

## HEURISTIC PROGRAMMING PROJECT MEMOS

There are six informal groups within the Heuristic Programming Project. Knowledge-Based Consultation Systems (MYCIN) MOLGEN Protein-Crystallography Hydroid DENDRAL ' Meta-DENDRAL

HPP-64-1, J. Lederberg, DENDRAL-64-A System for Computer Construction, Enumeration and Notation of Organic Molecules as Three Structures and Cyclic Graphs (technical reports to NASA, also available from the author and summarized in HPP-68-1).

HPP-64-2, J. Lederberg, Computation of Molecular Formulas for Mass Spectrometry, Idol&n-Day Incorporated, 1964.

HPP-65-1, J. Lederberg, Topological Mapping of Organic Molecules, NASA CR-48899, 1965, Proceedings of the National Academy of Science, 53 1, 134, January.

HPP-65-2, J. Lederberg, Systematics of Organic Molecules, Graph Topology and Hamilton Circuits. General outline of the DENDRAL system. April 1965.

HPP-65-3, Edward A. Feigenbaum and Richard W. Watson, AIM-30, AD785056, An Initial Problem Statement for a Machine Induction Research Project (working paper), April 1965.

HPP-66-1, Donald A. Waterman, AIM-38, AD785066, A Filter for a Machine Induction System (working paper), January 1966.

HPP-66-2, Staffan Persson, STAN-CS-66-50, AIM-46, PB176761, Some Sequence Extrapolating Programs: a study of representation and modeling in inquiring systems, Ph.D. Thesis in Computer Science, (UC. Berkeley, September 1966).

HPP-66-3, Bruce Buchanan, AIM-47, Logics of Scientific Discovery, Ph.D. Thesis in Philosophy (Michigan State University, December 1966).

HPP-67-1, Georgia Sutherland, AIM-49, DENDRAL - a Computer Program for Generating and Filtering Chemical Structures (working paper), February 1967.

HPP-67-2, J. Lederberg, Hamilton Circuits of Convex Trivalent Polyhedra (up to 18 vertices), American Mathematics Monthly, 74, 5, May 1967.

HPP-67-3, Joshua Lederberg and Edward A. Feigenbaum, AIM-54, Mechanization of Inductive Inference in Organic Chemistry, in 8. Kleinmuntz (ed.), Formal Representations for Human Judgment, New YorkWiley, 1968.

HPP-68-1, Edward Feigenbaum, Georgia Sutherland and Bruce Buchanan, Heuristic DENDRAL: A Program for Generating Explanatory Hypothesis in Organic Chemistry, in

B.K. Kinariwala and F.F. Kuo (eds.), Proceedings of the Hawaii International Conference on System Sciences, January 1968, University of Hawaii Press, 1968.

HPP-68-2, J. Lederberg, Online Computation of Molecular Formulas from Mass Number, NASA CR-94977, 1968.

HPP-68-3, Bruce G. Buchanan, Georgia Sutherland and Edward A. Feigenbaum, AIM-62, Heuristic DENDRAL: A Program for Generating Explanatory Hypotheses in Organic Chemistry, in B. Melzer and D. Michie (eds.), Machine Intelligence 4, Edinburgh:Edinburgh University Press, 1969.

HPP-68-4, Edward A. Feigenbaum, AIM-67, AD680487, Artificial Intelligence: Themes in the Second Decade, in Final Supplement to Proceedings of IFIP-68 International Congress, Edinburgh, August 1968.

HPP-68-5, Donald Waterman, AIM-74, STAN-CS-68-118, AD681027, Machine Learning of Heuristics, Ph.D. Thesis in Computer Science (Stanford University, December 1968).

HPP-69-1, Georgia Sutherland, AIM-&O, AD685612, Heuristic DENDRAL: a Family of LISP Programs (working paper), March 1969.

HPP-69-2, Bruce G. Buchanan, G.L. Sutherland and E.A. Feigenbaum, AIM-99, Toward an Understanding of Information Processes of Scientific Inference in the Context of Organic Chemistry, in B. Meltzer and D. Michie (eds.), Machine Intelligence 5, Edinburgh:Edinburgh University Press, 1970.

HPP-69-3, Donald A. Waterman, AIM-102, Generalization Learning Techniques for Automating the Learning of Heuristics, in Artificial Intelligence, 1, 121, July 1969.

