normal-form grammar 133, 136, 169
- Normal-form pushdown automaton 156
- $n$ th power
  - of a relation 2
  - of an element of a monoid 7
- Null matrix 32
- Nullable symbol 130
- Oettinger, A. 214
- One-to-one function 5
- Onto function 5
- Order of magnitude 21
- Ordered tree 117
- Output alphabet 161
- Output effect 161
- Output produced by a pushdown transducer 161
- Output produced by a RAM 13
- Pair, C. 215
- Palindrome 15, 158
- Palindrome with centre marker 34, 159
- Panic mode recovery 212
- Papadimitriou, C. H. 35, 114
- Parikh, R. J. 123
- Parse 160, 161
- Parse tree 117
- Parser
  - bottom-up 160
  - left 160, 161
  - produce-shift 161
  - recursive descent 196
  - right 160, 161
  - shift-reduce 164
  - simple precedence 200
  - SLL( $k$ ) 175
  - strong LL(1) 173
  - strong LL( $k$ ) 175
  - top-down 160
- Partial function 5
- Partial mapping 5
- Partial order 4
- Partial solution 15
- Partially decidable decision problem 15
- Partially ordered set 4
- Partially solvable decision problem 15
- Partition 4
- passes-any** relation 190
- passes-null** relation 190
- Path 3
- Pennello, T. J. 64
- Perles, M. 113
- Permutation of a string 148
- points** relation 190
- Polynomial time reduction 23
- Porter, J. H. 114
- Position of a grammar 190, 209
- Positive closure
  - of a set under a relation 3
  - of a subset of a monoid 8
- Positively closed monoid 7
- Postfix-form 210
- Power
  - of a relation 2
  - of an element of a monoid 7
- Pratt, V. R. 114
- Precedence grammar 204, 213
- Precedence relations 199
- Predecessor of a node 3
- Predictive machine 156
- PREFIX function 10
- Prefix of a string 10
- Prefix-free language 108
- Price, J. K. 214
- Process
  - of a finite automaton 72
  - of a pushdown automaton 155
  - of a RAM 13
- Produce action 156–157, 175
- Produce-produce conflict 158, 168, 180
- Produce-shift parser 161
- Product
  - of boolean matrices 32
  - of relations 2
- Production of a rewriting system 24
- Proof by induction 26
- Properly nested traversal 40
- Pumping 80
- Pumping lemma 107
- Pushdown automaton 154
- Pushdown transducer 161
- Pushdown-machine program 154
- Rabin, M. O. 113
- RAM 12
- Random access machine 12

- Range
  - of a relation 1
  - of a relational expression 54
- Rayward-Smith, V. J. 215
- Reachable state 74
- reaches** relation 74
- reads- $\alpha$**  relation 89
- reads-empty** relation 89
- Real time 107, 207
- Recognition of context-free languages 144
- Recursive descent implementation of an SLL(1) parser 196
- Recursive function 14
- Recursive language 14
- Recursively enumerable language 14
- Reduce action 165, 200
- Reduced context-free grammar 130
- Reduced finite automaton 74
- Reduce-reduce conflict 168, 205
- Reducible decision problem 18
- Reduction of decision problems 18, 23
- Reflexive partial order 4
- Reflexive relation 2
- Reflexive transitive closure
  - of a graph 4
  - of a relation 3
- Regular expression 66–67
- Regular factor 67
- Regular grammar 83
- Regular language 68
- Regular primary 67
- Regular term 67
- Relation 1
  - denoted by a relational expression 55
- Relational expression 54
- Relational factor 54
- Relational primary 54
- Relational product 2
- Relational term 54
- Remaining input string 154
- Restriction of a function 5
- Reversal
  - of a rewriting system 86
  - of a rule 86
  - of a string 10
- Rewriting system 24
- Right parse 160
- Right parser 160, 161
- Right quotient 108
- Right sentence 120
- Right sentential form 119
- Right-biased interpretation 99
- Right-hand side of a rule 24
- Right-invariant relation 110
- Right-linear grammar 83
- Rightmost derivation 119–120
- Rightmost derives relation 118–119
- Right-recursive nonterminal 148, 211
- Root 4
- Rosenkrantz, D. J. 113, 151, 214, 215
- Ross, D. T. 114
- $R$ -related 1
- Rule of a rewriting system 24
- Ruzzo, W. L. 151
- Salomaa, A. 35, 114, 151
- Savitch, W. J. 22, 114
- Savitch's theorem 22
- Scanner 100
- SCC function 39
- Schmidt, E. M. 113, 214
- Schützenberger, M. P. 214
- Scott, D. 113
- Screening 105
- Self-embedding nonterminal 148
- Semigroup 7
- Semi-Thue system 24
- Sentence
  - of a grammar 117, 120
  - of a language 11
  - of a sentential form 117
- Sentential form
  - of a grammar 117, 119
  - of a string 25
- Sequence
  - infinite 6
  - of length  $n$  9
- Sethi, R. 151, 215
- $s$ -grammar 170
- Shamir, E. 113
- Shift action 156–157, 165, 175, 200
- Shift-reduce conflict 168, 205
- Shift-reduce parser 164
- Simple grammar 170
- Simple language 170
- Simple precedence grammar 204
- Simple precedence parser 200
- Single rule 136
- Sippu, S. 151, 215
- Size
  - of a context-free grammar 117
  - of a rewriting system 28
  - of a set 5
- $s$ -language 170
- SLL( $k$ ) grammar 178
- SLL( $k$ ) language 178
- SLL( $k$ ) parser 175
- SLL( $k$ ) property 180
- Soisalon-Soininen, E. 215
- Solution to a decision problem 15
- Solvable decision problem 15, 21
- Son node 4
- Space complexity
  - of a derivation 29

