

REFERENCES

- ANDERBERG, M. R. 1973. *Cluster Analysis for Applications*. New York: Academic Press.
- ANDERSON, J. R., AND G. H. BOWER. 1980. *Human Associative Memory*. Washington, D.C.: Winston.
- ANDREWS, H. C. 1972. *Introduction to Mathematical Techniques in Pattern Recognition*. New York: Wiley Interscience.
- APPELT, D. 1985. "Planning English Referring Expressions." *Artificial Intelligence* 26.
- BALLARD, D. H., AND C. M. BROWN. 1982. *Computer Vision*. Englewood Cliffs: Prentice Hall.
- BOBROW, D. G., AND T. WINograd. 1977. "An Overview of KRL, a Knowledge Representation Language." *Cognitive Science*, 1, 3.
- BOCK, P. 1985. "The Emergence of Artificial Intelligence: Learning to Learn." *AIF Magazine*, 6, 3 (Fall).
- BRACHMAN, R. J. 1978. "A Structural Paradigm for Representing Knowledge." Report No. 3605, Bolt Beranek and Newman, Inc. Cambridge, Mass.
- . 1979. "What's in a Concept? Structural Foundations for Semantic Networks." In *Associative Networks*, ed. N. V. Findler. New York: Academic Press.
- BRATKO, IVAN. 1986. *PROLOG: Programming for Artificial Intelligence*. Menlo Park, CA: Addison-Wesley.
- BROOKS, R. A. 1981. *Model-Based Computer Vision*. Ann Arbor: UMI Research Press.
- BROWNSTON, L., R. FARRELL, E. KANT, AND N. MARTIN. 1985. *Programming Expert Systems in OPS5: An Introduction to Rule-Based Programming*. Reading, MA: Addison-Wesley.
- BUCHANAN, B. G., AND E. H. SHORTLIFFE. 1984. *Rule-Based Expert Systems: The MYCIN Experiments of the Stanford Heuristic Programming Project*. Reading, MA: Addison-Wesley.
- BUDD, T. 1987. *A Little Smalltalk*. Reading, MA: Addison-Wesley.
- BURSTEIN, M. H. 1983. "A Model of Learning by Incremental Analogical Reasoning and Debugging." 45-48 in *Proceedings of AAAI-83*, Washington, D.C.
- . 1986. "Incremental Analogical Reasoning." In *Machine Learning: An Artificial Intelligence Approach*, Vol. II, eds. R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. Los Altos: Morgan Kaufmann.
- CARBONELL, J. G. 1983. "Learning by Analogy: Formulating and Generalizing Plans from Past Experience." In *Machine Learning: An Artificial Intelligence Approach*, eds. R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. Palo Alto: Tioga.
- . 1983a. "Derivational Analogy and Its Role in Problem Solving." 64-69 in *Proceedings of AAAI-83*, Washington, D.C.
- . 1983b. "Analogy in Problem Solving." In *Machine Learning: An Artificial Intelligence Approach*, Vol. II, eds. R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. Los Altos: Morgan Kaufmann.
- . 1986. "Derivational Analogy: A Theory of Reconstructive Problem Solving and Expertise Acquisition." In *Machine Learning*, Vol. II, eds. R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. Los Altos: Morgan Kaufmann Publishers, Inc.
- . AND S. MINTON. 1983. "Metaphor and Common-Sense Reasoning." 83-110 in *Technical Report CMU-CS-83-110*. Carnegie-Mellon University, Pittsburgh.
- CHOMSKY, NOAM. 1965. *Aspects of the Theory of Syntax*. Cambridge: MIT Press.

- CLOWES, M. B. 1971. "On Seeing Things." *Artificial Intelligence*, 2, 1.
- COHEN, P. R. 1985. *Heuristic Reasoning About Uncertainty: An Artificial Intelligence Approach*. Boston: Pitman Publishing.
- , AND E. A. FEIGENBAUM, eds. 1982. *The Handbook of Artificial Intelligence*, Vol. 3. Los Altos: Morgan Kaufmann.
