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Knowledge-Based Expert Systems: A Brief Bibliography

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1. Introduction

A number of Artificial Intelligence (AI) systems have appeared in recent years whose approaches appear very fruitful for a wide variety of real-world tasks that are performed by knowledgeable (but not necessarily understanding) experts. In the interest of acquainting a wider audience to a representative sampling of these systems, and especially to the approaches they embody, the following selective reading list is proposed. These readings are not overly technical, and usually make their main points by way of examples of natural language dialog between a user and the expert AI system. Papers usually contain further references to related work and background material. The intended audience includes engineers (especially designers), social scientists, computer specialists without AI background, and other professionals.

In the following, I have grouped papers roughly into categories, some of which contain specific systems while others are broader overviews or even general introductions to the wider field of AI. In the interest of being representative, a number of systems of approximately equal significance to those given here have been omitted. The papers here do in fact refer to these others.

1.1. Expert Systems in General

[Feigenbaum 77]

[Waterman&Hayes-Roth 78]

[Michie 79]

[Nii 80]

[Newell 81]

[Winston 77]

[Simon 69]

[Nilsson 80]

[Boden 77]

[McCorduck 79]

[Erman&Lesser 78]

? Forthcoming: AI Handbook, by Barr and Feigenbaum

? Forthcoming: book on expert systems by Hayes-Roth et al (Aug. '80 workshop)

1.2. Electronics and Computers

[Brown&Burton 75]

[Sussman 77]

[Sussman&Steele 80]

[de Kleer 79]

[Borning 79]

[McDermott.J 80]

[Grinberg 80]

[Director&Parker&Siewiorek&Thomas 81]

1.3. Engineering Design in General

[Rieger&Grinberg 77]

[Freeman&Newell 71]

[Eastman 81]

[Bennett&Engelmore 79]

[Powers 72]

[Fenves&Norabhoompipat 78]

1.4. Other expert systems

[Davis&Buchanan&Shortliffe 77]

[Pople 81]

[Duda&Gaschnig&Hart 79]

[Nii&Aiello 79]

[Buchanan&Feigenbaum 78]

[Lindsay&Buchanan&Feigenbaum&Lederberg 80]

[Genesereth 79]

[Weiss&Kulikowski&Amarel&Safir 78]

[Waterman&Peterson 80]

1.5. Other Specific AI Techniques of Interest

[Clancey 79]

[Sacerdoti 75]

[Stefik 81]

[Lenat 75]

[Lesser&Erman 77]

[Davis 80]

[Hayes&Ball&Reddy 81]

[Teitelman&Masinter 81]

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2. Bibliography

[Bennett&Engelmore 79]

Bennett, J. S. and Engelmore, R. S.
 SACON: A knowledge-based consultant for structural analysis.
 In *Proc. Sixth International Joint Conference on Artificial Intelligence*, pages 47-49.
 Tokyo, 1979.
 Advises users of a program, MARC, for analysis of physical structures

[Boden 77]

Boden, M.
Artificial Intelligence and Natural Man.
 Basic Books, New York, 1977.
 Chapters 1, 10, 12, 15 are pertinent to expert systems

[Borning 79]

Borning, A. H.
THINGLAB - A Constraint-Oriented Simulation Laboratory.
 PhD thesis, Stanford University, 1979.

[Brown&Burton 75]

Brown, J. S. and Burton, R. R.
 Multiple representations of knowledge for tutorial reasoning.
 In Bobrow, D. G. and Collins, A., editor, *Representation and Understanding: Studies
 in Cognitive Science*, pages 311-349. Academic, New York, 1975.
 SOPHIE electronics lab simulation

[Buchanan&Feigenbaum 78]

Buchanan, B. G. and Feigenbaum, E. A.
 DENDRAL and Meta-DENDRAL: their applications dimensions.
Artificial Intelligence 11:5-24, 1978.
 Chemistry (mass spectroscopy) and scientific inference

[Clancey 79]

Clancey, W. J.
 Tutoring rules for guiding a case method dialogue.
International Journal of Man-Machine Studies 11:25-49, 1979.
 Turning expert systems into teaching / tutorial ones; also 6th IJCAI (1979), pp. 155-161

[Davis 80]

Davis, R.
 Meta-rules: reasoning about control.
Artificial Intelligence 15:179-222, 1980.
 There is a companion paper in the same issue, pp. 223-239

[Davis&Buchanan&Shortliffe 77]

Davis, R., Buchanan, B. and Shortliffe, E.
 Production rules as a representation for a knowledge-based consultation program.
Artificial Intelligence 8:15-45, 1977.
 Discusses MYCIN, an expert on infectious diseases and treatments; see 6th IJCAI (1979), pp. 923-925
 (EMYCIN)

[de Kleer 79]

de Kleer, J.
Causal and Teleological Reasoning in Circuit Recognition.
 PhD thesis, Massachusetts Institute of Technology, 1979.