HPP-69-4, Joshua Lederberg, Georgia Sutherland and Bruce G. Buchanan, AIM-104, A Heuristic Program for Solving a Scientific Inference Problem: Summary of Motivation and Implementation, in R. Banerji and Mesarovic (eds.), Theoretical Approaches to Non-Numerical Problem Solving, New York:Springer-Verlag, 1970.

HPP-69-5, J. Lederberg, Topology of Molecules, in The Mathematical Sciences - A Collection of Essays, edited by the National Research Council's Committee on Support of Research in the Mathematical Sciences (COSRIMS), Cambridge, Mass.:The M.I.T. Press, 1969, p.37.

HPP-69-6, J. Lederberg, G.L. Sutherland, B.G. Buchanan, E.A. Feigenbaum, A.V. Robertson, A.M. Duffield and C. Djerassi, Applications of Artificial Intelligence for Chemical Inference 1. The Number of Possible Organic Compounds: Acyclic Structures Containing C, H, O and N; Journal of the American Chemical Society, 91, 2973, 1969.

HPP-69-7, A.M. Duffield, A.V. Robertson, C. Djerassi, B.G. Buchanan G.L. Sutherland, E.A. Feigenbaum and J. Lederberg, Application of Artificial Intelligence for Chemical Inference II. Interpretation of LOU Resolution Mass Spectra of Ketones, Journal of the American Chemical Society, 91, 11 May 1969.

HPP-69-8, C.W. Churchman and B.G. Buchanan, On the Design of Inductive Systems: Some Philosophical Problems, British Journal for the Philosophy of Science, 20, 311, 1969.

HPP-69-9, G. Schroll, A.M. Duffield, C. Djerassi, B.G. Buchanan, G.L. Sutherland, E.A. Feigenbaum and J. Lederberg, Application of Artificial intelligence for Chemical Inference III. Aliphatic Ethers Diagnosed by Their Low Resolution Mass Spectra and NMR Data, Journal of the American Chemical Society, 91, 7440, 1969.

HPP-70-1, A. Buchs, A.B. Delfino, C. Djerassi, A.M. Duffield, B.G. Buchanan, E.A. Feigenbaum, J. Lederberg and G. Schroll, Application of Artificial intelligence for Chemical Inference IV. Saturated Amines Diagnosed by Their Low Resolution Mass Spectra and Nuclear Magnetic Resonance Spectra, Journal of the American Chemical Society, 92, 6831, 1970. L

HPP-70-2, Bruce G. Buchanan and Thomas E. Hedrick, AIM-123, Some Speculation About Artificial Intelligence and Legal Reasoning, Stanford Law Review, 23, 40, November 1970.

HPP-70-3, Y.M. Sheikh, A. Buchs, A.B. Delfino, G. Schroll, A.M. Duffield, C. Djerassi, B.G. Buchanan, G.L. Sutherland, E.A. Feigenbaum and J. Lederberg, Applications of Artificial Intelligence for Chemical Inference V. An Approach to the Computer Generation of Cyclic Structures. Differentiation Between All The Possible Isomeric Ketones of Composition C<sub>10</sub>O, Organic Mass Spectrometry, 4, 493, 1970.

HPP-70-4, A. Buchs, A.B. Delfino, A.M. Duffield, C. Djerassi, B.G. Buchanan, E.A. Feigenbaum and J. Lederberg, Applications of Artificial intelligence for Chemical Inference VI. Approach to a General Method of Interpreting LOU Resolution Mass Spectra with a Computer, Helvetica Chimica Acta, 53, 1394, 1970.

HPP-70-5, Edward A. Feigenbaum, Bruce G. Buchanan and Joshua Lederberg, AIM-131, STAN-CS-70-176, AD7 15 128, On Generality and Problem Solving: a Case Study Using the DENDRAL Program, in B. Meltzer and D. Michie (eds.), Machine Intelligence 6, Edinburgh:Edinburgh University Press, 1971.

HPP-70-6, B. G. Buchanan, G. L. Sutherland and E. A. Feigenbaum, Rediscovering some Problems of Artificial Intelligence in the Context of Organic Chemistry, Machine Intelligence 5, 253, Edinburgh:Edinburgh University Press, 1970.