- DAVIS, R., AND D. B. LENAT. 1982. *Knowledge-Based Systems in Artificial Intelligence*. New York: McGraw-Hill.
- DEJONG, G. 1981. "Generalizations Based on Explanations." 67-69 in *Proceedings of the Seventh IJCAI*, Vancouver, B.C.
- , AND R. MOONEY. 1986. "Explanation-Based Learning: An Alternative View." *Machine-Learning* 1: 145-76.
- DE KLEER, J. 1986. "An Assumption-Based TMS." *Artificial Intelligence* 28,2.
- . 1986a. "Problem Solving with the ATMS," *Artifical Intelligence* 28,2.
- DEMPSSTER, A. P. 1968. "A Generalization of Baysian Inference." *Journal of the Royal Statistical Society, Series B*, 30,2.
- DEVIJVER, P., AND J. KITTNER. 1982. *Pattern Recognition: A Statistical Approach*. Englewood Cliffs: Prentice Hall.
- DIETTERICH, T. C., AND R. S. MICHALSKI. 1981. "Inductive Learning of Structural Descriptions: Evaluation Criteria and Comparative Review of Selected Methods." *Artificial Intelligence* 16,3: 257-94.
- . 1983. "A Comparative Review of Selected Methods for Learning from Examples." In *Machine Learning: An Artificial Intelligence Approach*, eds. R. S. Michalski, J. G. Carbonell and T. M. Mitchell. Palo Alto: Tioga.
- DOYLE, J. 1979. "A Truth Maintenance System." *Artificial Intelligence* 12,3 (Nov): 231-72.
- DUDA, R. O., AND P. E. HART. 1973. *Pattern Classification and Scene Analysis*. New York: Wiley.
- ERNST, G. W., AND A. NEWELL. 1969. *GPS: A Case Study in Generality and Problem Solving*. New York: Academic.
- ESHERA, M. A., AND KING-SUN FU. 1984. "A Graph Distance Measure for Image Analysis." *IEEE Transactions on Systems, Man, and Cybernetics* SMC-14,3.
- FEIGENBAUM, E. A. 1985. Paper presented at the Fifth International Joint Conference on Artificial Intelligence, Los Angeles, CA.
- , AND P. MCCORDUCK. 1983. *The Fifth Generation*. Reading, MA: Addison-Wesley.
- FIKES, R. E., AND N. J. NILSSON. 1971. "STRIPS: A New Approach to the Application of Theorem Proving to Problem Solving." *Artificial Intelligence* 2:189-208.
- FILLMORE, C. J. 1968. *The Case for Case in Universals in Linguistic Theory*. Eds. E. Bach and R. Harris. New York: Holt, Rinehart, and Winston.
- . 1977. *The Case for Case Reopened in Syntax and Semantics 8: Grammatical Relations*. Ed. P. Cole and J. Sadock. New York: Academic Press.
- FISCHLER, M. A., AND R. A. ELSCHLAGER. 1973. "The Representation and Matching of Pictorial Structures." *IEEE Transactions on Computers* 22,1.
- FU, K. S. 1968. *Sequential Methods in Pattern Recognition and Machine Learning*. New York: Academic.

- . 1970. "Statistical Pattern Recognition." 35-80 in *Adaptive, Learning, and Pattern Recognition Systems*, eds. J. M. Mendel and K. S. Fu. New York: Academic.
- . 1970a. "Stochastic Automata as Models of Learning Systems." 393-432 in *Adaptive, Learning, and Pattern Recognition Systems*, eds. J. M. Mendel and K. S. Fu. New York: Academic.
- . 1974. *Syntactic Methods in Pattern Recognition*. New York: Academic.
- . 1975. "Grammatical Inference: Introduction and Survey." 95-111, 409-23 in *IEEE Transactions on Systems, Man, and Cybernetics*, Vol 5.
- GALLANT, S. I. 1988. "Connectionist Expert Systems." *Communications of the ACM* 31:2.
- GARVEY, T. D., J. D. LOWRANCE, AND M. A. FISCHLER. 1981. "An Inference Technique for Integrating Knowledge from Disparate Sources." *Proceedings of the Seventh International Joint Conference on Artificial Intelligence*, Vancouver B.C.