[Director&Parker&Siewiorek&Thomas 81]

Director, S. W., Parker, A. C., Siewiorek, D. P. and Thomas, D. E.
 A design methodology and computer aids for digital VLSI systems.
IEEE Trans. on Circuits and Systems To appear, July, 1981.

- [Duda&Gaschnig&Hart 79] Duda, R. O., Gaschnig, J. and Hart, P. E.
 Model design in the Prospector system for mineral exploration.
 In Michie, D., editor, *Expert Systems in the Micro Electronic Age*, pages 153-167.
 University of Edinburgh, Scotland, 1979.
 See also [Waterman&Hayes-Roth 78], pp. 203-222
- [Eastman 81] Eastman, C. M.
 Recent developments in representation in the science of design.
 In *Proc. 18th Design Automation Conference*, IEEE Computer Society and ACM,
 June, 1981.
 (Forthcoming); Building design, geometric modelling, and integrity of design databases
- [Erman&Lesser 78] Erman, L. D. and Lesser, V. R.
 System engineering techniques for artificial intelligence systems.
 In Hanson, A. and Riseman, E., editor, *Computer Vision Systems*. Academic, New
 York, 1978.
 General system-building ideas
- [Feigenbaum 77] Feigenbaum, E. A.
 The art of artificial intelligence: I. Themes and case studies of knowledge
 engineering.
 In *Proc. Fifth International Joint Conference on Artificial Intelligence*, pages 1014-
 1029. Massachusetts Institute of Technology, 1977.
 Overview of a number of Stanford systems and their methods
- [Fenves&Norabhoompipat 78] Fenves, S. J. and Norabhoompipat, T.
 Potentials for artificial intelligence applications in structural engineering design
 and detailing.
 In Latombe, J.-C., editor, *Artificial Intelligence and Pattern Recognition in
 Computer Aided Design*, pages 105-119. IFIP Working Conference, Grenoble,
 France, March, 1978.
 A view from outside AI
- [Freeman&Newell 71] Freeman, P. and Newell, A.
 A model for functional reasoning in design.
 In *Proc. Second International Joint Conference on Artificial Intelligence*, pages
 621-640. London, 1971.
 Somewhat general, problem-solving approach
- [Genesereth 79] Genesereth, M. R.
 The role of plans in automated consultation.
 In *Proc. Sixth International Joint Conference on Artificial Intelligence*, pages 311-
 319. Tokyo, 1979.
 User consultant for MACSYMA
- [Grinberg 80] Grinberg, M. R.
 A knowledge based design system for digital electronics.
 In *Proceedings of the First Annual National Conference on Artificial
 Intelligence*, pages 283-285. AAAI, 1980.

Semi-Automatic Digital Designer (SADD)

- [Hayes&Ball&Reddy 81] Hayes, Phil, Ball, E. and Reddy, R.
Breaking the man-machine communication barrier.
Computer 14(3):19-30, March, 1981.
- [Lenat 75] Lenat, D. B.
BEINGS: Knowledge as interacting experts.
In *Proc. Fourth International Joint Conference on Artificial Intelligence*, pages 126-133. Tblisi, 1975.
- [Lesser&Erman 77] Lesser, V. R. and Erman, L. D.
A retrospective view of the HEARSAY-II architecture.
In *Proc. Fifth International Joint Conference on Artificial Intelligence*, pages 790-800. Boston, 1977.
- [Lindsay&Buchanan&Feigenbaum&Lederberg 80] Lindsay, R. K., Buchanan, B. G., Feigenbaum, E. A. and Lederberg, J.
Applications of Artificial Intelligence to Chemistry: The DENDRAL Project.
McGraw-Hill, New York, 1980.
- [McCorduck 79] McCorduck, P.
Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence.
Freeman, San Francisco, 1979.
Chapter 12 is pertinent to expert systems
- [McDermott.J 80] McDermott, J.
R1: an expert configurer.
Technical Report CMU-CS-80-119, Carnegie-Mellon University, April, 1980.
Configures VAX computer systems; OPS language
- [Michie 79] Michie, D. (ed.).
Expert Systems in the Micro Electronic Age.
Edinburgh University Press, Scotland, 1979.
A recent collection of papers
- [Newell 81] Newell, A.
How to view the computer.
In *Foundations of Computer-Aided Chemical Process Design*. Engineering
Foundation, New York, 1981.
(Forthcoming)
- [Nii 80] Nii, H. P.
Heuristic Programming Project 1980.
Stanford University, Department of Computer Science, 1980.
Overview of a number of expert systems projects
- [Nii&Aiello 79] Nii, H. P. and Aiello, N.
AGE (Attempt to Generalize): A knowledge-based program for building knowledge-based programs.
In *Proc. Sixth International Joint Conference on Artificial Intelligence*, pages 645-655. Tokyo, 1979.

