MASSACHUSETTS INSTITUTE OF TECHNOLOGY
ARTIFICIAL INTELLIGENCE LABORATORY

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AI Lab Faculty
1992–1993

Edited by Mark C. Torrance

Abstract: This document is meant to introduce new graduate students in the MIT AI Lab to the faculty members of the laboratory and their research interests. Each entry consists of the faculty member's picture, if available, some information on how to reach them, their responses to a few survey questions, and a few paragraphs excerpted from the AI Lab President's Report, as edited by Patrick Winston.

This document is meant to introduce new graduate students in the MIT AI Lab to the faculty members of the laboratory and their research interests. Each entry consists of the faculty member's picture, if available, some information on how to reach them, their responses to a few survey questions, and a few paragraphs excerpted from the AI Lab section of the MIT President's Report, as edited by Patrick Winston.

Below you will find a copy of the survey each professor was asked to complete. Careful reading of the questions may help you better interpret their responses.

Most current students and faculty agree that it is a good idea to visit many professors and students before you settle on an advisor and group. Many older students say they wish they had spent more time getting a broad sense of the variety of work done in the lab before they committed to their current advisors.

Some people in the lab feel that the *User's Guide to Tech Square* gives the mistaken impression that you need to be well-prepared before you talk to a faculty member about his/her research. The faculty expect new students to come around to talk to them during the first few months of the year. Such a meeting does not constitute a commitment on either part to form a working relationship, so you are encouraged to meet as many of the faculty as you can during your first few weeks and months here. You'll find, for example, that many of the faculty surveyed here explicitly encourage students to approach them with little or no preparation. Consider this document a gentle introduction to the faculty, and don't be shy!

The survey

The following message was sent by email to all the faculty members in the AI Lab, to the research staff in the AI Lab who work with graduate students, and to the three faculty/research staff in the Medical Decision Making Group (on the 4th floor), which is sort of in between LCS and AI.

Questions with numerical answers have been converted to a uniform scale for purposes of the presentation above. The lowest numbered choice in the survey was converted to a bar of no length, the highest numbered choice to a full-length bar.

Dear *faculty member*,

Scott Hofmeister and I, with others, are planning orientation for the new graduate students for this Fall. Some of the most frequently asked questions involve the availability/willingness of professors to meet with and/or supervise new students. It would help us tremendously (and save you from talking to us in person!) if you will take a few moments to respond to this simple multiple-choice message.

1. Having been one myself, I know that many students enter the AI lab not yet even knowing what general area within AI they want to study. How willing would you be to talk to such students while they are in this stage?

   1 not interested

   3 indifferent

   5 very interested

2. What level of preparation do you feel is *necessary* on the part of a student before you would want to meet with that student? (provide your own description if none below apply)

   1 no preparation

   2 read blurb about my work in LCS or AI progress report

   3 Skimmed some of my recent papers

   4 Carefully read papers/has specific questions

   5 Has already talked to some of my students

   6 Already has an idea for a thesis proposal

3. Do you have group meetings? If so, would you suggest a new student come to the meeting to get a flavor of your group before meeting with you? (Yes/No)

4. How interested are you in taking new students at this time?

   1 not interested

   3 indifferent

   5 very interested

5. How important is it that new students have their own funding?

   1 not important

   2 somewhat important

   3 necessary

6. Can you recommend one or two of your graduate students who would be good for interested new students to ask about your/their work?

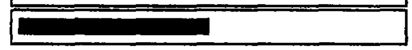
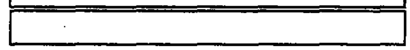
7. (optional) Describe your current research interests in 2-3 short phrases.

Any other comments you have about integration of new students into your group or new student orientation in general would be warmly received.

Thank you very much for your time,

Hal Abelson

Office: NE43-410 Phone: x3-5856 email: hal@ai

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Yes
Should you attend them	Talk with his students first
Seeking new students	
Must have your own funding	
Current students to talk to	Read biographies in blurb

Professor Abelson works on problems in AI and scientific computation and on the programming language Scheme.