- GENTNER, D. 1983. "Structure Mapping: A Theoretical Framework for Analogy." *Cognitive Science* 7,2(April-June): 155-170.
- GOLDBERG, A., AND D. ROBSON. 1983. *Smalltalk-80: The Language and Its Implementation*. Reading, MA: Addison-Wesley.
- GOLDSTEIN, I. P., AND R. B. ROBERTS. 1977. "Nudge, a Knowledge-Based Scheduling Program." 257-63 in *Proceedings of the Fifth International Joint Conference on Artificial Intelligence*.
- GONZALEZ, R. C., AND M. G. THOMPSON. 1978. *Syntactic Pattern Recognition*. Reading, MA: Addison-Wesley.
- GREINER, R. 1988. "Learning by Understanding Analogies." *Artificial Intelligence* 35: 81-125.
- GUPTA, M. M., A. KANDEL, W. BANDLER, AND J. B. KISZKA, EDs. 1985. *Approximate Reasoning in Expert Systems*. New York: North-Holland.
- GUZMAN, A. 1969. "Decomposition of a Visual Scene into Three-Dimensional Bodies." In *Automatic Interpretation and Classification of Images*, ed. A. Grasselli. New York: Academic.
- HALLIDAY, M. A. K. 1961. "Categories of the Theory of Grammar." *Word* 17: 241-292.
- HAYES-ROTH, F., AND J. McDERMOTT. 1977. "Knowledge Acquisition from Structural Description." 356-62 in *Proceedings of IJCAI-5*.
- . "An Interference Matching Technique for Inducing Abstractions." *Communications of the ACM* 26: 401-10.
- HAYES-ROTH, F., D. A. WATERMAN, AND D. B. LENAT, EDs. 1983. *Building Expert Systems*. Reading, MA: Addison-Wesley.
- HENDRIX, G. G. 1978. *Semantic Knowledge in Understanding Spoken Language*. Ed. D. E. Walker. New York: North-Holland.
- . 1979. "Encoding Knowledge in Partitioned Networks." 51-120 in *Associative Networks: Representation and Use of Knowledge by Computers*, ed. N. V. Findler. New York: Academic.
- . E. D. SACERDOTI, D. SAGALOWICZ, AND J. SLOCUM. 1986. "Developing a Natural Language Interface to Complex Data." 563-84 in *Readings in Natural Language Processing*, eds. B. J. Grosz, K. S. Jones, B. L. Webber. Los Altos: Morgan Kaufmann.

- HUFFMAN, D. A. 1971. "Impossible Objects as Nonsense Sentences." In *Machine Intelligence* 6, eds. B. Meltzer and D. Michie. Edinburgh: Edinburgh UP.
- HUGHES, G. E., AND M. J. CRESSWELL. 1968. *An Introduction to Modal Logic*. London: Methuen.
- HUNT, E. B., J. MARIN, AND P. J. STONE. 1966. *Experiments in Induction*. New York: Academic.
- IBA, G. A. 1979. Learning Disjunctive Concepts from Examples. Master's thesis, MIT, 1979.
- KAELER, T., AND D. PATTERSON. 1986. *A Taste of Smalltalk*. New York: W. W. Norton.
- KANDEL, A. 1982. *Fuzzy Techniques in Pattern Recognition*. New York: Wiley.
- KELLER, R. M. 1987. "Defining Operability for Explanation-Based Learning." *Proceedings of the Sixth National Conference on Artificial Intelligence*, Seattle, WA.
- KLAHR, P., AND W. S. FAUGT. 1980. "Knowledge-based Simulation." *Proceedings of the First Annual National Conference on Artificial Intelligence*, Palo Alto, CA.
- , D. McARTHUR, AND R. NARAIN. 1982. "SWIRL: An Object-Oriented Air Battle Simulator." *Proceedings of the Second Annual Conference on Artificial Intelligence*, Pittsburgh.
- KLING, R. E. 1971. "A Paradigm for Reasoning by Analogy." *Artificial Intelligence* 2,2(Fall): 147-78.
