COMPUTER SCIENCE AT STANFORD
1977-1978

by

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COMPUTER SCIENCE DEPARTMENT
School of Humanities and Sciences
STANFORD UNIVERSITY

Computer Science at Stanford

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Highlights of 1977-78

The year 1977-78 was one in which the Computer Science Department continued its steady growth in quality and prestige and its slow growth in number of staff and students.

The awards won by, and honors accorded to, the faculty were many and varied. The department itself received a #1 ranking in a national survey of computer science departments. Its joint effort with Electrical Engineering to build excellence in the computer systems area has been quite successful. Jointly with the computer engineering laboratories of Electrical Engineering, the department is moving to acquire a DEC System 20/60 computer as an interdepartmental research resource. The department will move to its new home in Margaret Jacks Hall, at the front of the Stanford Quad, during the 1978-79 academic year,

RECOGNITION OF DEPARTMENTAL ACHIEVEMENT

In a recently completed survey of academic standing of American Computer Science departments, our department was rated highest. The survey was done by Professor Bitner of the University of Texas. A replication in the style of the American Council of Education surveys is being done by Professor Conway of Cornell.

AWARDS FOR INDIVIDUAL ACHIEVEMENT

Excellence is a fragile thing--here today, gone tomorrow, unless carefully tended and nurtured. Symbolic of the recognition given to individual achievement by our department and by Stanford, this report summarizes the major awards won by staff and students during the year.

The university awarded its first endowed chair in Computer Science to Professor Donald E. Knuth. Don is now the Fletcher Jones Professor of Computer Science, as a result of a magnificent gift to endowment by the Fletcher Jones Foundation. Don was invited to the Gibbs Lectureship of the American Mathematical Society (an honor previously held by Einstein, Von Neumann, and Weiner, among others); and he was also given the Distinguished Alumnus Award of the California Institute of Technology.

The Association for Computing Machinery announced that its 1978 Turing Award would be given to Professor Robert Floyd at the December meeting of the ACM. Four of our faculty are now winners of the prestigious Turing Award (Floyd, Knuth, McCarthy, and Wilkinson).

Professor Robert Tarjan was awarded a Guggenheim Fellowship for the 1978-79 year. Two years ago, Professor Floyd was a winner of the same honor.

'Professor George Dantzig was awarded an honorary doctorate from Yale University at its June, 1978 graduation.

Professor Gene Golub was awarded the George E. Forsythe Memorial Lectureship of the Society of Industrial and Applied Mathematics. In addition, Gene was honored by the university's School of Humanities and Sciences with the Dean's Award for Distinguished Teaching. This is the second time since the inception of the award a few years ago that one of our faculty has won the Dean's Teaching Award (Professor Winograd was the first).

Professor Edward Feigenbaum won the award of the 1978 National Computer Conference "in recognition of his authorship of the outstanding technical paper" presented at the conference in June, 1978.

The Forsythe awards for excellence in student teaching were awarded by the department to students John Gilbert and William Laaser.

The Forsythe Lectures in Computer Science were initiated in 1977 by Professor James Wilkinson, F.R.S., of our faculty.

CHANGES TO THE FACULTY

Zohar Manna, who works in the theory of programming and automatic program synthesis, was appointed Professor of Computer Science.

Symbolizing our commitment to computer systems research and teaching, and to a permanent liason with Electrical Engineering in the computer systems area, Professor Forest Baskett was promoted to Associate Professor (with tenure) of Computer Science and Electrical Engineering.

Douglas Lenat, a recent Stanford Ph.D. in Artificial Intelligence research, and faculty member at Carnegie-Mellon University, returned to Stanford as Assistant professor of Computer Science.

We regret the departures of Professors Barth, Chvatal, Green, and Lederberg, the latter to the Presidency of Rockefeller University.

PROGRESS IN THE SYSTEMS AREA

The department shares its research and teaching in the computer systems area with the Electrical Engineering department, via the interdepartmental (and newly renamed) Computer Systems Laboratory. This laboratory is now headed by Professor Michael Flynn. The Provost recently described the current state of affairs as "the love affair between Electrical Engineering and Computer Science." He was referring to the shared enthusiasm between the departments for the concept of a Center for Integrated Systems, combining researchers in computer science, computer systems, integrated circuits, and material sciences.

While such a joint center is years away, immediate steps are being taken to coordinate our activities. Baskett's joint appointment is one step. The joint acquisition of a bi-departmental computer resource is another. Joint proposals for equipment for systems research have been made. And jointly the curriculum for students in the systems area has been revised and updated.

Through proposals to Hewlitt-Packard, the departments of CS/EE have been granted two new HP-300 systems for student/faculty "hands-on" systems research. It is anticipated that four more of these machines will be granted, allowing significant experimentation with concepts such as distributed operating systems and small machine networking.

The National Science Foundation made a small grant for the acquisition of four Zilog experimental systems to assist teaching in the systems area.

Much of the systems development activity of both CS and EE has been focused on the S-l computer system. This high-powered multiprocessor system is being built at LLL (Livermore) based on Stanford architecture and design. Operating system and language software development is being done here by faculty, students, and staff of the Computer Systems Lab and the Artificial Intelligence Lab.

DEPARTMENTAL COMPUTER

A high priority goal for the past two years has been the acquisition of a computer for general research use in the department. This year the NSF awarded a $150,000 seed grant for such a machine. This money will be supplemented by funds from the CS, EE, and OR departments, A DECSystem 2060 has been selected.

NEW BUILDING

Completion date of Margaret Jacks Hall has slipped (of course). We are expecting the move to the new building to take place in the period April-June 1979. The new building is crowded. Space for "expansion" has vanished. There is almost no visitor space.

FUND RAISING

Continuing on a pessimistic note, energetic efforts to raise funds from private sources for department needs have gone largely unrewarded. Foundations and corporations seem presently uninterested in significant computer science support.

The industrial affiliates program, however, is prospering. It had its best year ever in 1978. Twenty three companies attended an excellent two day program.

THE PROVOST RESIGNS -- AND RETURNS!

Provost William F. Miller will resign his vice presidency and resume his teaching and research in Computer Science and the Graduate School of Business. At GSB he will be the Herbert Hoover Professor of Public and Private Management. With sincere thanks to him for his years of distinguished service to the university community, the department welcomes his return.

SUMMARY

We have been trying to optimize along the dimension of individual excellence--in faculty research and teaching, and in the graduate student thesis research. Our assessment is that we are succeeding, but that the walls of the mountain of excellence are steep. The climb to the top is slow and difficult, while a fall can be swift and precipitous.

We have been working with Electrical Engineering to build jointly the best academic computer systems program of research and teaching in the country, and we are making significant progress. If the Center for Integrated Systems becomes a reality, it will have no peer in academic institutions in the world.

We continued to be harrassed by resource-related problems--not enough faculty, not enough space, not enough computing equipment to satisfy our needs and our aspirations.

THANKS

The administrative work of the department is expedited by a dedicated and excellent staff. As Department Chairman, I would like to give thanks particularly to Dennis Brown (Associate Chairman), who handles the bulk of day-to-day academic affairs; to Betty Scott (Administrative Officer) who does all budgetary, financial, contractual activities and interfaces with the Stanford administration; to Jonathan King (Special Assistant) whose deft and talented pen helped acquire resources, produce this report, etc.; and to the department secretaries who diligently help keep our show on the road.

Edward A. Feigenbaum
Chairman

Analysis of Algorithms

Research in the Analysis of Algorithms seeks greater quantitative understanding of the fundamental algorithms of computer science. It includes the development of new, efficient methods for use on computers; the analysis of the performance of important computer techniques and of the computational complexity of problems; studies of programming languages; and supporting studies in combinatorial theory.