- of a language recognizer 20
- of a pushdown automaton 160
- of a RAM 19
- of a transformation 20
- of deriving in a grammar 137
- of leftmost deriving 150
- of rightmost deriving 150
- SPACE function
  - for grammars 137
  - for pushdown automata 160
  - for rewriting systems 29
- Space-bounded derivation 29
- Space-bounded language recognizer 20
- Space-bounded pushdown automaton 160
- Space-bounded transformation 20
- Space-constructible function 22
- Spanning of a monoid 8
- Stack alphabet 154
- Stack contents 154
- Stack implementation of an SLL(1) parser 194
- Stack string 202
- Start symbol 83, 115
- State alphabet 72
- State program 100
- Stearns, R. E. 97, 113, 151, 214, 215
- Stockmeyer, L. J. 113
- String concatenation 9
- String
  - infinite 6
  - of length  $n$  9
- Strong LL(1) parser 173
- Strong LL( $k$ ) grammar 178
- Strong LL( $k$ ) language 178
- Strong LL( $k$ ) parser 175
- Strongly connected component 39
- Subgraph 4
- Submonoid 8
- Subtree 4
- Successor of a node 3
- Succinctness of language descriptions 71
- SUFFIX function 10
- Suffix of a string 10
- Sum of boolean matrices 31
- Surjection 5
- Symbol 11
- Symmetric relation 2
- Syntax error 122
- Syntax tree 117
- Szymanski, T. G. 64, 113, 214, 215
  
- Tarjan, R. E. 64
- Terminal alphabet 83, 115
- terminal** relation 186
- Terminal string 116
- Thompson, K. 114
  
- Time complexity
  - of a derivation 29
  - of a language recognizer 20
  - of a pushdown automaton 160
  - of a RAM 19
  - of a transformation 20
  - of deriving in a grammar 136–137
  - of leftmost deriving 150
  - of rightmost deriving 150
- TIME function
  - for grammars 137
  - for pushdown automata 160
  - for rewriting systems 29
- Time-bounded derivation 29
- Time-bounded language recognizer 20
- Time-bounded pushdown automaton 160
- Time-bounded reduction 23
- Time bounded transformation 20
- Top-down parser 160
- Topmost stack symbol 155
- Total function 5
- Total mapping 5
- Total order 4
- Total solution 15
- Totally decidable decision problem 15
- Totally ordered set 4
- Totally solvable decision problem 15
- Transducer 161
- Transformation 14, 20
- Transition 72
- Transition graph 73
- Transitive closure
  - of a graph 4
  - of a relation 2
- Transitive relation 2
- Tree 4
- Two-form grammar 133
  
- Ullman, J. D. 35, 64, 113, 114, 151, 214, 215
- Unambiguity problem 97
- Unambiguous context-free grammar 122
- Unambiguous finite automaton 73
- Unambiguous language description 70
- Unambiguous pushdown automaton 155
- Unambiguous regular expression 70
- Unambiguous regular grammar 83
- Uncountable set 5
- Undecidable decision problem 15
- Uniform cost criterion 19
- Uniform cost space complexity 19–20
- Uniform cost time complexity 19
- Uniform cost workspace complexity 19
- Unit rule 136
- unit-rule** relation 145, 206
- Unsolvable decision problem 15
- Useful symbol 129
- Useless symbol 130

- Valiant, L. G. 151
- Valid stack string 202
- Vertex 3
- Vocabulary 11
  
- Waite, W. M. 35, 151, 215
- Warshall, S. 64
- Weak precedence grammar 213
- Weber, H. 199, 215
- Well-formed lexical description 100
- Wirth, N. 199, 215
- Wirth-Weber precedence relations 199
- Wood, D. 114, 151, 215
  
- Workspace complexity
  - of a language recognizer 20
  - of a RAM 19
  - of a transformation 20
- Workspace-bounded language recognizer 20
- Workspace-bounded transformation 20
- Wortman, D. B. 215
- Wotschke, D. 214
  
- Yamada, H. 113
- Yes-instance 15
- Younger, D. H. 151, 169
  
- Zeiger, P. 113