- KOLODNER, J. L. 1983a. "Maintaining Memory Organization in a Dynamic Long Term Memory." *Cognitive Science* 7,4.
- . 1983b. "Reconstructive Memory: A Computer Model." *Cognitive Science* 7,4.
- . 1984. *Retrieval and Organizational Strategies in Conceptual Memory: A Computer Model*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- KORF, R. E. 1983. *Learning to Solve Problems by Searching for Macro-Operators*. Marshfield, MA: Pitman.
- . 1985. "Depth-first Iterative Deepening: An Optimal Admissible Tree Search." *Artificial Intelligence* 27: 97-109.
- LANGLEY, P. W., H. A. SIMON, AND G. L. BRADSHAW. 1983. "Rediscovering Chemistry with the BACON System." In *Machine Learning: An Artificial Intelligence Approach*, eds. R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. Palo Alto: Tioga.
- LARSON, J., AND R. S. MICHALSKI. 1977. "Inductive Inference in the Variable Valued Predicate Logic System VL2: Methodology and Computer Implementation." Report No. 869, Computer Science Dept., University of Illinois, Urbana, Ill.
- LENAT, D. B. 1980. "The Nature of Heuristics." Report No. HPP-80-26, Heuristic Programming Project, Computer Science Department, Stanford University.
- . 1982. "The Nature of Heuristics." *Artificial Intelligence* 19,2 (Oct): 189-249.
- . 1983. "Theory Formation by Heuristic Search: The Nature of Heuristics II: Background and Examples." *Artificial Intelligence* 21,1-2 (Mar): 31-59.
- . 1983a. "EURISKO: A Program That Learns New Heuristics and Domain Concepts: The Nature of Heuristics III: Program Design and Results." *Artificial Intelligence* 21,1-2 (Mar): 61-98.
- LENAT, D. B., AND J. S. BROWN. 1984. "Why AM and Eurisko Appear to Work." *Artificial Intelligence* 23.

- LOVELAND, D. 1978. *Automatic Theorem Proving: A Logical Basis*. Amsterdam: North Holland.
- MARR, D. 1982. *Vision*. New York: Freeman.
- , and E. C. Hildreth. 1980. "Theory of Edge Detection." *Proc. Royal Society of London, Ser. B*, 207.
- MCCARTHY, J. 1968. "Programs with Common Sense." 403-09 in *Semantic Information Processing*, ed. M. Minsky. Cambridge: MIT Press.
- . 1980. "Circumscription: A Form of Nonmonotonic Reasoning." *Artificial Intelligence* 13: 27-39.
- MCCORDUCK, P. 1979. *Machines Who Think*. San Francisco: W. H. Freeman and Co.
- McDERMOTT, J. 1979. "Learning to Use Analogies." 568-76 in *Proceedings of the Sixth IJCAI*, Tokyo.
- MICHALSKI, R. S. 1980. "Pattern Recognition as Rule-Guided Inductive Inference." *IEEE Transactions on Pattern Analysis and Machine Intelligence* PAMI-2.4 (July): 349-61.
- . 1980a. "Knowledge Acquisition Through Conceptual Clustering: A Theoretical Framework and an Algorithm for Partitioning Data into Conjunctive Concepts." *Policy Analysis and Information Systems* 4.3 (Sept): 219-44.
- . 1983. "A Theory and Methodology of Inductive Learning." *Artificial Intelligence* 20.2 (Feb): 111-61.
- . 1986. "Understanding the Nature of Learning." In *Machine Learning: An Artificial Intelligence Approach*, Vol II, eds. R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. Los Altos: Morgan Kaufmann.
- , AND R. STEPP. 1983. "Learning from Observation: Conceptual Clustering." In *Machine Learning: An Artificial Intelligence Approach*, eds. R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. Palo Alto: Tioga.
- MINSKY, M. L., ed. 1968. *Semantic Information Processing*. Cambridge: MIT Press.
- . 1975. "A Framework for Representing Knowledge." In *The Psychology of Computer Vision*, ed. P. H. Winston. New York: McGraw-Hill.