Faculty:

Robert W. Floyd Professor of Computer Science	Complexity Theory Analysis of Algorithms

During the academic year 1977-78, Professor Floyd worked mainly on the organization and documentation of the Introductory Programming courses, which this year were taught for the first time on an interactive computer. He introduced material on axiomatic complexity theory and Chaitin's theory of program size complexity to the curriculum in the Advanced Computability course. In collaboration with John Gill and three others, he developed a nearly minimum space spelling checker. He is developing algorithms to dissect two-dimensional figures into congruent pieces where possible, and to find the convex hull of finite point sets in a small number of dimensions, in linear expected time with near minimum proportionality factors. He is investigating the application of statistical approximations to complex situations in games, such as backgammon, which are describable as random walks. During the academic year 1978-79, Floyd plans to spend a sabbatical at M.I.T. where he hopes to collaborate with Rivest and Vaughn Pratt. He aspires to complete the implementation of the Chiron programming language (a language designed for novice use) and to document novel methods of compile time error recovery and type matching arising in the Chiron compiler. Broadly speaking, Floyd's current interests center on computational complexity theory and the design of efficient algorithms. He retains an interest in program verification and compiler construction. Professor Floyd was named as the 1978 recipient of the prestigious Turing Award of the Association for Computing Machinery.

Donald E. Knuth Fletcher Jones Professor of Computer Science	Analysis of Algorithms Combinatorics and Discrete Mathematics

Professor Knuth's research during his sabbatical year 19774978 was directed towards improvements in computer typesetting. He designed and implemented a new type of document compiler for manuscript processing (named TEX), and a new type of font-design compiler for preparing digitized symbols defined by mathematical formulas. He also completed a major revision of Volume 2 of his series of books on *The Art of Computer Programming,* producing a book which is serving as the first test of the new typesetting ideas. During the year he was selected to give the annual Gibbs Lecture of the American Mathematical Society; he also received the Distinguished Alumni award from the California Institute of Technology, the highest honor that Caltech gives its graduates. Professor Knuth was named at the beginning of last year as the Fletcher Jones Professor of Computer Science, the first holder of an endowed chair in the department.

Robert E. Tarjan
Associate Professor of Computer Science

Analysis of Algorithms
Complexity of Computation
Graph Theory

The aim of Professor Tarjan's research is to develop efficient algorithms for combinatorial problems, to study the general properties of data structures useful in solving such problems, and to derive lower bounds on the complexity of such, problems using simple but realistic computation models. Recent projects include the application of fast divide-and-conquer techniques to problems defined on planar graphs, analysis of data structures for lists which allow fast access in the vicinity of a "finger", further study of data structures for a set union problems, and examination of the problem of scheduling unit-time tasks with arbitrary start times and deadlines.

Andrew C. Yao
Assistant Professor of Computer Science

Analysis of Algorithms
Computational Complexity

The major interests of Professor Yao are the analysis of algorithms and concrete computational complexity. The central theme of his research is to understand the complexity of specific computations in concrete models. Recently, his research has emphasized the probabilistic analysis of algorithms. Topics studied include a unified complexity measure of probabilistic computations, the decision-tree complexity of pattern matching for random strings, the average-case complexity of selection problems, and analysis of the expected performance of Next-Fit and First-Fit bin-packing algorithms.

F. Frances Yao
Assistant Professor of Computer Science

Analysis of Algorithms
Computational Complexity

Professor Yao's interests are in the analysis of algorithms and computational complexity. During the past year, the following topics were studied: the determination of the average-case complexity of the i^{th} largest element; optimality of linear merging; and characterization of the information bounds in the shortest-path problem. She is currently interested in some complexity problems of string-matching algorithms.

Advanced Ph.D. Students:

Scot Drysdale (working with Andrew Yao).
Generalized Voronoi diagrams and geometric searching

John Gilbert (working with Robert Tarjan).
Graph theoretic models of Gaussian elimination with unrestricted pivoting.

Tom Lengauer (working with Robert Tarjan).
Time/space tradeoffs in a pebbling game on graphs.

Lyle Ramshaw (working with Donald Knuth).
Automation of the analysis of algorithms.

Artificial Intelligence Laboratory

Research at the Stanford AI Laboratory consists of a number of related research projects, with both basic and applied research objectives. Current projects include basic research in artificial

intelligence and formal reasoning, image understanding, mathematical theory of computation, program verification, natural language understanding and knowledge-based programming. The Lab is also a center for computer systems research supporting the basic AI research.

Faculty:

C.Cordell Green
Assistant Professor of Computer Science

Automatic Programming
Artificial Intelligence

Professor Green's current research interest is automatic programming. During the past year, he continued his work on the PSI program synthesis system. This is a computer program which acquires high-level descriptions of programs in English and other forms and produces efficient implementations of these programs. In 1977-78 the PSI system conducted several dialogues with the user and synthesized several programs, up to three pages in length. In a closely-related piece of research, some new areas of programming knowledge, including ordered set operations and space re-utilization, were codified at a level suitable for machine use. This led to the synthesis of symbol-manipulation programs such as quicksort and mergesort. In the coming academic year Professor Green and his group hope to implement and test these new program synthesis rules. As a new domain, they will consider the synthesis of information storage and retrieval programs. A new program synthesis system is now being designed.

Zohar Manna
Professor of Computer Science

Mathematical Theory of Computation
Logical Analysis and Synthesis of Programs
Semantics of Programs

The aim of Dr. Manna's research is to develop the mathematical theory of computation and to make its results accessible to practical application. The theoretical aspect of this research involves the mathematical explication of computational phenomena. For example, various techniques have been developed and formalized for proving as theorems properties of computer programs. A special mathematical model, the "fixedpoint" theory, has been employed for studying the properties of recursive programs. Abstract programs, each representing a class of concrete programs, have been studied as a tool for comparing the power of various programming language features. The practical aspect of this subject relates to the mechanical verification of computer programs. Efforts have been made to find relationships between existing verification methods and to develop new methods. Related efforts are intended to lead to the automation of many of the processes a programmer usually performs by hand, such as debugging, documentation, modification, and optimization. An ultimate goal of this research is the development of synthesis techniques, by which the entire programming task is performed automatically.

John McCarthy
Profess@ of Computer Science

Formal Reasoning
Mathematical Theory of Computation

Professor McCarthy has worked in the area of formal reasoning applied to computer science and artificial intelligence since 1957. This past year he has developed a technique for completely characterizing LISP and other recursive programs within first order logic by the functional equation and a minimization axiom schema. This technique is well suited to automatic proof checking and Professor McCarthy plans to exploit this breakthrough by verifying more complex programs directly within first order logic. In addition many of the standard program verification techniques can be represented by axiom schemas in this system. Recently McCarthy has discovered how to represent facts about knowledge and belief in unmodified first order logic and the solution works no matter how many mental qualities must be treated. This work will be further developed in the next year. He has also recently discovered that an axiom schema of first order logic called a minimization schema can be used to represent in a flexible way the conjecture that the entities that can be shown

to exist on the basis of the information in a certain data base are all the relevant entities that exist. This conjecture is a common feature of human reasoning. Finally, Professor McCarthy has investigated continuous functionals that don't arise from simple recursive programs. Some of them require parallel evaluation, and the work may lead to a treatment of program correctness that unifies parallel programs with the more usual sequential programs. In addition to his research activities, Professor McCarthy has played a central role in creating the LOTS interactive computing facility for introductory computer science courses.

Terry W inograd
Assistant Professor of Computer Science and Linguistics

Natural Language Understanding
Knowledge Representation

Professor Winograd's research during 1977-78 was in three areas: knowledge representation; linguistic and cognitive theory; and human interaction with computers. He continued work on the development of KRL (Knowledge Representation Language) in collaboration with researchers at the Xerox Palo Alto Research Center. A second version of KRL has been implemented and is now being evaluated in an experimental application. In linguistic theory, Professor Winograd is continuing to develop his point of view of language understanding as an activity depending on process and context, rather than as the static phenomenon described by analytic linguists. The notions of process and context range across many aspects of language and cognition. Some of the ideas in this area, especially the philosophical underpinnings, are being developed together with Fernando Flores, a former minister of the Chilean government and research associate in the Stanford Computer Science department. The third area of Professor Winograd's recent work concerns making computers easier to use, both for programmers and non-professionals who interact with computer systems. He has examined better ways to express computing concepts than have been possible with traditional kinds of programming languages. Professor Winograd was awarded a Mellon Leave for fall quarter, and during the rest of the year continued teaching his courses and seminar on computational linguistics. He received the Dean's Award for teaching in the Fall.