HPP-71-1, A. Buchs, A.B. Delfino, C. Djerassi, A.M. Duffield, B.G. Buchanan, E.A. Feigenbaum, J. Lederberg, G. Schroll and G.L. Sutherland, Applications of Artificial

Intelligence for Chemical Inference VII. The Application of Artificial intelligence in the interpretation of Low-Resolution Mass Spectra, *Advances in Mass Spectrometry*, 5, 3 14, 1971.

HPP-71-2, Bruce G. Buchanan and Joshua Lederberg, AIM-141, STAN-CS-71-216, AD732457, The Heuristic DENDRAL Program for Explaining Empirical Data, in *Proceedings of the IFIP Congress 71*, Ljubijan, Yugoslavia, February 1971.

HPP-71-3, Robert E. Kling, AIM-147, STAN-CS-71-216, Reasoning by Analogy with Applications to Heuristic Problem Solving: a Case Study, Ph.D. Thesis in Computer Science, August 1971.

HPP-71-4, B.G. Buchanan, E.A. Feigenbaum and J. Lederberg, AIM-145, A Heuristic Programming Study of Theory Formation in Science, in *Proceedings of the Second International Joint Conference on Artificial Intelligence*, Imperial College, London, 1971.

HPP-71-5, B.G. Buchanan, A.M. Duffield and A.V. Robertson, An Application of Artificial Intelligence to the Interpretation of Mass Spectra, in G.W.A. Milide (ed.), *Mass Spectrometry Techniques and Applications*, New York:Wiley, 1971, p.121. 1

HPP-72-1, D.H. Smith, B.G. Buchanan, R.S. Engelmore, A.M. Duffield, A. Yeo, E.A. Feigenbaum, J. Lederberg and C. Djerassi, Applications of Artificial Intelligence for Chemical Inference VI II. An Approach to the Computer Interpretation of the High Resolution Mass Spectra of Complex Molecules. Structure Elucidation of Estrogenic Steroids, *Journal of the American Chemical Society*, 94, 5962, 1972.

HPP-72-2, B.G. Buchanan, E.Z. Feigenbaum and N.S. Sridharan, Heuristic Theory Formation: Data Interpretation and Rule Formation, In 8. Meltzer and D. Michie (eds.), *Machine Intelligence 7*, Edinburgh:Edinburgh University Press, 1972.

HPP-72-3, Bruce G. Buchanan, AIM-181, STAN-CS-72-325, Review of Hubert Dreyfus' "What Computers Can't DO": a Critique of Artificial Reason, *Computing Reviews*, January 1973.

HPP-72-4, J. Lederberg, Rapid Calculation of Molecular Formulas from Mass Values, *Journal of Chemical Education*, 49, 613, 1972.

HPP-72-5, Joshua Lederberg, Use of a Computer to Identify Unknown Compounds: The Automation of Scientific Inference, in George R. Waller (ed.), *Biochemical Applications of Mass Spectrometry*, New York:interscience, 1972.

HPP-72-6, H. Brown, L. Hjelmeland and L. Masinter, STAN-CS-72-318, Constructive Graph Labeling Using Double Cosets, *Discrete Mathematics*, 7, 1, 1974.

HPP-73-1, D.H. Smith, B.G. Buchanan, R.S. Engelmore, H. Aldercreutz and C. Djerassi, Applications of Artificial Intelligence for Chemical Inference IX. Analysis of Mixtures

without Prior Separation as Illustrated for Estrogens, Journal of the American Chemical Society, 95, 6078, 1973.

HPP-73-2, D.H. Smith, B.G. Buchanan, W.C. White, E.A. Feigenbaum, C. Djerassi and J. Lederberg, Applications of Artificial intelligence for Chemical Inference X. INTSVM. A Data Interpretation Program as Applied to the Collected Mass Spectra of Estrogenic Steroids, Tetrahedron, 29, 3117, 1973.

HPP-73-3, Harold Brown and Larry Masinter, STAN-CS-73-361, An Algorithm for the Construction of the Graphs of Organic Molecules, Discrete Mathematics, 8, 227, 1974.

HPP-73-4, N.S. Sridharan et al., AIM-205, STAN-CS-73-370, AD764288, A Heuristic Program to Discover Synthesis for Complex Organic Molecules, June 1973.

HPP-73-5, N.S. Sridharan, STAN-CS-73-381, Computer Generation of vertex Graphs (working paper), July 1973.