- , AND S. PAPERT. 1969. *Perceptrons: An Introduction to Computational Geometry*. Cambridge: MIT Press.
- MITCHELL, T. M. 1977. "Version Spaces: A Candidate Elimination Approach to Rule Learning." 305-10 in *Proceedings of the Fifth IJCAI*.
- . 1982. "Generalization as Search." *Artificial Intelligence* 18.2. (Mar): 203-26.
- , R. M. KELLER, AND S. T. KEDAR-CABELLI. 1986. "Explanation-Based Generalization: A Unifying View." *Machine Learning* 1.
- , S. MAHADEVAN, AND L. STEINBERG. 1985. "LEAP: A Learning Apprentice for VLSI Design." 573-80 in *Proceedings of the Ninth IJCAI*, Los Angeles, CA.
- , P. E. UTGOFF, AND R. B. BANERJI. 1983. "Learning by Experimentation: Acquiring and Refining Problem-Solving Heuristics." *Machine Learning: An Artificial Intelligence Approach*, eds. R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. Palo Alto: Tioga.
- MOSTOW, D. J. 1983b. "Operationalizing Advice: A Problem-Solving Model." 119-16 in *Proceedings of the International Machine Learning Workshop*, ed. R. S. Michalski. Allerton House, University of Illinois at Urbana-Champaign, June 22-24.

- NARENDRA, K., AND M. THATHACHAR. 1974. "Learning Automata: A Survey." *IEEE Transactions on Systems, Man, and Cybernetics SMC-4*, 4.
- NEWELL, A., AND H. A. SIMON. 1972. *Human Problem Solving*. Englewood Cliffs: Prentice Hall.
- NIU, H. P. 1986a. "Blackboard Systems: The Blackboard Model of Problem Solving and the Evolution of Blackboard Architectures." *AI Magazine* 7, 2.
- . 1986b. "Blackboard Systems: Blackboard Application Systems, Blackboard Systems from a Knowledge Engineering Perspective." *AI Magazine* 7, 3.
- NILSSON, N. J. 1971. *Problem Solving Methods in Artificial Intelligence*. New York: McGraw-Hill.
- . 1980. *Principles of Artificial Intelligence*. Palo Alto: Tioga.
- . 1986. "Probabilistic Logic." *Artificial Intelligence* 28, 1.
- OHTA, Y. 1985. *Knowledge-based Interpretation of Outdoor Natural Color Scenes*. Boston: Pitman.
- PATTERSON, D. W., AND K. CHU. 1987. "GIDES: An Expert System that Learns." UTEP Report CS-101-87, University of Texas at El Paso, El Paso, TX.
- PEARL, J. 1986. "Fusion, Propagation, and Structuring in Belief Networks." *Artificial Intelligence* 29: 241-288.
- . 1987. "Distributed Revision of Composite Beliefs." *Artificial Intelligence* 33: 173-215.
- PREWITT, J. M. S. 1970. *Object Enhancement and Extraction in Picture Processing and Psychopictories*. Eds. B. S. Lipkin and A. Rosenfeld. New York: Academic.
- QUILLIAN, M. 1968. "Semantic Memory." In *Semantic Information Processing*, ed. M. Minsky. Cambridge: MIT Press.
- QUINLAN, J. R. 1983. "Inductive Inference as a Tool for the Construction of High-Performance Programs." In *Machine Learning: An Artificial Intelligence Approach*, eds. R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. Palo Alto: Tioga.
- REDDY, R., L. ERLMAN, R. FENNEL, AND R. NEELEY. 1973. "The HEARSAY Speech Understanding System." *IEEE Transactions on Computers* C-25.
- REITER, R. 1980. "A Logic for Default Reasoning." *Artificial Intelligence* 13: 81-132.
- RENDELL, L. A. 1985. "Toward a Unified Approach for Conceptual Knowledge Acquisition." *AI Magazine* 4, 4 (Winter): 19-27.
- . 1985. "A General Framework for Induction and a Study of Selective Induction." *Machine Learning* 1.