Research Associates:

Thomas Binford
Research Associate in Computer Science

Image Understanding

Dr. Binford has led the computer vision and robotics group at the AI lab. During the past year, he has developed an analytic model of stereo vision, developed a quasi-optimal path calculation analysis for manipulators, led the design and implementation of a model-based vision system, and participated in research on an edge-based stereo system. The research group has completed the AL system for assembly, force control software for AL, force sensor interfacing, and developed an interactive programming system related to AL, called POINTY. They have made a high level object modeling and graphics system based on generalized cone representation, and a stereo vision system. Dr. Binford plans to extend the research described above in the areas of stereo vision and shape representation. The robotics group will extend its research to advanced programming systems which use parts representation in problem-solving systems for planning assemblies. Work will begun in research to aid handicapped persons. Research is supported for applications in manufacturing, planetary exploration, and photointerpretation.

Derek C. Oppen
Research Associate in Computer Science

Program Verification
Theorem Proving

Dr. Oppen's main interest is in developing techniques for reasoning about programs and the data

structures they manipulate. A primary goal has been to design a simplifier, or theorem-prover, for efficiently simplifying expressions and formulas over the sorts of data structures typically found in programming languages. Related work includes obtaining decidability results and complexity bounds for various theories of data structures, investigating the role of parallelism in theorem proving, and designing efficient pattern matching algorithms for dynamically changing data bases. Dr. Oppen is also interested in various theoretical aspects of program verification and semantics, for instance, in extending programming logics to handle types and run-time interrupts.

Richard Weyhrauch
Research Associate in Computer Science

Mathematical logic
Metamathematics
Formal reasoning

Dr. Weyhrauch is in charge of the work on FOL, an interactive proof generater for First Order Logic proofs. One purpose of this work is to see if traditional ideas about formal systems are of any use to AI. There have been several major accomplishments over the past year. FOL now has a powerful evaluator for first order expressions. This uses an improved semantic attachment facility. For any particular theory, FOL now provides a suitable meta theory. This, together with the use of reflection principles, allows a user to implement any subsidary deduction rules he chooses. These features are currently being used to demonstrate how it is possible to build theories of theory building, i.e. we can reason not only about objects, but we can also reason about how we make theories of these objects. --This kind of meta reasoning has far reaching consequences for AI. For example, we can reason about the control structures of routines that search for theorems. Another area of current research is perception. The question is: how can we get from sense data the theories of the world. There are several projects involved with this question. A third area of interest is in mathematical theory of computation. Here the attempt is to develope a recursion theory of LISP and to create a single unified environment in which we can both the evaluate programs and prove properties of the functions they define.

Advanced Ph.D. Students:

R. David Arnold (working with Tom Binford).
Au tomated stereo perception.

Alan Borning (working with Terry Winograd)
A system for building simulations using constraints

Martin Brooks (working with Zohar Manna).
Automatic debugging of LISP programs.

Juan Bulnes (working with John McCarthy).
A goal command language for the first order logic proof checker.

Robert Elschlager (working with Cordell Green).
Assimilation of natural language program descriptions.

Robert Filman (working with John McCarthy).
Exploration in knowledge representations.

Richard Gabriel (working with Terry Winograd and Cordell Green).
Automatic explanation within a program synthesis system.

Don Gennery (working with Tom Binford).

The use of computer stereo vision in modelling the environment of an exploring vehicle.

Chris Goad (working with G. Kreisel, Department of Philosophy).
The computational content of proofs.

Ron Goldman (working with Tom Binford)
Geometric and spatial representation of objects in the domain of mechanical assembly,

Elaine Kant (working with Cordell Green).
Efficiency knowledge for an automatic programming system.

Richard Karp (working with David Luckham),
Mechanical verification of operating systems.

William Laaser (working with Cordell Green).
Synthesis of recursive programs.

David Levy (working with Terry Winograd).
Modeling discourse comprehension: an exploration of the syntax of linguistic thought.

Paul Martin (working with Terry Winograd).
Resource-limited understander for goal directed dialogues.

Larry Masinter (working with Terry Winograd).
A program is not its listing – programming systems which are uncommitted to factorization according to object or process.

Brian McCune (working with Cordell Green).
Building program models incrementally from informal descriptions.

Mitch Model (working with Terry Winograd).
Understanding and debugging multiprocess systems.

Hans Moravec (working with John McCarthy).
Obstacle avoidance by computer vision.

Jorge Phillips (working with Cordell Green).
Domain knowledge acquisition in automatic programming systems.

Wolfgang Polak (working with David Luckham).
Applying the Stanford verifier to nontrivial programs such as a compiler for a subset of Pascal.

William Scherlis (working with David Luckham).
Topics in program transformation.

Louis Steinberg (working with Cordell Green).
Dialogue moderator for an automatic program synthesis system.

David Wilkins (working with John McCarthy).
Using patterns to solve problems and control search.

Heuristic Programming Project

The Heuristic Programming Project focuses on both theoretical and applied aspects of artificial intelligence research. The work of the group is aimed at the design of knowledge-based systems which are expert at solving problems in specific fields. The application fields have been carefully chosen both to provide a rich source of research problems, and to advance basic research in the areas of greatest interest to the project. These areas of basic interest include the study of scientific problem solving, hypothesis induction, and theory formation. A number of highly successful long-term collaborations exist between this group and scientists in medically related fields. It is also a major group in a nationwide community of artificial intelligence research groups addressing biomedically relevant problems and sharing the SUMEX computer facility, housed at the Stanford Medical School.

Faculty

Bruce G. Buchanan
Adjunct Professor of Computer Science

Artificial Intelligence
Scientific Inference
Biomedical Applications

Professor Buchanan is exploring problems of scientific inference, theory formation, and knowledge acquisition by computer. He was a major contributor to the heuristic search model of scientific inference in the DENDRAL program, which provides explanations of analytic data in organic chemistry. He is building on this with the METADENDRAL program, which finds regularities in large sets of data and proposes general principles to account for them. Professor Buchanan's interest in biomedical applications of artificial intelligence has led to interdisciplinary projects at the Medical School, including work on the MYCIN program whose goal is to provide computer assisted therapy consultation. An interesting aspect of this work is the development of a system which offers competent therapeutic advice, explains its reasoning, and incorporates new knowledge into its database from interactions with users. MYCIN research is being extended to the understanding of tutorial dialogues and their application to teaching about drug therapy in MYCIN's area of competence. Professor Buchanan has been named Program Chairman of the 1979 International Joint Conference on Artificial Intelligence, to be held in Tokyo.

Edward A. Feigenbaum
Professor of Computer Science
Chairman of the Computer Science Department

Knowledge Engineering
Models of Scientific Problem Solving

Professor Feigenbaum has played a major role in organizing the Heuristic Programming Project and involving it in applications drawn from scientific and medical domains. He has recently been active in starting several new research projects in the broad area of modelling scientific problem solving. These are in the areas of experiment planning in molecular genetics; structure determination in protein crystallography; and pulmonary function diagnosis and treatment. Professor Feigenbaum is also greatly interested in making the results of artificial intelligence research accessible and usable to those outside the field. He is directing the writing of an "AI Handbook" which will organize the concepts, methods, and techniques of artificial intelligence in encyclopedia form. He is involved in an analogous project in software, the AGE project, whose goal is to provide software packages to aid the construction of expert computer programs by people other than artificial intelligence researchers. As department chairman, Professor Feigenbaum's main goals are to achieve a smooth transition to new quarters in the Quad, to improve the level of computing facilities available in the department, and to consolidate recent faculty gains in the systems area. Professor Feigenbaum became Principal Investigator of the SUMEX project last summer.