The research of the MIT Project for Mathematics and Computation (Project MaC), under the direction of Professors Abelson and Sussman, is working to demonstrate breakthrough applications that exploit new computer representations and reasoning mechanisms that they have developed. These mechanisms enable intelligent systems to autonomously design, monitor, and understand complex physical systems, through appropriate mixtures of numerical computing, symbolic computing, and knowledge-based methods. They call this mixed approach *intelligent simulation.*

Chris Atkeson

Office: NE43-771 or in 9th floor labs Phone: x3-0788 email: cga@ai

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Yes
Should you attend them	When you're invited
Seeking new students	
Must have your own funding	
Current students to talk to	Andrew Moore, Stefan Schaal, Paul Viola, Gideon Stein

Professor Atkeson and his group work on memory-based learning, learning strategies, and motor learning. They use robotics as a domain to explore learning algorithms and approaches. Professor Atkeson describes his research in the following way.

One major research area is memory-based learning, which defers representational choices until the data is available and the query to be answered is known. Memory-based learning is fast, minimizes the amount of training data needed, avoids interference in the learning of multiple tasks, and permits explicit control of many aspects of the learning algorithm such as forgetting. We have used memory-based learning to train robots to perform challenging dynamic tasks such as juggling. We are in the process of applying memory-based learning to the control of complex mobile robots (such as autonomous helicopters) and complex processes (such as an internal combustion engine). We are developing cross validation techniques to fine tune memory-based learning algorithms to particular problems, so that one generic algorithm can handle a wide range of problems without human intervention. We also developing memory-based approaches to reinforcement learning. Other approaches to learning transformations are being explored, including projection pursuit regression and radial basis functions. Ying Zhao recently completed her PhD thesis on fast training methods for projection pursuit learning.

A new area of interest is using learning to refine and even discover strategies to perform tasks. We are focusing on the design of dynamic processes. We have built several machines, including the world record bounce juggling machine, based on the ideas we are exploring.

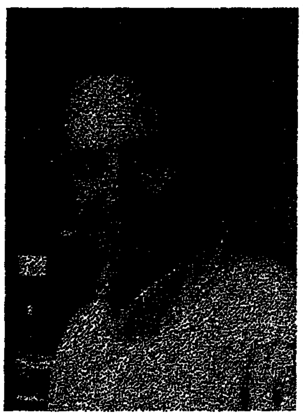
Bob Berwick

Office: NE43-838 Phone: x3-8918 email: (best choice) berwick@ai

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Yes
Should you attend them	Best to meet with him first
Seeking new students	
Must have your own funding	
Current students to talk to	Carl DeMarcken

Professor Berwick suggests you may want to read the blurb about his work in the AI Lab section of the MIT President's Report, but that's not necessary before you speak with him. He is very interested in new students, and encourages you to schedule an appointment by sending email or leaving a phone message. He describes funding as a bit tight this fall term only, with better prospects for the future. He works in the areas of natural language processing, machine learning (genetic algorithms, network models), learning word meanings, child language acquisition, and machine translation.

Professor Berwick and his colleagues have been building the next generation of natural language parsers and translators, based on modular linguistic theories. During the past year, a completely modular parser for English was extended to cover Japanese and German. This is the first complete parsing implementation of the current linguistic theory that has been developed at MIT by Chomsky, Hale, Higgenbotham, and others. Unlike extant systems elsewhere that must use a large number of completely different rules for different languages, this system uses just a handful of the same principles, parameterized in a few ways, to cover very different languages. In addition, Berwick's group explored how to learn these parameterizations automatically from the actual language input that parents provide to children, assuming the kinds of visual input and naive physical reasoning capabilities that can be reasonably assumed to be present in young children. These systems can learn what words like *roll* and *walk* mean, or that *Mary* is a thing that is also a Noun, simply by "observing" the world around them. The principle-based parsing system has been reimplemented for general distribution on Sun workstations, and extended to include a wider variety of Japanese.