HPP-73-6, R. Carhart and C. Djerassi, Applications of Artificial Intelligence for Chemical Inference XI. The Analysis of C 13 NMR Data for Structure Elucidation of Acyclic Amines, Journal of the American Chemical Society (Perkin II), 2, 1753, 1973.

HPP-73-7, B.G. Buchanan and N.S. Sridharan, AIM-215, STAN-CS-73-387, AD769380, Analysis of Behavior of Chemical Molecules: Rule Formation on Non-Homogeneous Classes of Objects, in Proceedings of the Third International Joint Conference on Artificial Intelligence, Stanford, California, August 1973.

HPP-73-8, D. Michie and B.G. Buchanan, Current Status of the Heuristic DENDRAL Program for Applying Artificial intelligence to the Interpretation of Mass Spectra, in R.A.G. Carrington (ed.), Computers for Spectroscopy, London:Adam Hilger, 1974. Also University of Edinburgh School of Artificial Intelligence, Exp. Prog. Report No. 32, 1978.

HPP-73-9, N.S. Sridharan, AIM-217, STAN-CS-73-391, AD770610, Search Strategies for the Task of Organic Chemical Synthesis, August 1973.

HPP-73-10, E.H. Shortliffe, S.G. Axline, B.G. Buchanan, T.C. Merigan, and S.N. Cohen, An Artificial Intelligence Program to Advise Physicians Regarding Antimicrobial Therapy, Computers and Biomedical Research, 6, 544, 1973.

HPP-73-11, Larry Masinter, N.S. Sridharan, J. Lederberg and D.H. Smith, AIM-216, STAN-CS-73-389, AD7 1299, Applications of Artificial Intelligence GOT Chemical Inference XI/. Exhaustive Generation of Cyclic and Acyclic Isomers, in Journal of the American Chemical Society, 96, 7702, 1974.

- HPP-74-1, E.H. Shortliffe, S.G. Axline, B.G. Buchanan and S.N. Cohen, Design Considerations for a Program to Provide Consultations in Clinical Therapeutics, in Proceedings of San Diego Biomedical Symposium, February 1974.
- HPP-74-2, Edward H. Shortliffe, AIM-251, STAN-CS-74-465, AD-A001 373, MYCIN: A Rule-Based Computer Program for Advising Physicians Regarding Antimicrobial Therapy Selection, Ph.D. Thesis in Medical Information Sciences, October 1974. Also in Computer-Based Medical Consultations: MYCIN, New York:American Elsevier, 1976.
- HPP-74-3, B.G. Buchanan, Scientific Theory Formation by Computer, in T.C. Simon (ed.), Computer Aided Learning Processes, Nato Advanced Study Institutes Series, Series E: Applied Science, 14, 515, Leyden:Noordhoff, 1976. Also appeared in NATO Adv. Study Inst. on Computer Oriented Learning Proc., Bonas, France, 1974.
- HPP-74-4, E.A. Feigenbaum, Computer Applications: Introductory Remarks, in Proceedings of Federation of American Societies for Experimental Biology, 33, 2331, 1974.
- HPP-74-5, L.M. Masinter, N.S. Sridharan, R.E. Carhart and D.H. Smith, Applications of Artificial Intelligence for Chemical Inference X 111. Labeling of Objects Having Symmetry 1, 2, Journal of the American Chemical Society, 96, 7714, 1974.
- HPP-74-6, Dennis H. Smith, Larry M. Masinter and Natesa S. Sridharan, Heuristic DENDRAL: Analysis of Molecular Structure, in W.T. Wipke, S. Heler, R. Feldmann and E. Hyde (eds.), Computer Representation and Manipulation of Chemical Information, New York:Wiley, 1974.
- HPP-74-7, Harold Brown, STAN-CS-74-469, Molecular Structure Elucidation III, SIAM Journal of Applied Math, 32, 3, May 1977, p.534.
- HPP-75-1, E.H. Shortliffe and B.G. Buchanan, A Model of Inexact Reasoning in Medicine, Mathematical Biosciences, 23, 351, 1975.
- HPP-75-2, E.H. Shortliffe, R. Davis, S.G. Axline, B.G. Buchanan, C.C. Green and S.N. Cohen, Computer-Based Consultations in Clinical Therapeutics; Explanation and Rule Acquisition Capabilities of the MYCIN System, Computers and Biomedical Research, 8, 303, August 1975.
- HPP-75-3, E.H. Shortliffe, F.S. Rhame, S.G. Axline, S.N. Cohen, B.G. Buchanan, R. Davis, A.C. Scott, R. Chavez-Pardo and W.J. Van Melle, MYCIN: A Computer Program Providing Antimicrobial Therapy Recommendation, Clinical Medicine, August 1975.
- HPP-75-4, E.H. Shortliffe, Judgmental Knowledge as a Basis for Computer-Assisted Clinical Decision Making, in Proceedings of the 1975 International Conference on Cybernetics and Society, September 1975.