Joshua Lederberg
President, The Rockefeller University (NYC)

Artificial Intelligence
Machine-Aided Inference in Experimental Science

Professor Lederberg's research interests are rooted in his experimental work in molecular biology, but for many years he has been investigating ways in which computer science could be used to support the work of the laboratory investigator in the cognitive domain. His concrete efforts in this direction include the DENDRAL and MOLGEN programs within the Heuristic Programming Project. At the present time, his main interest in computer science is how to represent formal and informal knowledge in the field of molecular genetics so as to facilitate machine induction of new hypothetical principles to be tested in the laboratory. This work is proceeding in the MOLGEN project. Program tools for constructing large knowledge bases representing genetic concepts, laboratory transformations and strategies have been built. The next step will be to test these tools on sample problems drawn from contemporary research in the genetics laboratory. Eventually, it is hoped to have a set of programs which can assist the working geneticist in planning experiments and generating new hypotheses. In addition to his work with MOLGEN, Professor Lederberg was the founding principal investigator of the SUMEX-AIM computer resource and will continue as an associate to Professor Feigenbaum's leadership for this national community of artificial intelligence researchers with biomedical interests who use it.

Douglas B. Lenat
Assistant Professor of Computer Science

Models of Discovery
Knowledge Representation

Professor Lenat is conducting research on the processes and knowledge used to suggest and test new discoveries in science, particularly in elementary mathematics. He has developed a line of computer programs which contain rules for analogic and inductive reasoning to direct an exploration of the space of theorems of number theory. As part of his investigations of discovery, he has studied various knowledge representation methods, such as production rules, cooperating expert knowledge sources, and frame-like entities referred to as "beings". Professor Lenat is now trying to expand his work on scientific discovery to the domain of molecular genetics.

Research Associates:

Raymond Carhart
Research Associate in Computer Science

Combinatorial Theory
Applications to Chemistry

Dr. Carhart has been associated with the DENDRAL program for several years. His main activities have concerned the implementation of a constrained, exhaustive generator for chemical structures, which could be used by working chemists in the laboratory as an independent tool, or in conjunction with the hypothesis formation programs of DENDRAL. Developing the generator led to various advances in programming algorithms from group theory and graph theory. Dr. Carhart's current investigations include the development of heuristic methods to transform chemical constraints into the most effective possible search space constraints on structure generation. Dr. Carhart has recently returned from a one-year leave of absence at the University of Edinburgh, where he redesigned the constrained structure generator to be a more efficient, compact and exportable tool for the laboratory chemist.

Lewis G. Creary
Research Associate in Computer Science

Hypothesis Formation
Rule-Based Systems

Dr. Creary is working mainly on the Meta-DENDRAL project, developing methods for automatic data selection and inductive hypothesis formation in the area of mass spectrometry. The main emphasis in his current work is on directing the processes of data selection and inductive inference

so that they result in confirmable hypotheses that are especially well suited for a particular use, such as the identification of chemical compounds. This is based on the idea that the logical or *'truth-oriented" criteria for sound scientific inquiry may legitimately and fruitfully be combined with other, more directly utilitarian, criteria. Future work currently in the planning stage includes a systematic comparative analysis of a number of alternative computational methods for the type of inductive inference performed by Meta-DENDRAL. Dr. Creary is also concerned with the representation and utilization of human expertise in rule-based systems of the MYCIN type. More generally, he is interested in a broad range of issues relating to scientific methodology and to the representation and use of knowledge, both by machines and by humans.

Robert S. Engelmore — Heuristic Programming
Research Associate in Computer Science — Physical Science Applications

Dr. Engelmore's research interest is the application of artificial intelligence research to problems of scientific inference, specifically the combined use of formal and judgmental knowledge in the interpretation of physical data. His current research concerns the development of programs to infer the three-dimensional structure of proteins from x-ray crystallographic data. This involves first the transformation of the original data into higher level symbolic descriptions and second, the matching of these symbolic descriptions with expected features of the structure, to derive an atomic level description of the molecule. The major AI task is the latter, namely the development of a hypothesis formation program which brings various sources of knowledge to bear on the structure inference problem. The other task, the "signal-to-symbol" transformation, is probably best done as a highly interactive man-machine activity, using the human for visual identification of important regions of the electron density map, and the machine for providing graphic displays and other forms of low-level interpretation of electron density maps. Various systems for performing this task are currently being tested.

H. Penny Nii — Multiple Sources of Knowledge
Research Associate — Biomedical Applications

Ms. Nii was responsible for the system design and implementation of a major project concerning the application of heuristic techniques to signal understanding (passive sonar). She is the originator and currently the group leader of the AGE Project, an attempt to cumulate AI tools and aid users in the design of knowledge-based programs. She is also coordinating and supervising the work on PUFF and VM Programs, a joint project with the Pacific Medical Center in the application of AI techniques to clinical medicine. Her primary interest concerns problems in the organization and utilization of multiple sources of knowledge and data in problem solving.

James G. Nourse — Heuristic Programming
Research Associate in Computer Science — Chemistry Applications

Dr. Nourse's current research concerns adding stereochemical (three dimensional) information into the DENDRAL programs. Those programs were developed with a very limited concept of chemical molecules. They were represented as two dimensional graphs, whose only important feature was the type and connectivity of nodes. In actual chemistry, the three dimensional molecular structure plays a crucial role in determining many properties. Thus, there is a need for introducing this factor to get more effective heuristics in structure generation programs using chemical constraints for pruning.

Dennis H. Smith — Chemistry Applications
Research Associate in Chemistry

Dr. Smith has been associated with the DENDRAL project since 1971. His activities have included participation in both development of DENDRAL and Meta-DENDRAL programs and applications of these programs to chemical problems. His participation in program development has been in the

role of designer and end-user, thus bridging the gap between the producers of such systems (e.g., CONGEN, REACT, STEREO and Meta-DENDRAL, with Drs. Carhart, Varkony, Nourse and Buchanan) and their applrcations to diverse problems in his own work and that of others in the chemical community. HIS studies have included applications of the programs to instrumental analysis and structural problems in metabolic chemistry, environmental chemrstry and natural products of biological importance. HIS current work is involved with design of semi-automated systems for the chemical laboratory in which computer programs assist chemists in analysis and interpretation of spectroscopic and chemical data gathered on unknown molecular structures.

Advanced Ph.D. Students:

Janice Aikins (working with Bruce Buchanan and Ed Feigenbaum).
Using prototypes to guide goal-directed reasoning in knowledge-based systems.

Dennis Brown (working with Ed Feigenbaum).
Knowledge-based programmer's assistant for detection, diagnosis, and correction of programming errors.

William Clancey (working with Bruce Buchanan).
Guidance principles for computer aided teaching of a large rule base.

Lawrence Fagan (working with Ed Feigenbaum and Bruce Buchanan).
On-line consultative advice in the Intensive care unit.

Carl Farrell (working with Bruce Buchanan).
A heuristic search model for automatic theory formation.

Peter Friedland (working with Ed Feigenbaum).
Applications of artificial intelligence to molecular genetics.

Tom Mitchell (student in Electrical Engineering, working with Bruce Buchanan),
Bottom up methods for rule induction.

Reid Smith (student in Electrical Engineering, working with Bruce Buchanan).
Problem solving in a distributed processor architecture.

Mark Stefik (working with Ed Feigenbaum).
Knowledge-based system for planning experiments in molecular genetics.

William Van Melle (working with Bruce Buchanan).
A domain-independent development system for creating efficient rule-based expert systems.

Numerical Analysis

The research in numerical analysis involves two closely related aspects: development of mathematically based theory to solve particular problems, and implementation of appropriate computer algorithms, with emphasis on programming considerations such as coding efficiency, numerical accuracy, generality of application, data structures, and machine independence. A broad library of programs to solve numerical problems is informally maintained by the numerical analysis

group, in cooperation with the Stanford Center for Information Processing and the Stanford Linear Accelerator Center. The group runs a weekly series of seminars and maintains wide outside contacts, centered on an active program of visitors to Stanford.