Rod A. Brooks

Office: NE43-822 Phone: x3-5223 email: brooks@ai

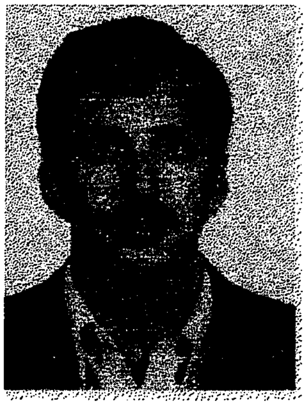
Professor Brooks will be on sabbatical from September 1st for nine months, so he won't be around to meet with new students. He hopes that lots of his current students graduate this year and that he will have room for new students in 1993.

Professor Brooks and his staff and students have been building mobile robots and testing their theories of how to organize intelligence. They have made progress on a number of fronts: integrating complex systems into kilogram scale robots, developing simple visual reflexes for mobile robots, understanding how multiple robots can work together and producing extremely tiny robots.

During the past year the first prototypes of a new generation of six-legged robots were demonstrated, incorporating 23 actuators, 150 sensors, and 11 processors in a 2.5 kilogram package. The initial programs for this new generation of robots rely on a new computational model of hormone-like arbitration of behaviors. A number of computationally undemanding visual reflexes, such as a loom detector, a person head nodding-or-shaking detector, and a visual proximity sensor for robots were designed, formally analyzed and implemented, and demonstrated individually. A submillimeter, thin film piezo-electric motor built on a silicon substrate using photolithographic techniques was demonstrated spinning, and progress was made in developing finite element models in order to understand its behavior.

In addition, Maja Mataric demonstrated how robust, cooperative group behavior can emerge from the behavior of individual robots which have no explicit group behaviors programmed in. Up to 12 mobile robots have been operated simultaneously to demonstrate fundamental group behaviors such as dispersion, flocking, homing and following. When the robots operate, there is no central control, there is no explicit communication between the robots, and there is no explicit leader. Instead, each robot relies on its own sensors to detect the presence of another robot and know that it is a robot of the same type as itself.

Bill Dally

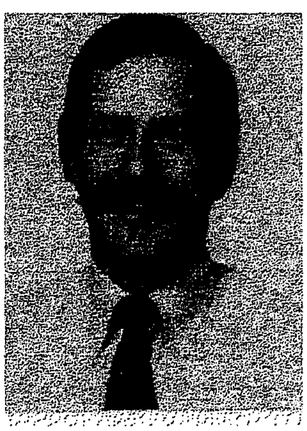


Office: NE43-620 Phone: x3-6043 email: billd@ai

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Yes
Should you attend them	If you want
Seeking new students	
Must have your own funding	
Current students to talk to	Steve Keckler, Ellen Spertus

The Concurrent VLSI Architecture Group under the direction of Professor Dally has been developing techniques for applying VLSI technology to solve information processing problems. The group has been developing the J-Machine, a fine-grain concurrent computer that offers supercomputer performance and tests a number of new concepts in interconnection networks, addressing mechanisms, processor architecture, and concurrent software systems. During the past year, the group completed the design of a single node of the J-Machine, known as the Message Driven Processor. The MDP chip was fabricated by our industrial partner, and first samples of the chip worked correctly, at greater than predicted performance. They have built an initial multi-node system, and expect to complete a 1024 node prototype J-Machine by year's end. They are continuing to develop system software, languages, applications, and high-speed peripherals for the machine. They have written a distributed operating system and compilers for the Concurrent Smalltalk and Concurrent Aggregates programming languages. As one of the machine's initial applications, they are developing a high performance, reliable transaction processing system.

Randy Davis



Office: NE43-801A Phone: x3-5879 email: davis@ai

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Yes
Should you attend them	That would be fine
Seeking new students	
Must have your own funding	
Current students to talk to	Jeremy Wetheimer

Professor Davis works on design, understanding how things work, and physical intuition.

Professor Davis, Dr. Shrobe, and their associates are building knowledge-based systems that use models of structure, function, and causality to perform a wide range of problem solving and reasoning tasks. The systems they have built can reason about how a device works and how it fails in a manner similar to an experienced engineer. This is an important advance in the art of knowledge-based systems construction, because it provides the system with a more fundamental understanding of the device than is possible using traditional approaches.