HPP-75-5, E.H. Shortliffe, S. Axline, B.G. Buchanan, R. Davis and S. Cohen, A Computer-Based Approach to the Promotion of Rational Clinical Use of Antimicrobiats, in William A. Gouveia, Gianni Tognoni, and Eppo van der Kleijn (eds.), Clinical Pharmacy and Clinical Pharmacology, New York:Elsevier/North-Holland Publishing Company, 1976.

HPP-75-6, Randall Davis, Bruce Buchanan and Edward Shortliffe, AIM-266, STAN-CS-75-519, AD-A019641, Production Rules as a Representation of a Knowledge-Based Consultation Program, in Artificial Intelligence, 8, 1, February 1977.

HPP-75-7, Randall Davis and Jonathan King, AIM-271, STAN-CS-75-524, AD-A019702/OWC, An Overview of Production Systems, in E.W. Elcock and Donald Michie (eds.), Machine Intelligence 8; Machine Representations of Knowledge, Chichester, England:Ellis Horwood Ltd., 1977.

HPP-75-8, R.G. Dromey, B.G. Buchanan, J. Lederberg and C. Djerassi and D. I-J. Smith, Applications of Artificial Intelligence for Chemical Inference XIV. A General Method for Predicting Molecular Ions in Mass Spectra, Journal of Organic Chemistry, 40, 770, 1975.

HPP-75-9, D.H. Smith, Applications of Artificial Intelligence for Chemical Inference XV. Constructive Graph Labelling Applied to Chemical Problems. Chlorinated Hydrocarbons, Analytical Chemistry, 47, 1176, 1975.

HPP-75-10, R.E. Carhart, D.H. Smith, H. Brown and N.S. Sridharan, Applications of Artificial intelligence for Chemical inference XVI. Computer Generation of Vertex Graphs and Ring Systems, Journal of Chemical Information and Computer Science, 15, 124, 1975.

HPP-75-11, R.E. Carhart, D.H. Smith, H. Brown and C. Djerassi, Applications of Artificial Intelligence for Chemical Inference XVII. An Approach to Computer-Assisted Elucidation of Molecuhr Structure, Journal of the American Chemical Society, 97, 5755, 1975.

HPP-75-12, E.H. Shortliffe, S.G. Axline, B.G. Buchanan, R. Davis and S.N. Cohen, Computer-Assisted Consultations Regarding the Antimicrobi&l Treatment of Bacteremia, Journal t May 1975.

HPP-75-13, B.G. Buchanan, Applications of Artificial Intelligence to Scientific Reasoning, in Proceedings of Second USA-Japan Computer Conference, American Federation of Information Processing Societies Press, August 1975.

HPP-75-14, R.E. Carhart, S.M. Johnson, D.H. Smith, B.G. Buchanan, R.G. Dromey, and J. Lederberg, Networking and a Collaborative Research Community: A Case Study Using the DENDRAL Programs, in P. Lykos (ed.), Computer Networking and Chemistry, Washington, D.C.:American Chemistry Society, 1975.

HPP-75-15, D.H. Smith, Applications of Artificial intelligence for Chemical Inference XVIII. The Scope of Structural Isomerism, *Journal of Chemical Information and Computer Sciences*, 15, 203, 1975.

HPP-75-16, E.H. Shortliffe and R. Davis, Some Considerations for the Implementation of KnowledgeBased Expert Systems, *SIGART Newsletter*, 55, 9, December 1975.

HPP-76-1, D.H. Smith, J.P. Konopelski and C. Djerassi, Applications of Artificial Intelligence for Chemical Inference XIX. Computer Generation of Ion Structures, *Organic Mass Spectrometry*, 11, 86, 1976.