Faculty:

George B. Dantzig
Professor of Operations Research and Computer Science (Criley Chair of Transportation)

Large Scale Models
Combinatorics
Linear Programming

Professor Dantzig is interested in the optimization of large-scale systems, particularly in the modelling and optimization of large-scale systems, in combinatorial mathematics and mathematical programming. He has been active in developing the Systems Optimization Laboratory that uses as its principal tools, numerical analysis, advanced methods of data handling, linear and non-linear programming, and systematic experiments comparing algorithms on representative models -- for example energy/economic planning models. Professor Dantzig received the National Academy of Sciences Award in Applied Mathematics and Numerical Analysis for 1977; he was appointed a Vinton Hayes Senior Fellow in the Division of Applied Science, at Harvard University, 1978; and he received an Honorary Doctorate Degree from Yale University, 1978.

Gene H. Golub
Professor of Computer Science

Matrix Computation
Structured Linear Systems
Least Squares and Eigenvalues

Professor Golub's work has the unifying theme of matrix computation, with the aim of devising and analyzing algorithms for solving numerical problems that arise in scientific and statistical computations. He has been active in developing new numerical methods which have been incorporated into useful program libraries. Methods that are the subject of recent and current reseach are ones to: construct all possible matrices of specified structure with prescribed eigenvalues; update solutions when the matrix of coefficients changes by a small rank; compute a few of the extreme eigenvalues of large, sparse matrices; use the conjugate gradient method to calculate the solution of sparse systems which are similar to already solved ones; exploit linear coefficients which may enter normally nonlinear least squares problems; and solve linear least squares problems with linearly or almost linearly independent parameters. Professor Golub was named to give the George E. Forsythe Memorial Lecture at the SIAM National Meeting of 1978. The Lectureship, established by the ACM's Special Interest Group in Numerical Mathematics (SIGNUM), is awarded every two years for leadership in numerical mathematics. Professor Golub was also awarded the Dean's Award for Excellence in Teaching from Stanford's School of Humanities and Sciences in 1978.

John G. Herriot
Professor of Computer Science

Sptine Functions
Partial Differential Equations

Professor Herriot is interested in the development and testing of efficient algorithms for spline interpolation. He is collaborating in this work with two students at Stanford. Algorithms for spline interpolation with fairly general end conditions are being developed. He is also interested in studying and comparing methods for numerical solution of partial differential equations.

Joseph Oliger
Assistant Professor of Computer Science

Ordinary Differential Equations
Partial Differential Equations

Professor Oliger's research is directed toward constructing, analyzing, and implementing efficient algorithms for computing approximate solutions of time dependent partial differential equations.

These equations often arise in problems in meteorology, oceanography, and geophysics. Current problems being investigated include: finding criteria for the stability of approximations of the initial boundary value problem for hyperbolic equations which can be easily checked by engineers and scientists; comparing the efficiencies of various methods; studying adaptive methods for time dependent problems, methods for problems with different time scales, and methods for calculations with non-standard data.

James H. Wilkinson
Professor of Computer Science

Numerical Linear Algebra
Eigenvalue Problems

Professor Wilkinson is a member of the Stanford faculty on a one academic quarter per year basis. He spends the rest of the year at the National Physical Laboratory in England. Professor Wilkinson is often referred to as one of the "world's greatest numerical analyst." His research has been fundamental in the area of numerical linear algebra. Among his major contributions are pioneering work on error analysis of linear algebraic equations which has made possible the development of stable numerical methods for solving linear programming problems. His book, *The Algebraic Eigenvalue Problem,* is a classic. Professor Wilkinson is noted as an especially excellent teacher and lecturer, and as a willing collaborator with young researchers. At Stanford, he teaches one course per year and participates in the research of the Numerical Analysis group and others around campus. This year, Professor Wilkinson gave the Inaugural Lectures of the Forsythe Lecture Series, named for the late-Computer Science Department Chairman George Forsythe.

Advanced Ph.D. Students:

Daniel Boley (working with Gene Colub).
Inverse eigenvalue problems for symmetric matrices

John Bolstad (working with Joseph Oliger).
Mesh refinement for time-dependent partial differential equations.

William Coughran (working with Joseph Oliger).
Stability for variable coefficient initial boundary value problems.

Eric Grosse (working with Gene Colub).
Numerical methods in crystallography.

Systems

-Systems research in the Computer Science Department spans many different topics and takes place in many different settings. For example, program verification and processor design research are taking place at the Artificial Intelligence Laboratory, while distributed computing research is being pursued within the Heuristic Programming Project. The greatest concentration of systems research takes place within the Digital Systems Laboratory (soon to be renamed the Computer Systems Laboratory), a joint laboratory of the Departments of Computer Science and Electrical Engineering. Major areas of interest include reliability, networks, data bases, and concurrent programs. The systems faculty has completed a thorough revision of the systems curriculum. The entire new course sequence will be taught for the first time in the 1978-79 academic year. [Some of the faculty members listed here are officially in the Electrical Engineering department rather than Computer Science].

Faculty:

Forest Baskett
Associate Professor of Computer Science and Electrical Engineering

Operating Systems
Performance Evaluation
Computing System Organization

Professor Baskett is interested in the design and analysis of computing systems and computing system coniponen ts. For the past two years he has been on leave at the Los Alamos Scientific Laboratory where he has been leading a group designing and implementing a large, modern operating system, DEMOS, for the GRAY-1 computer. The design of that system is potentially suitable as the basis for a distributed operating system in a network environment. Professor Baskett would like to pursue that possibility. An important component of DEMOS is a sophisticated file system designed for high performance. Professor Baskett has been involved in the development of some Markov models of the file system to predict and analyze the performance of the buffering scheme used by the file system . This work suggests an easy way to use some new technologies to fill the "access gap" in storage speeds. The scheme would even work well for floppy disks on microcomputers. Professor Baskett is interested in designing and developing display oriented personal computing systems in 'a scientific networking environment. An important part of such a network might be a multiprocessor computing engine. Professor Baskett hopes to continue to contribute to the design and analysis of multiprocessor systems. Professor Baskett also expects to continue his work in the measurement and analysis of computer system components, including CPU structures. The aim is to develop a more scientific basis for the engineering of computing systems.

Michael J. Flynn
Professor of Electrical Engineering

Computer Organization
Computer Architecture
Emulation

The emphasis of Professor Flynn's work is directed at computer architecture and organization, especially the area of Interpretive computer design. An emulation laboratory has been built to aid in the study of the processor instruction execution of both physical and conceptual processors and the basic characteristics of "optimal" instruction processors. The laboratory includes a machine, the EMMY, which can emulate a wide range of architectures and thus aid these investigations. Other areas of research include memory hierarchy design, understanding and modelling program behavior, and studying characteristics of parallel processors such as limits on their performance.

John L. Hennessy
Assistant Professor of Electrical Engineering

Programming Languages
Operating Systems
Distributed Computing

Professor Hennessy's primary interest is in the area of programming methodology and programming language design. He is Investigating programming language features which support the construction of reliable software. Professor Hennessy is also interested in the special problems of software design in the operating systems environment. Currently, he is investigating the problems of software construction for distributed systems.

Balasubramanian Kumar
Assistant Professor of Electrical Engineering

High Speed Computer Architecture
Performance Evaluation
Modelling Program Behavior

Professor Kumar's chief interest is in the analysis of architecture and algorithms for high speed computation. Along with this interest, he is also modelling the performance of distributed software systems, including operating systems, with particular attention to the programs' memory reference behavior.