New work is focused on understanding how things work in a variety of domains, including simple mechanical devices like four-bar linkages, and mechanistic explanations of biological phenomena. Examples of understanding include the ability to produce descriptions of device behavior from a description of their structure, the ability to predict behavior under unusual circumstances, and the ability to redesign to fit those new circumstances.

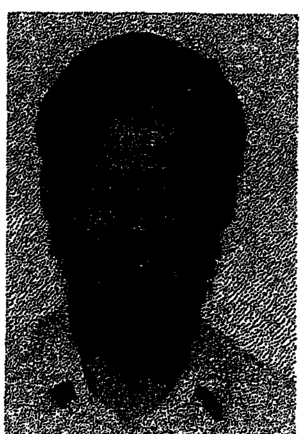
See also information under Howard Shrobe.

Jon Doyle

Office: NE43-419 Phone: x3-3512 email: doyle@medg

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Yes
Should you attend them	If interested
Seeking new students	
Must have your own funding	
Current students to talk to	Mike Frank

Professor Doyle works in the Medical Decision Making Group (MeDG). Professor Doyle's current projects focus on developing a new architecture for reasoning, planning, and learning organized to exploit ideas of rational deliberation and action taken from decision theory and political economy, and on developing mathematical theories of rationality for limited agents. These involve fundamental studies in knowledge representation, nonmonotonic reasoning, a new approach to reason maintenance, and computational economies. He's also interested in philosophical topics, and in applying mathematics to problems of qualitative physics.



Eric Grimson

Office: NE43-725 Phone: x3-5346 email: welg@ai

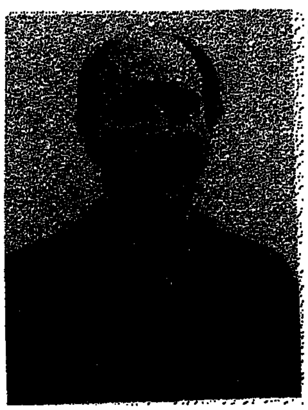
Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Yes
Should you attend them	Not necessary
Seeking new students	
Must have your own funding	
Current students to talk to	Sandy Wells, Karen Sarachik, Tao Alter

Professor Grimson works in the area of computer vision. Many of his students have recently graduated, so he is very interested in working with new students.

Work on object recognition, directed by Professor Grimson, has centered on the development of systems for recognizing objects in cluttered, noisy, unstructured environments. Such systems have been demonstrated in a variety of environments, using visual, laser, sonar, and tactile sensors. They have also been incorporated as part of a hand-eye system, as part of a navigation system for autonomous vehicles, and as part of an inspection and process control system for industrial parts. Recent efforts have focused on establishing a formal theory on which to judge the efficacy and robustness of recognition methods, on exploring alternative matching schemes for recognizing objects, on grouping methods for preprocessing the input data into salient sets of features, on the role of visual attention in recognition, and on the use of current recognition systems in practical applications.

Professor Grimson and his students also continue to work on the development and use of new stereo vision systems. Recent highlights include a novel, highly accurate stereo matching algorithm, with potential implications for the understanding of biological vision systems, and work on object recognition from stereo data.

Carl Hewitt



Office: NE43-813 Phone: x3-5873 email: hewitt@ai

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Project meetings
Should you attend them	No
Seeking new students	
Must have your own funding	
Current students to talk to	Carl Manning

Professor Hewitt is very interested in speaking to new students. His group is working on laboratory software projects in creating and using collaborative mobile telecomputing software systems. These projects are performed in small teams using mobile telecomputer equipment including: panel display and digitizer technology, infrared and radio wireless interconnect, operating systems support, electronic ink, character and gesture recognition and parameterization, interaction using shared displays. He is also interested in collaborative activities involved in presentation management, meetings, software engineering, and commitment processing. He is trying to evaluate the current state of the art in mobile telecomputing and its prospects (together with its supporting infrastructure) for becoming the world's largest industry in the next 15-20 years.