HPP-76-2, Raymond E. Carhart and Dennis H. Smith, Applications of Artificial Intelligence for Chemical Inference XX. Intelligent Use of Constraints in Computer-Assisted Structure Elucidation, *Computers in Chemistry*, 1,79, 1976.

HPP-76-3, C.J. Cheer, D.H. Smith, C. Djerassi, B. Tursch, J.C. Braekman and D. Dalozé, Applications of Artificial Intelligence for Chemical Inference XXI. Chemical Studies of Marine Interbrates - XVII. The Computer-Assisted Identification of [+I-Palostrol in the Marine Organism *Cespitularia* sp. , aff. *subviridis*, *Tetrahedron*, 32, 1807, 1976.

HPP-76-4, B.G. Buchanan, D.H. Smith, W.C. White, R.J. Gritter, E.A. Feigenbaum, J. Lederberg and Carl Djerassi, Applications of Artificial Intelligence for Chemical Inference XX It. Automatic Rule Formation in Mass Spectrometry by Means of the Meta-DENDRAL Program, *Journal of the American Chemical Society*, 986168, 1976,

HPP-76-5, T.H. Varkony, R.E. Carhart and D.H. Smith, Applications of Artificial Intelligence for Chemical Inference XX Ill. Computer-Assisted Structure Elucidation. Modelling Chemical Reaction Sequences Used in Molecular Structure Programs, in W.T. Wipke (ed.), *Computer-Assisted Organic Synthesis*, Washington, D.C.:American Chemical Society, 1977.

HPP-76-6, D.H. Smith and R.E. Carhart, Applications of Artificial Intelligence for Chemical Inference XXIV. Structural Isomerism of Mono and Sesquiterpenoid Skeletons 1, 2-, , *Tetrahedron*, 32, 2513, May 1976.

HPP-76-7, Randall Davis, AIM-283, STAN-CS-76-552, Applications of Meta Level Knowledge to the Construction, Maintenance and Use of Large Knowledge Bases, Ph.D. Thesis in Computer Science, July 1976.

HPP-76-8, Douglas Lenat, AIM-286, STAN-CS-76-570, AM: An Artificial Intelligence Approach to Discovery in Mathematics as Heuristic Search, Ph.D. Thesis in Computer Science, July 1976.

HPP-76-9, Bruce G. Buchanan, Joshua Lederberg and John McCarthy, AIM-291, STAN-(X-76-577, Three Reviews of J. Weixenbaum's Computer Power and Human Reason, November 1976

HPP-76-10, Bruce G. Buchanan and Dennis Smith, Computer Assisted Chemical Reasoning, in E.V. Ludena, N.H. Sabelli and A.C. Wahl (eds.), Computers in Chemical Education and Research, New York:Plenum Press, 1977, p.401.

HPP-76-11, Raymond E. Carhart, A Model-Based Approach to the Teletype Printing of Chemical Structures, Journal of Chemical Information and Computer Sciences, 16, 82, 1976.

HPP-77-1, AC. Scott, W. Clancey, R. Davis and E.H. Shortliffe, STAN-CS-77-593, Explanation Capabilities of Knowledge-Based. Production Systems, American Journal of Computational Linguistics, Microfiche 62, Knowledge-Based Consultation Systems, 1977.

HPP-77-2, Robert S. Englemore and H. Penny Nii, STAN-CS-77-589, A Knowledge-Based System for the Interpretation of Protein X-Ray Crystallographic Data (working paper), January 1977.

HPP-77-3, B.G. Buchanan, R. Davis, V. Yu and S. Cohen, Rule Based Medical Decision Making by Computer, Proceedings of MEDINF0.77, Tronto, 1977.

HPP-77-4, T.M. Mitchell and G.M. Schwenzer, Applications of Artificial Intelligence for Chemical Inference XXV. A Computer Program for Automated Empirical <sup>13</sup>C NMR Rule Formation, Organic Magnetic Resonance, forthcoming.

HPP-77-5, Mark Stefik and Nancy Martin, STAN-CS-77-596, A Review of Knowledge-Based Systems as a Basis for a Genetics Experiment Designing System (working paper), February 1977.