David Luckham
Adjunct Professor of Electrical Engineering

Program Verification

Dr. Luckham directs the Program Verification Group at the Artificial Intelligence Laboratory. The work of this group is largely devoted to developing new programming languages and automated aids to programming. The group has implemented a verifier for a nearly complete version of the Pascal programming language. The verifier is currently being run at Stanford and two other ARPA Net sites to test its portabilty and to obtain some preliminary feedback from different user groups. Distribution on a limited basis is planned for Fall 1978. A special version of this verifier for automatic detection of runtime errors in programs has also been implemented. The success of the verifier depends on recent advances made by Dr. Luckham's group in theorem proving, specifically the theory and implementation of cooperating special purpose decision procedures. Such systems are the best method of constructing theorem provers that has been found to date. It is expected that such theorem provers will play an important role in the implementation of sophisticated analysis and decision programs in application areas other than program verification. The group is working on a concurrent systems programming language. Aspects of this project include language design, programming techniques for parallel processes, theory of documentation of concurrent systems, and implementation of a verifier and compiler.

Edward J. McCluskey
Professor of Computer Science and
Electrical Engineering

Computer Architecture and Organization
Logic Design
Reliable Systems
Fault-Tolerant Computing

Professor McCluskey is concerned with the development of insight into the architecture and implementation of computer systems for which the reliability, availability, and maintainability are important as well as the cost and performance. Of particular importance are the development of measures that combine both the performance and reliability aspects of the system. These measures are then used to evaluate existing designs in order to develop an understanding of the good features and to invent new features and designs. Special attention is currently being paid to the problem of designs which are easily tested. A quite different area of research involves the development of techniques for designing IIL circuits which operate with four rather than two signal levels. Professor McCluskey was the founder of the Digital Systems Laboratory and is currently the Director of its Center for Reliable Computing which includes the research of four faculty members as well as a number of students and research associates.

Susan Owicki
Assistant Professor of Electrical Engineering

Program Verification
Concurrent Programs
Operating Systems

Professor Owicki's main research interest is the verification of concurrent programs of the sort found in operating systems, computer networks, and large data base systems, where the criteria for correctness are more varied than in sequential programs. She is attempting to develop a clear understanding of these criteria and to find proof techniques for verifying that they are satisfied. A related interest is the design of programming languages for concurrent programs, and the effects of language on program design and verification. Professor Owicki is currently investigating the design of a verifiable operating system and verifiable protocols for distributed data base systems. She received the 1977 ACM Systems and Languages Paper Award for the paper "An Axiomatic Proof Technique for Parallel Programs", coauthored with David Cries.

Fouad Tobagi
Assistant Professor of Electrical Engineering

Computer Networks
Performance Evaluation

Professor Tobagi is joining the Stanford faculty at the beginning of summer quarter, 1978. His major interests are in the area of the mathematical modeling, analysis, and optimization of computer systems, data communications systems, and computer networks. He has participated in the design, analysis, and measurement of the ARPA Packet Radio Network. Currently, he is investigating a variety of questions concerning radio packet switching, including assessing the performance of real time transmission protocols.

Willem M. vanCleemput — Design Automation of Digital Systems
Assistant Professor of Electrical Engineering

Professor vanCleemput's interests are in the area of digital systems design, with a special emphasis on providing computer aids to designers. His current research concentrates on various aspects of the circuit layout problem: generating logic diagrams, flow charts, printed circuit board designs, and integrated circuit layouts. The aim of the current researh project is to develop automated layout techniques that produce acceptable designs in a short period of time so that they will be economically competitive with existing manual methods and will permit the introduction of the newest technology circuits in a shorter time. Another area of interest is digital design languages. The current tendency in hardware design is no longer to build and test a prototype, but rather to describe a design in a suitable language and to validate this description at various levels of detail, Most design languages today allow description of a system at a single level of detail only (the register-transfer level), while most validation is done through extensive simulation. The aim of this research is to provide description capabilities at various levels of detail and to perform design validation without simulation, where this is feasible.

Gio W iederhold — Database design; Operating Systems; Distributed Computing; Applications in Medicine and Planning
Assistant Professor of Computer Science

Professor Wiederhold's chief interest is in "the design of useful computer systems". Activities in this rather broad topic range from trying to gain a better understanding of the capabilities of future systems to the application of modern software design techniques to current hardware. He is particularly interested in applications which are of a size or complexity which is not easily handled by current computer systems so that a quantitative engineering analysis is warranted prior to implementation. Professor Wiederhold's current research activities include an investigation of the interaction of alternative multiprocess architectures with several classes of large computing problems drawn from artificial intelligence, distributed databases, and numerical analysis; an examination of the use of AI techniques and conceptual database models as the basis for a database query and update processing interface; the further development of several pilot medical database projects; and operating system and complier design for the effective use of an asynchronous multiprocessor system for large computations which utilizes many parallel executing process.

Research Associates:

M. Danielle Beaudry — Reliability Evaluation
Research Associate in Computer Systems Laboratory

Dr. Beaudry is responsible for the Digital Systems Laboratory project on reliability evaluation of computer systems. This research effort concentrates on analytical modeling of both fault-tolerant and fault-resistant computing systems, as well as the integration of modeling and simulation techniques for the evaluation of fault-tolerant computer architectures. Dr. Beaudry is also interested in the interrelationship between performance and reliability analysis for computing systems.

Advanced Ph.D. Students:

Marion L. Blount (working with Ed McCluskey).
Probabilistic fault diagnosis models for digital systems.

Ramez El-Masri (working with Gio Wiederhold).
Improving access to information in large databases.

Hector Garcia-Molina (working with Gio Wiederhold).
Network protocols for distributed databases.

Erik Gilbert (working with Gio Wiederhold).
Effective operating system design for a high-performance multiprocessor.

Thomas McWilliams (working with Forest Baskett).
Hierarchical design and verification of digital systems.

Terry Roberts (working with Susan Owicki).
Evaluation of text editors.

L. Curt Widdoes (working with Forest Baskett).
Performance analysis of pipelined machines.

Clark Wilcox (working with Michael Flynn).
A high-level language emulation.

Ph.D. degrees, 1977-78

Autumn 1977:

David R. Barstow, "Automatic Construction of Algorithms and Data Structures Using a Knowledge Base of Programming Rules," advisor: Cordell Green.

Bernard Mont-Reynaud, "Hierarchical Properties of Flows, and the Determination of Inner Loops," advisor: Donald Knuth

Winter 1978:

Michael Thomas Heath, "Numerical Algorithms for Nonlinearly Constrained Optimization," advisor: Gene H. Golub.

Leonard Jay Shustek, "Analysis and Performance of Instruction Sets," advisor: Forest Baskett.

John Edward Zolnowsky, "Aspects of Computational Geometry," advisor: Forest Baskett.

Spring 1978:

Tony Fan-Cheong Chan, "Comparison of Numerical Methods for Initial Value Problems," advisor: Joseph Oiiger.

Summer 1978:

Franklin Luk "Sparse and parallel matrix computations," advisor: Gene Goiub.

Luis Trabb Pardo "Set representation and set intersection," advisor: Donald Knuth.

Jacobo Valdes-Ayesta "Parsing flow charts and series-parallel graphs," advisor: Robet Tarjan.

Masters degrees, 1977-78

Autumn 1977:

Brent Tzion Haiipern
Carios Eduardo Rouira-M
Eiva Perez Trevino
Morris Daniel Webb

Winter 1978:

Max Karl Agoston
Miriam Beth Bischoff
David Ellsworth Dew
Norman Haas
Robert Glen Martin
Patrick Raymon McGoldrick
Luis Isidoro Trabb Pardo
David Wayne Wail
Pierluigi Zappacosta

Spring 1978:

Henry Joseph Borron
Robert Burns Fishei
Ramiro Rafael Garcia-G
Erik James Gilbert
Steven Charles Classman
Yaw Wen Hu
Masazumi Ishii
Thomas Joseph M alloy
Willis Freeman M arti
Scott Alan McGregor
Roland Raymond Weng
Pierre David Ziiber

Summer 19'78:

Philippe Aiain Cadiou
Frederick Chi-tak Chow
Michael Terence Deviin
Si Yi Don
Robert Alvin Elschiager
Linda Weinert
Richard A. Hronicek

Colloquia Speakers

Computer Science Colloquia:

(Autumn 1977)

Ira Goldstein (MIT) "The Genetic Epistemology of Rule Systems"