The Message-Passing Semantics group, under the guidance of Professor Hewitt, has been developing the foundations for Open Systems that perform robustly in changing environments. An Open System is one that is always subject to unanticipated communications from outside and whose operations are subject to indeterminate results. Robustness means the ability to keep commitments in the face of conflict and indeterminacy, which are ubiquitous in Open Systems. Robust computer systems are needed to meet the challenge of Open Systems to gain from the advantages of openness while meeting the requirements that are imposed by openness. Open Systems undergo continual change: some change coming from within, through communication among internal parties, some from without through interaction with the environment. The primitives of ultraconcurrent systems are called ACTORs. These can be organized into systems of ORGs (Organizations of Restricted Generality). The Actor model provides a scientific and technological basis for Open Systems because it supports dynamic reconfigurability, compositionality, and extensibility. The ORG model provides a scientific and technological basis for organizational systems because it supports teamwork, management, liaison, and organizational representation. The group's research focuses on theoretical, architectural, and linguistic aspects of organizational systems composed of humans and telecomputer systems. This year research was focused on the beginnings of mobile telecomputer systems as an important domain of application.

Berthold K. P. Horn

Office: NE43-715A Phone: x3-5863 email: bkph@ai

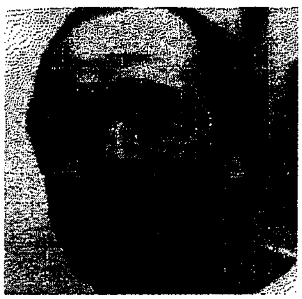
Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	VLSI Vision Wednesdays
Should you attend them	If interested
Seeking new students	
Must have your own funding	
Current students to talk to	Clay Thompson, Ron Chaney

A bunch of Professor Horn's students have recently graduated or are about to, so he's "in the market for some new faces." He prefers to talk to students after they have taken the vision course or read his book, *Robot Vision*, but these are not absolutely necessary before you speak to him. He says incoming students tend to be enamoured of AI and don't think much of vision, and it's too hard to convince them otherwise. However, he says, he does talk to them.

Professor Horn and his students work on problems in motion vision. Currently, the extension of existing methods in the time direction is being explored. While one can get good motion information from just two image frames, distances to objects are determined only rather coarsely. Methods from computer graphics are used to predict the shape and position of an object at the next image frame time, based on the estimated shape and position and the estimated motion at the present time. Dramatic improvements in the accuracy of the reconstructed object shape are attained in this fashion, although after about ten frames the errors introduced by the prediction phase begin to balance out the improvements obtained from continuing the solution in time.

This group is also looking into the object recognition through the computation of stable "invariants." While the idea of invariants is an old one in the field, it has in the past been applied to two-dimensional patterns, not three-dimensional objects. There has been some work recently elsewhere on invariants for recognition, but none that actually took into account the constraint provided by perspective projection. Ignoring this constraint leads to unstable methods of little interest in the real world of noisy data. New "invariants" are now being developed that exploit an accurate knowledge of the imaging model. Those require fewer features and lead to stable recognition schemes.

Boris Katz



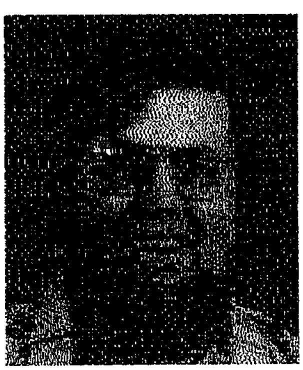
Office: NE43-824 Phone: x3-6032 email: boris@ai

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	No
Should you attend them	Not applicable
Seeking new students	
Must have your own funding	
Current students to talk to	

Boris Katz does research in Natural language processing and information retrieval. Currently he is developing an integrated natural language processing system START. The system analyzes English text and automatically transforms it into an appropriate representation for storing into the knowledge base. The user gains access to information in the knowledge base by querying it in English. The system analyzes the query and decides through a matching process what information in the knowledge base is relevant to the question. Then it retrieves this information and formulates its response also in English.