HPP-77-6, Bruce G. Buchanan and Tom Mitchell, STAN-CS-77-597, Model-Directed Learning of Production Rules, in D.A. Waterman and F. Hayes-Roth (eds.), Pattern-Directed Inference Systems, New York:Academic Press.

HPP-77-7, H. Penny Nii and Edward A. Feigenbaum, STAN-CS-77-612, Rule-Based Understanding of Signals, Proceedings of Pattern-Directed Inference Systems, May 1977.

HPP-77-8, R. Davis, Knowledge Acquisition on Rule-Based Systems: Knowledge about Representations as a Basis for System Construction and Maintenance, Proceedings of Pattern-Directed Inference, May 1977.

HPP-77-9, R. Davis, Interactive Transfer of Expertise I: Acquisition of New Inference Rules, Proceedings of Fifth IJCAI, 1, 321, August 1977.

HPP-77-10, R. Davis, A Decision Support System for Medical Diagnosis and Therapy Selection in Data Base, SIGBDP Newsletter, 8, 58, Winter, 1977.

HPP-77-11, Dennis H. Smith and Raymond E. Carhart, Structure Elucidation Based on Computer Analysis of High and Low Resolution Mass Spectral Data, in M.L. Gross (ed.), in Symposium on Chemical Applications of High Performance Spectrometry, Washington, D.C.:American Chemical Society, 1978.

HPP-77-12, Reid G. Smith, The Contract Net: A Formalism for the Control of Distributed Problem Solving, Proceedings of the Fifth IJCAI, 1, 472, August 1977.

HPP-77-13, Tom M. Mitchell, Version Spaces: A Candidate Elimination Approach to Rule Learning, Proceedings of the Fifth IJCAI, 1, 305, August 1977.

HPP-77-14, Reid G. Smith, Tom M. Mitchell, Richard A. Chestek and Bruce G. Buchanan, A Model for Learning Systems, Proceedings of the Fifth IJCAI, 1, 338, August 1977.

HPP-77-15, E.A. Feigenbaum, R.S. Englemore and C.K. Johnson, A Correlation Between Crystallographic Computing and Artificial intelligence, in Acta Crystallographica, A33, 13, 1977.

HPP-77-16, Randall Davis and Bruce G. Buchanan, Meta-Level Knowledge: Overview and Applications, Proceedings of the Fifth IJCAI, 1, 920, August 1977.

HPP-77-17, Bruce G. Buchanan, Heuristic DENDRAL: A Short Summary (working paper), (class notes for CS 224, Spring 1977).

HPP-77-18, Jerry Feitelson and Mark Stefik, A Case Study of the Reasoning in a Genetics Experiment (working paper), April 1977.

HPP-77-19, N. Martin, P. Friedland, J. King and M.J. Stefik, Knowledge Base Management for Experiment Planning in Molecular Genetics, Proceedings of the Fifth IJCAI, 1, 882, August 1977.

HPP-77-20, Gretchen M. Schwenzer and Tom M. Mitchell, Computer Assisted Structure Elucidation Using Automatically Acquired I3C NMR Rules, in D. Smith (ed.), Computer Assisted Structure Elucidation, ACS Symposium Series, Vol. 54:58, 1977.

HPP-77-21, Hector Garcia-Molina and Gio Wiederhold, Application of the Contract Net Protocol to Distributed Data Bases (working paper), April 1977.

HPP-77-22, Gretchen M. Schwenzer, Applications of Artificial intelligence for Chemical Inference XXVI. Analysis of C-13 NMR for Mono-Hydroxy Steroids Incorporating Geometric Distortions, Journal of Organic Chemistry, Vol. 43, 1079, 1978.

HPP-77-23, James G. Nourse, Generalized Stereoisomerization Modes, *Journal of the American Chemical Society*, 99, 2063, 1977.

HPP-77-24, Kent Morrill, Dennis H. Smith and Carl Djerassi, Computer-Assisted Analysis of the High Resolution Mass Spectra of Macrolide Antibiotics, submitted for publication.

HPP-77-25, Edward A. Feigenbaum, The Art of Artificial intelligence: 1. Themes and Case Studies of Knowledge Engineering, *Proceedings of the Fifth IJCAI*, 1, 1014, August 1977.