- ROBERTS, L. G. 1965. "Machine Perception of Three Dimensional Solids." In *Optical and Electro-Optical Information Processing*, eds. J. T. Tippett et al. Cambridge: MIT Press.
- ROBERTS, R. B., AND I. P. GOLDSTEIN. 1977. "The FRL Primer." AI Memo #408, MIT AI Lab, Cambridge.
- ROSENBLATT, F. 1962. *Principles of Neurodynamics: Perceptrons and the Theory of Brain Mechanisms*. Washington: Spartan Books.
- RUMELHART, W. R., AND D. A. NORMAN. 1981. "An Activation-Trigger-Schema Model for the Simulation of Skilled Typing." *Proceedings of the Third Annual Conference of the Cognitive Science Society*, Berkeley CA.

- SAGAN, C. 1977. *The Dragons of Eden*. New York: Random House.
- SAMMUT, C., AND R.-B. BANERJI. 1983. "Learning Concepts by Asking Questions." In *Machine Learning: An Artificial Intelligence Approach*, Vol. II, eds. R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. Los Altos: Morgan Kaufmann.
- SAMUEL, A. L. 1959. "Some Studies in Machine Learning Using the Game of Checkers." *IBM Journal of Research and Development* 3.
- . 1963. "Some Studies in Machine Learning Using the Game of Checkers." In *Computers and Thought*, eds. E. A. Feigenbaum and J. Feldman. New York: McGraw-Hill.
- . 1963. "Some Studies in Machine Learning Using the Game of Checkers. II-Recent Progress." *IBM Journal of Research and Development* 11: 601-17.
- SCHANK, R. C. 1972. "Conceptual Dependency: A Theory of Natural Language Understanding." *Cognitive Psychology* 3.
- . 1982. *Dynamic Memory: A Theory of Reminding and Learning in Computers and People*. Cambridge: Cambridge UP.
- . AND R. P. ABELSON. 1977. *Scripts, Plans, Goals and Understanding*. Hillsdale, NJ: Lawrence Erlbaum.
- . AND P. G. CHILDERS. 1984. *The Cognitive Computer*. Menlo Park, CA: Addison-Wesley.
- . N. GOLDMAN, C. REIGER, AND C. RIESBECK. 1973. "MARGIE: Memory, Analysis, Response Generation, and Inference in English." *Proceedings of the Third International Joint Conference on Artificial Intelligence*, Stanford, CA.
- SCHUBERT, L. K., R. G. GOEBEL, AND N. J. CERCONE. 1979. "The Structure and Organization of a Semantic Net for Comprehension and Inference." In *Associative Networks*, ed. N. V. Findler. New York: Academic.
- SELFridge, M. A. 1981. "A Computer Model of Child Language Acquisition." 92-95 in *Proceedings of the Seventh IJCAI*, Vancouver, B.C.
- SHAFER, G. A. 1979. *Mathematical Theory of Evidence*. Princeton: Princeton UP.
- SHANNON, C. E. 1955. "A Chess Playing Machine: In *The World of Mathematics*, Vol 4, ed. J. R. Newman. New York: Simon and Schuster.
- . AND W. WEAVER. 1963. *The Mathematical Theory of Communication*. Urbana: University of Illinois Press.
- SHAPIRO, S. C. 1979. "The SNePS Semantic Network Processing System." In *Associative Networks*, ed. N. V. Findler. New York: Academic.
- SHORTLIFFE, E. H. 1976. *Computer-based Medical Consultations: MYCIN*. New York: American Elsevier.
- SIMON, J. C. 1986. *Patterns and Operators*. New York: McGraw-Hill.
- Smalltalk/V Tutorial and Programming Handbook*. 1987. Los Angeles: Digitalk, Inc.
- SOBEL, I. 1970. "Camera Models and Machine Perception." AIM-21 Stanford, CA.
- SOWA, J. F. 1984. *Conceptual Structures: Information Processing in Mind and Machine*. Reading, MA: Addison-Wesley.
- SPATH, H. 1980. *Cluster Analysis Algorithms for Data Reduction and Classification of Objects*. Chichester, Eng.: Ellis Horwood LTD.