During the recent Voyager Neptune encounter, the START system was successfully employed by members of the press at the Jet Propulsion Laboratory to obtain answers to their questions about the encounter, the Voyager spacecraft, and the Solar system.

Tom Knight

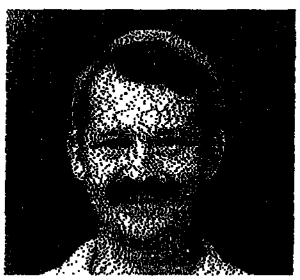


Office: NE43-735 Phone: x3-7807 email: tk@ai

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Yes, Transit group
Should you attend them	Either way
Seeking new students	
Must have your own funding	
Current students to talk to	Mike Bolotski, André DeHon

Dr. Knight is interested in computer hardware to support AI programs, constructing intelligent machines, supercomputers for AI, computing for early vision and hearing, computational uses of biology and biological uses of computation. He also recommends that you spend some time eating lunch on the seventh floor (where all the cool graduate students hang out).

The Symbolic Parallel Architecture group, under the direction of Dr. Knight, has been developing a uniform, large scale, parallel symbolic supercomputer called *Transit*. Unlike most parallel machines, this architecture has been explicitly designed to support a wide range of parallel programming models with excellent performance. The key realization is the critical importance of low latency in the processor-to-processor communications path. This low latency communications is used as a substrate for coherent caches and processor-to-processor message passing. The implementation of *Transit* is being done in three phases: construction of the routing network, coherent cache implementation, and finally processor design. The routing network is currently under detailed design and simulation. Its construction involves novel three-dimensional packaging and cooling technology, novel VLSI techniques for chip-to-chip communications, and a very simple, high speed routing component. The initial prototype is expected to yield a remote memory access latency of about 300ns and a per-port peak bandwidth of 800 megabaud. The aggregate switch bandwidth approaches a terabaud.



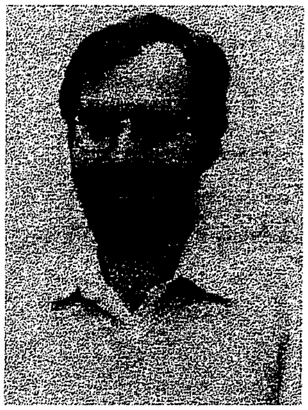
Bill Long

Office: NE43-420A Phone: x3-3508 email: wjl@lcs.mit.edu

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Yes, MEDG on 4th floor
Should you attend them	It's a good introduction
Seeking new students	
Must have your own funding	
Current students to talk to	Yeona Jang, Tze-Yun Leong

Dr. Long is a research scientist in the Medical Decision Making Group. He works on automated reasoning in cardiovascular domains. Current manifestations include diagnosis of heart failure using constraints, probabilities, and case based reasoning; predicting the effects of therapies; reasoning about heart failure management; explaining complex diagnoses; estimating probability of acute ischemia from a case base using logistic regression, decision tree induction, or neural nets; reasoning about intensive care management of patients in respiratory distress.

Tomás Lozano-Pérez



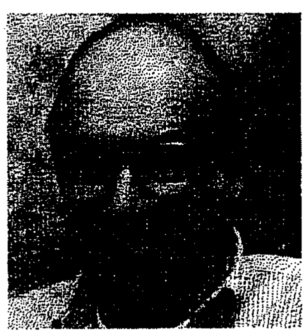
Office: NE43-836A Phone: x3-7889 email: tlp@ai

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Yes
Should you attend them	Not necessary
Seeking new students	
Must have your own funding	
Current students to talk to	Sundar Narasimhan, Nancy Pollard, Jose Robles

Professor Lozano-Pérez has recently switched his focus from robotics to computational biology, including the interpretation of folded protein structures. The paragraphs below discuss his previous robotics research. He would be particularly interested in new students who would like to learn more about computational biology. Funding is only extremely tight in the short term, with better prospects in the future.