Edward Feigenbaum (Stanford University) "The Art of Artificial Intelligence: Themes and Case Studies of Knowledge Engineering"

Rerthold K. P. Horn (MIT) "Understanding Images and Image Understanding"

J. Strothcr Moore (SRI International) "An Automatic Theorem Prover for Recursive Function Theory"

Jark Schwartz (Courant Institute) " Metamathematical Extensibility of Proof Verifiers"

John McCarthy (Stanford University) "Epistemological Problems of Artificial Intelligence"

Andrew Yao (Stanford University) "On the Intrinsic Complexity of Probabilistic Computations"

R. Stevrn Glanville (Hewlett-Packard Corp.) "A Machine Independent Code Generation Algorithm"

David Hare1 (MIT) "Expressing and Proving Propcrties of Recursive Programs"

(Winter 1978)

Al Aho (Bell Labs) "Answering Queries from Tables"

Dan Weller (IBM) "A Graphics-Based Programming-Support System"

R. W. Floyd (Stanford University) "Finding Convex Hulls Efficif ntly"

Corkry Cartwright (Cornell University) "First Order Semantics: a Natural Programming Logic for Recursively Defined Functions"

CuthbertHurd "Computing 25 Years Ago, or, Thrm was the days or was they?"

David Beech (IKM U.K. Laboratories) "Practical Program Semantics"

Jean Paul Jacob (IBM San Jose and University of California) "DECISIONS, DECISIONS...Computer-based Decision Support Systems"

Rrrnda Baker (Bell Labs) "Program Structure versus Programming Language Control Constructs

Jim King (IBM) "Program Analysis by Symbolic Execution"

Anthony Wasserman (University of California at San Francisco) PLAIN: A Programming Language for Creating Reliable Interactive Programs"

(Spring 1978)

Richard Weyhrauch (Stanford University) "Mctamathrmatics for the Practical Man"

Tom McWilliams (Stanford University) "S-l Multi-processor A rchitecture"

John Gaschnig (S.R.I. International) "Case Studies of Backtrack vs Waltz-type vs New Algorithms for Satisficing Assignment Problems"

Ralph Mcrkle (Stanford University) "The New Cryptography"

Warrrn Teitelman (Xerox-Palo Alto Research Center) "A Display Oriented Programmer's Assistant"

Nori Suzuki (Xerox Palo Alto Research Center) "Consistent and Complete Proof Rules of Strong Correctnss of Parallel Programs

JeanVuillemin (Universite de Paris-Sud) "Geometrical Combinatorics as a Tool for Designing Efficient Algorithms"

Grrgnry Chaitin (IBM) "Toward a Mathematical Definition of LIFE."

Kristen Nygaard (Institutt for Informatik Oslo,Norway) "Workers' Participation in Systems Design"

F. L. Bauer (Institut fur Informarik dc Technischen Universitat, Muenchen) "A Philosophy of Programming"

John Backus (IBM) "Functional Programming, its Algebra of Programs and a Critique of von Neumann Programming"

Numerical Analysis Seminars:

(A utumn 1977)

Jerome H. Friedman (Stanford Linear Accelerator Center) "A Nested Partitioning Algorithm for Numerical Multiple Integration".

Carlos Felippa (Lockheed, Palo Alto Rcscarch Laboratory) "Local Iterative Procedures for Improving Penalty Function Solutions".

Pierre Jean Laurent (Univcrsttc Scicnrifique et Medicale de Grenoble) "Spline Functions and Optimal Evaluation of Funct ionals".

Stan Jensen (Lockheed, Palo Alto Research Laboratory) "Large Numerical Problems in Structural Mechanics".

Donald Joyce (Massey University. New Zealand) "Extrapolation to the Limit-Algorithms and Applications".

(Winter 1978)

Richard Rrcnt (A ustralian National University and University of Rcrkrlcy) "Fast Algorithms for Computation and Reversion of Power Series".

Grrmund Dahlquist {Royal Institute of Technology, Swrdrn) "Some Properties of Positive Real Functions and Their Application to Stability Questions in the Numerical Solution of Differential Equations".

Germund Dahlquist (Royal Institute of Technology, Sweden) "Still Differential Equations - Basic Notions, Problems, and Methods".

Rolf Jeltsch (Ruhr Unrvcrsrtat, Bochum, Germany) 'On the Stability Regions of Methods for Solving Initial Value Problems of ODE's".

John Butcher (Univcrsrty of Auckland, New Zealand) "Some Stability Questions Associated with Runge-Kutta Methods"

Anthony Leonard (NASA Amcs Rcscarch Center) "Computing Fluid Motions with Vortex Elements".

Achi Brandt (ICASE and Weizmann Institute of Science) "Multilevel Adaptive Techniques: Existing Software".

Carl de Boor (Mathematics Rrscarch Center, University of Wisconsin) "Optimal Nodes for Polynomial Interpolation".

Mac Hyman (Los Alamos Scrcntific Lahorarory) "The Method of Lines Solution of Partial Differential Equations'.

(Spring 1978)

Michael Mock (University of California, Rcrkclcy and Rutgers University) "Hyperbolic Systems of Conservation Laws and Numerical Methods that Sometimes Work".

Bjorn Engquist (University of California, Los Angeles) "Composite Meshes for Time Dependent Problems".

Olavi Nevanlinna (Oulu University, Finland and Mathematics Research Center, University of Wisconsin) "Numerical Solution of a Singularly Perturbed Nonlinear Volterra Equation Arising from a Model of Melting Plastic".

Werner Liniger (IBM Rcsrarch Center, Yorktnwn Heights) "Contractive One-Leg Methods for thr Integration of Stiff Initial Value Problems"

E Dale Martin (NASA Ames Rcscarch Ccntrr) "Semidirect Numerical Solution of Gasdynamic Conservation Equations with Arbitrary Geometry'.

Frank Nattcrer (Oregon State University and University of Saarbruecken) 'An Error Analysis of a Picture Reconstruction Problem".

Roland Sweet (University of Colorado ar Denver) "The State of Software for Partial Differential Equarions'.

Michael Osborne (Thr Australian National Univrrsity, Canberra) "Collocation Methods for Boundary Value Problems"

Phillip Colella (University of California and Lawrence Livermore Laboratory) "Sampling Dcpendcnce of the Glimm Scheme".

Artificial Intelligence Seminars:

(Winter 1978)

Robin Milner (University of Edinburgh) "Interactive Proof in LCF'

Bob Boyer (SRI International) The Automatic Deduction of the Unique Factorization Theorem'

Richard Weyhrauch (Stanford University) "Reflection and Metamathematics"

Brian Funt (Stanford University) "WHISPER: A Problem-Solving System Utilizing Diagrams and a Parallel Processing Retina"

Doug Appelt (Stanford University) 'SNIFFER: A Network Based Deduction System'

Don Grnncry (Stanford University) 'A Stero Vision System for an Autonomous Vechicle"

Jim Davidson (Stanford University) 'A Discourse Analysis in Natural Language'

(Spring 1978)

Bill Clancey (Stanford University) "A Knowledge Based Tutoring System'

Nachum Dershowitz (Stanford University) 'Proving Termination wrth Multiset Orderings"

Jim Stansfield (MIT) "A Multi-Player Game Approach to Intelligent Support Systems for Analysis"

Alan Borning (Xerox Palo Alto Research Center) "ThingLab -- A Physics Laboratory Simulator"

David Levy (Xerox Palo Alto Rcscarch Center) 'A Brief Excursion into the Space of Linguistic Thought

Hans Berlrncr (Carnegie-Mellon University) "The B* Tree Search Algorithm: A Best-first Proof Procedure'

Dick Gabriel (Stanford University) 'Yackety-Hacks: A Theory of Mind Speaks Out"

Dave Wilkins (Stanford University) 'Using Patterns and Plans in Chess'.

Paul Martin (Stanford University) 'Inferring Goal Structures from Diplomacy Dialogues'.

Peter Suzman (University of Edinburgh) "Commonsense Representation and Understanding".