- [Nilsson 80] Nilsson, N. J.
Principles of Artificial Intelligence.
 Tioga, Palo Alto, CA, 1980.
 Chapters 1, 8, 9 and 10 are especially relevant to expert systems
- [Pople 81] Pople, H. E. Jr.
 Heuristic methods for imposing structure on ill-structured problems: the structuring of medical diagnosis.
 In *Artificial Intelligence in Medicine.* American Association for the Advancement of Science, 1981.
 (Forthcoming); see also 5th IJCAI (1977); pp. 1030-1037
- [Powers 72] Powers, G. J.
 Non-numerical problem solving methods in computer-aided design.
 In *IFIPS Conference on Computer-Aided Design.* Eindhoven, The Netherlands, 1972.
 Discussion of AI techniques applied to design problems
- [Rieger&Grinberg 77] Rieger, C. and Grinberg, M.
 The declarative representation and procedural simulation of causality in physical mechanisms.
 In *Proc. Fifth International Joint Conference on Artificial Intelligence*, pages 250-256. Massachusetts Institute of Technology, 1977.
 Complex interconnected systems simulated
- [Sacerdoti 75] Sacerdoti, E. D.
 The nonlinear nature of plans.
 In *Proc. Fourth International Joint Conference on Artificial Intelligence*, pages 206-214. Tblisi, 1975.
 Flexible problem-solving and planning
- [Simon 69] Simon, H. A.
The Sciences of the Artificial. -
 MIT Press, Cambridge, MA, 1969.
 Rationalizing the process of design
- [Stefik 81] Stefik, M. J.
 Planning with constraints (MOLGEN: part 1).
Artificial Intelligence 16:111-140, 1981.
 Planning experiments in molecular genetics; also 1980 Stanford U. Ph.D. Thesis
- [Sussman 77] Sussman, G. J.
 Electrical design: a problem for artificial intelligence research.
 In *Proc. Fifth International Joint Conference on Artificial Intelligence*, pages 894-900. Massachusetts Institute of Technology, 1977.
 Includes some general pointers; see also *Artificial Intelligence* 9: pp. 135-196, 1977 (EL)
- [Sussman&Steele 80] Sussman, G. J. and Steele, G. L. Jr.
 CONSTRAINTS - A language for expressing almost hierarchical descriptions.
Artificial Intelligence 14:1-39, 1980.

[Teitelman&Masinter 81]

Teitelman, W. and Masinter, L.
The INTERLISP programming environment.
Computer 14(4):25-33, April, 1981.
A flexible, responsive environment; issues of personal computing and user interfaces

[Waterman&Hayes-Roth 78]

Waterman, D. A. and Hayes-Roth, F. (Eds.).
Pattern-Directed Inference Systems.
Academic, New York, 1978.
Especially the first and last chapters; exhaustive references

[Waterman&Peterson 80]

Waterman, D. A. and Peterson, M.
Rule-based models of legal expertise.
In *Proceedings of the First Annual National Conference on Artificial Intelligence*, pages 272-275. AAAI, 1980.
Legal decision-making system (LDS); RITA and ROSIE languages

[Weiss&Kulikowski&Amarel&Safir 78]

Weiss, S. M., Kulikowski, C. A., Amarel, S. and Safir, A.
A model-based method for computer-aided medical decision-making.
Artificial Intelligence 11:145-172, 1978.
CASNET expert on glaucoma; see also 6th IJCAI (1979), pp. 942-947 (EXPERT)

[Winston 77]

Winston, P. H.
Artificial Intelligence.
Addison-Wesley, Reading, MA, 1977.
Chapters 1 and 5 are the most relevant