HPP-77-26, Thomas H. Varkony, Raymond E. Carhart and Dennis H. Smith, Computer Assisted Structure Elucidation, Ranking the Candidate Structures, Based on Comparison Between Predicted and Observed Mass Spectra, in *Proceedings of the 25th Annual Conference on Mass Spectrometry and Allied Topics*, Washington, D.C., 1977.

HPP-77-27, Hector Garcia-Molina, Overview and Bibliography of Distributed Data Bases, 1977.

HPP-77-28, Nils J. Nilsson, STAN-CS-77-618, A Production System for Automatic Deduction, *Machine Intelligence* 9, 1977.

HPP-77-29, Edward H. Shortliffe, A Rule-Based Approach to the Generation of Advice and Explanation in Clinical Medicine, August 1977.

HPP-77-30, Edward H. Shortliffe, Clinical Decisions Based on Physician-Computer Interactions: A Symbolic Reasoning Approach, presented at the Symposium on Making and Using Medical Decisions, Annual Meeting Society for Computer Medicine, November, 1977.

HPP-77-31, Kjell G. Knutsen, Some Issues in the Design of Large Multi-Microprocessor Networks (working paper), 1977.

HPP-77-32, Edward H. Shortliffe, MYCIN: A Knowledge-Based Computer Program Applied to Infectious Diseases, presented at the First Annual Symposium on Computer Application in Medical Care, Washington, DC., October 1977.

HPP-77-33, Randal Davis, Generalized Procedure Calling and Content-Directed Invocation, in the *Proceedings of Artificial Intelligence and Programming Languages Conference*, Published as SIGART/SIGPLAN Combined Issue, August 1977, pp. 45-54.

HPP-77-34, Thomas Varkony, Dennis Smith and Carl Djerassi, Computer-Assisted Structure Manipulation: Studies in the Biosynthesis of Natural Products, *Tetrahedron*, forthcoming.

HPP-77-35, R.G. Dromey, Mark J. Stefik, Thomas C. Rindfleisch and Alan M. Duffield, Extraction of Mass Spectra Free of Background and Neighboring Component Contributions from Gas Chromatography/Mass Spectrometry Data, *Analytical Chemistry*, 48, 1368, 1976.

HPP-77-36, Bruce G. Buchanan, issues of Representation in Conveying the Scope and Limitations of Intelligent Assistant Programs (working paper), 1977.

HPP-77-37, Avron Barr, Meta-Knowledge and Memory (working paper), November 1977.

HPP-77-38, Annemarie Wegmann, Variations in Mass Spectral Fragmentation Produced by Active Sites in a Mass Spectrometer Source, (submitted to *Analytical Chemistry*), 1977.

HPP-77-39, Bruce G. Buchanan, Tom M. Mitchell, Reid G. Smith and C. Richard Johnson, Jr., Models of Learning Systems, in Truelsen (ed.), *Encyclopedia of Computer Science*, New York, 1978.

HPP-78-1, Bruce G. Buchanan and Edward A. Feigenbaum, DENDRAL and Meta-DENDRAL: Their Applications Dimension, Stanford University, 1978.

HPP-78-2, Reid G. Smith, Issues in Distributed Sensor Net Design (working paper), January 1978.

HPP-78-3, Mark Stefik, Inferring DNA Structures from Segmentation Data: A Case Study, (submitted to *Artificial Intelligence*).

HPP-78-4, Hector Garcia-Molina, Distributed Database Coupling (working paper), March 1978.

HPP-78-5, never used.

HPP-78-6, Hector Garcia-Molina, Performance Comparison of Update Algorithms for Distributed Data Bases (working paper), 1978.

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HPP-78-12, Allan Terry and R. Englemore, Design and Evaluation of First Crystals System (working paper), July 1978 ARTIFICIAL INTELLIGENCE PROJECT (SAIL) MEMOS

AIM-46, STAN-CS-66-50, PB176761, Staffan Persson, Some Sequence Extrapolating Programs: a Study of Representation and Modeling in Inquiring Systems, Thesis: Ph.D. in Computer Science, 176 pages, September 1966.

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AIM-117, , , John McCarthy et al, Project Technical Report, 75 pages, April 1970.

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AIM-131, STAN-CS-70-176, AD715128, Edward A. Feigenbaum, Bruce G. Buchanan and Joshua Lederberg, On Generality and Problem Solving: a Case Study Using the Dendral Program, 48 pages, August 1970

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