- STEFIK, M., AND D. BOBROW. 1986. "Object-Oriented Programming: Themes and Variations." *AI Magazine* 6,4.
- STEPP, R. E., AND R. S. MICHALSKI. 1986. "Conceptual Clustering: Inventing Goal-Oriented Classifications of Structured Objects." In *Machine Learning: An Artificial Intelligence Approach*, Vol II, eds. R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. Los Altos: Morgan Kaufmann.
- SZLOVITS, P., AND S. PAUKER. 1978. "Categorical and Probabilistic Reasoning in Medical Diagnosis." *Artificial Intelligence* 11,1-2.
- TOU, J. T., AND R. C. GONZALEZ. 1974. *Pattern Recognition Principles*. Reading, MA: Addison-Wesley.
- TYERSKY, A. 1977. "Features of Similarity." *Psychological Review* 84,4.
- UTGOFF, P. E. 1984. Shift of Bias for Inductive Concept Learning. Ph.D. Diss., Department of Computer Science, Rutgers University.
- . 1986. "Shift of Bias for Inductive Conceptive Learning." In *Machine Learning: An Artificial Intelligence Approach*, Vol II, eds. R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. Los Altos: Morgan Kaufmann.
- VALIANT, L. G. 1984. "A Theory of the Learnable." *Communications of the ACM* 27,11 (Nov): 1134-42.
- VERE, S. A. 1978. "Inductive Learning of Relational Productions." 281-96 in *Pattern-Directed Inference Systems*, ed. D. A. Waterman and F. Hayes-Roth. New York: Academic.
- WALZ, D. 1975. "Understanding Line Drawings of Scenes with Shadows." In *The Psychology of Computer Vision*, ed. P. H. Winston. New York: McGraw-Hill.
- WEAVER, W. 1955. "Translation." In *Machine Translation of Languages*, ed. W. N. Locke and A. D. Booth. New York: Wiley.
- WEISS, S. M., C. A. KULIKOWSKI, A. AMAREL, AND A. SAFIR. 1978. "A Model-Based Method for Computer-Aided Medical Decision-Making." *Artificial Intelligence* 11.
- WINOGRAD, T. 1972. *Understanding Natural Language*. New York: Academic.
- . 1986. "A Procedural Model of Language Understanding." 249-66 in *Readings in Natural Language Processing*, eds. B. J. Grosz, K. S. Jones, and B. L. Webber. Los Altos: Morgan Kaufmann.
- WINSTON, P. H. 1975. "Learning Structural Descriptions from Examples." In *The Psychology of Computer Vision*, ed. P. H. Winston. New York: McGraw-Hill.
- . 1977. *Artificial Intelligence*. New York: Addison-Wesley.
- . 1980. "Learning and Reasoning by Analogy." *Communications of the ACM* 23,12 (Dec): 689-702.
- . 1986. "Learning by Augmenting Rules and Accumulating Censors." In *Machine Learning: An Artificial Intelligence Approach*, Vol II, eds. R. S. Michalski, J. G. Carbonell, and T. M. Mitchell. Los Altos: Morgan Kaufmann.
- WOODS, W. A. 1970. "Transition Network Grammars for Natural Language Analysis." *Communication of the ACM* 13(Oct).
- . 1972. "Speech Understanding Systems. Final Report, BBN Report 3438, Bolt, Berenek, and Newman, Cambridge, MA.
- . 1986. "Transition Network Grammars for Natural Language Analysis." 71-99 in

- Readings in Natural Language Processing*, ed. B. J. Grosz, K. S. Jones, and B. L. Webber. Los Altos: Morgan Kaufmann.
- ZADEH, L. A. 1977. "Fuzzy Sets and Their Application to Pattern Classification and Clustering Analysis," 251-99 in *Classification and Clustering*, ed. Van Ryzin. New York: Academic.
- . 1983. "The Role of Fuzzy Logic in the Management of Uncertainty in Expert Systems." In *Fuzzy Sets and Systems* 11,3.
- ZIMMERMAN, H. J. 1985. *Fuzzy Set Theory and Its Applications*. Dordrecht: Kluwer Nijhoff.

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