Digital Systems Seminars:

(Autumn 1977)

Dave House (Intel Corporation) "Trends in Microprocessors"

Bert Forbes (Hewlett-Packard) 'A 16 Bit CMOS/SOS Microprocrssor"

Robert McClure (Stanford Linear Accelerator Center) 'Computer X-ray Tomography'

Frank Sumner (IBM Rrscarch, San Jose) "The University of Manchrster Research Computer'

John Hennessy (Stanford University) 'A Real Time Programming Language for Microprocessors'

Al Hartman (Intel Corporation) 'Programming Languages for Microprocessors"

Fran Allen (IBM and Stanford University) "Procedure Summaries: Their Construction and Use'

John Guttag (University of Southern California) "Algebraic Specifications of Abstract Data Types"

(Winter 1978)

Ursula von Maydell (Univrrsity of A lbcrta) "Computer Performance: Studies and Statistics"

James Oliphant (Intel Corporation) 'CCD Memories"

Prakash G. Hcbalkar (IRM Research, San Jose) "Software Design Technology'

Wayne T. Wilner (Xerox) "Recursive Machines and Computing Technology"

Dr. John Levy (Tandem Computers) "Design of Internal Buses for Computer Syrtcms

A lvin Despain (University o f Califoria, Berkeley) "X-TR EE: A Multiprocessor System"

James McKevitt (Intel Corporation) "INTEL 8086 Microprocessor"

Danielle Beaudry (Stanford University) "Performance Considerations for the Reliability Analysis of Computing Systems"

(Spring 1978)

Herb Schorr (IRM T J. Watson Rcscarch Crnttr) "VLSI and High Pcrformancr M achinrs"

David Hodges (University of California. Berkeley) "The Analog Interface to Digital LSI Systems"

John Wensley (S.R.I Intrrnattonal) "The Development of the Sift Fault-Tolerant Computer Systrm"

Marion L Blount (Stanford University) "Probabilistic Fault Diagnosis Models for Digital Systems"

Henry Blume (Intel Corporation) "Single-Chip Microcomputers and thrir Peripheral Context"

Clarence Ellis (Xerox Palo Alto Research Center) "Synchronization in Distributed Systems"

James A. Katzman (Tandem Computers) "The Architecture of the Tandem 16 Nonstop System'

George Glasser (Centigram Corporation) "Commercial Voice Recognition: Definition, Capabilities and Applications"

Robert W . Martin (I B M Advanced Systems Develoment Division) "An Overview of the IBM Series-1 Computer and the Event Driven Executive Operating System for thr Series- I"

Elliott Organick (Stanford University) "Programming with Hardware"

Stanford CS Reports, 1977-78

STA N-CS-77-616
Kreiss, H., and J. Oliger, "Stability of the Fourier Method,' September 1977.

STAN-CS-77.617 (A IM300)
W inograd, T. "On Some Contested Suppositions of Generative Linguistics about the Scientific Study of Language," September 1977.

STAN-CS-77-618 (HPP 77-28)
Nilsson, N. J. "A Production System for A utomatic Deduction," Septrmbcr 1977.

STA N-CS- 77.619
Paul, W. J., and R. E. Tarjan, "Time-Space Trade-offs in a Pebble Game,' September 1977.

STA N.CS. 77-620
Bolstad, J., and J. Oliger, "Adaptation of the Fourier Method to the. Nonperiodic Initial Boundary Value Problem," September 1977.

STAN-CS-77.6::) (HPP 77-25)
Feigenbaum, E. A. "The Art of Arrrficial Intelligence: I. Themes a n d Case Studies o f Knowledge Engineering," September 1977.

STA N-CS- 7 7-622
Golub, G. H., hl. Heath, and G. Wahba, "Generalized Cross- validation as a Method for Choosing a Good Ridge Parameter," September 1977.

STA N-CS.77.63
Boley, D., and G. H. Golub, "Inverse Eigenvalue Problems for Band Matrices," September 1977.

STAN-CS.77.6114 (AIM 301)
Earnest, L. (ed.) "Recent Research in Computer Science," September 1977.

STA N.CS-77.63
Brown, M. R., and R. E. Tarjan, "A Fast Merging Algorithm," September 1977.

STA N-CS- 77-626
Yao, A. C "On the Loop Switching Addressing Problem," October 1977.

STA N-CS-77-627
Lipton, R. J., and R. E. Tarjan, "A Separator Theorem for Planar Graphs," October 1977.

STA N-CS. 77-628
Lipton, R. J., and R E. Tarjan, "Applications of a Planar Separator Theorem," October 1977.

STA N.CS. 77-629
Yao, A. C. "The Complexity of Pattern Matching for a Random String," October 1977.

STA N-CS-77.633 (A IM302)
Manna, Z., and R. Waldinger, "Synthesis: Dreams => Programs," October 1977.

STAN-CS-77.681 (AIM 303)
Dershowitz, N., and Z. Manna, 'Inference Rules for Program Annotation,. October 1977.

STAN-CS- 77.632 (A I M304)
Wagner, T. J. "Hardware Verification," October 1977.

STA N-CS-77-633 (AIM 305)
Faught, W. S. "Motivation and Intensionality in a Computer Simulation Model,' October 1977.

STA N-CS-77-634
Hoffman, W., and B. N. Parlrtt, "A New Proof of Global Convergence for the Tridiagonal QL A lgorithm," October 1977.

STA N-CS-77-635
Golub. G. H., F. T. Luk, and M. L. Overton, "A Block Lancros Method to Compute the Singular Value and Corresponding Singular Vectors of a Matrix," October 1977.

STA N-CS-77-636
Bube, K. P. "C1m Convergence of Trigonometric Interpolants," October 1977.

STA N-CS-77-637
Ramshaw, L., 'On the Gap Structure of Sequences of Points on a Circle,' October 1977.

STAN-CS- 77.638
O'Leary, D. "A Generalized Conjugate Gradient Algorithm for Solving a Class of Quadratic Programming Problems," October 1977.

STA N-CS-77-639 (A IM 306)
Green, C & Barstow, D. "On Program Synthesis Knowledge," November 1977

STA N-CS-77-640 (A IM 307)
Manna, Z. & Waldingcr, R. "Structured Programming With Recursion," November 1977.

STAN-CS-77.641 (AIM 308)
Barstow, D . "Automatic Construction of Algorithms and Data Structures," November 1977.

STA N-CS-77-642
Yao, A. 'On Constructing Minimum Spanning Trees in k-dimensional Spaces and Related Problems,' November 1977.

STA N-CS- 77.643
Tanabe, K. "A Geometric Method in Nonlinear Programming,' December 1977.

STA N-CS.77.64.1
Mont-Raynaud, B. 'Hierarchical Properties of Flows and the Determination of Inner Loops,' December 1977.

STA N-CS-77-645
Lipton, R.J., Rose, D.J. & Tarjan, R.E. "Generalized Nested Dissection." December 1977.

STAN-CS-77.616 (AIM 309)
Nelson, G. & Oppen, D. 'Efficient Decision Procedures Based on Congruence Closure," December 1977.

STA N.CS.77.647
Yao, A. 'A Lower Bound to Palindrome Rccognrtion by Probabilistic Turing Machines,' December 1977

STA N-CS-77.648
Knuth, DE. "Mathematical Typography," January 1978.

STAN-CS-77.649 (HPP-78-I)
Buchanan, B & Feigenbaum "DENDRAL a n d Meta-DENDRAL: Their Applications Dimension," January 1978.

STA N-CS-77.650
Lengauer T. & Tarjan, R. "A Fast Algorithm for Finding Dominators in a Flow Graph," February 1978.

STA N-CS-77-651 (AIM 310)
Dershowitz, N & Manna, Z "Proving Termination with Multiset Orderings," February 1978.

STAN-CS-77.652 (AIM 311)
Nelson G. & Oppen D. "A Simplifier Based on Efficient Decision Algorithms," February 1978.

STA N-CS-77-653
Shiloach, Y. "Multi-Terminal 0- I Flow," March 1978

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