Professor Lozano-Pérez and his associates have completed development and testing of the Handey task-level robot system. The completed system is described in a recent monograph from MIT Press. The Handey system plans all the motions required for pick-and-place tasks involving planar-faced parts. Handey first locates one of the parts on the robot's work table, then plans where to grasp the part so as to avoid all nearby obstacles. Next, Handey plans a collision-free path for the complete robot to reach the part, selects a sequence of regrasping motions (if necessary) to achieve a grasp compatible with the final destination, and finally, plans a path to place the part at the specified destination. Handey can deal with jointed parts, coordinate the motions of multiple robots, and grasp complex polyhedral objects using Dr. Salisbury's three-fingered hand. Handey can plan collision-free motions using a bitmap representation of configuration space computed using the Connection Machine. This parallel implementation is made possible by a simple, yet powerful algorithm for computing configuration-space obstacles. Work is underway on a new parallel approach to grasp selection.

Tom Marill

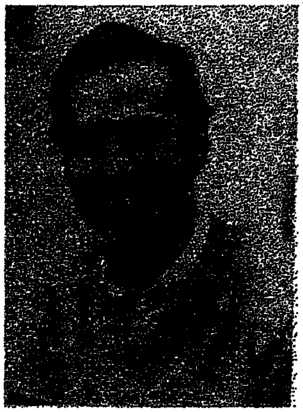


Office: NE43-824 Phone: x3-2662 email: marill@ai

Dr. Marill is not a professor and has no grant money with which to support students. Still, he'd be happy to meet with new students to tell them about what he's doing. If they get interested in it, he suggests perhaps he can help them out.

Dr. Marill is a Research Associate at the AI Lab. He works on novel approaches to solving problems in machine vision and image understanding, including inferring likely three dimensional structure from two dimensional line-drawings.

David McAllester



Office: NE43-412 Phone: x3-6599 email: dam@ai

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	No
Should you attend them	Not applicable
Seeking new students	
Must have your own funding	
Current students to talk to	Kevin Zalondek

Professor McAllester is currently looking for a new student to work on a programming environment for embedded control systems such as those used in insect-like mobile robots and avionics software. Students interested in this project should have considerable programming experience.

Professor McAllester's main line of research involves general purpose automated reasoning. He is continuing to develop a reasoning system called Ontic. The Ontic project needs people with strong mathematical aptitude who can work hard with only moderate guidance.

Professor McAllester has been building and testing automated reasoning systems. These reasoning systems incorporate a variety of new algorithmic techniques that allow effective automated reasoning about topics that are beyond the scope of any previous reasoning system. For example, the new reasoning systems have been able to verify proofs, starting with only the axioms of Zermelo-Fraenkel set theory, of the Stone representation theorem in lattice theory. This theorem involves an ultrafilter construction and is similar in complexity to the Tychonoff theorem that a product of compact topological spaces is compact. The novel algorithmic techniques include the integration of congruence closure into general theorem proving, monotone closure for reasoning about semantic types, focused forward chaining, and the incorporation of universal generalization into constraint propagation. In addition to evaluating automated reasoning systems in terms of their ability to verify abstract mathematical theorems, Professor McAllester is studying the application of automated reasoning systems in software verification. In particular, Professor McAllester has begun to concentrate on the special case of verifying computer programs to be "uncrashable."

Marvin Minsky

Office: E15-483 Phone: x3-5864 email: minsky@ai

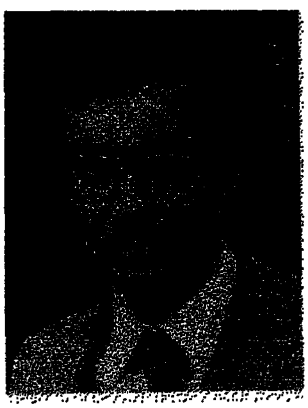
Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	No
Should you attend them	Not applicable
Seeking new students	
Must have your own funding	
Current students to talk to	None; each project is different

Professor Minsky likes to meet with new students as early as possible. If they have made up their minds, he believes it is very likely too late to keep them from falling into disaster. He likes potential students to have read his book, *The Society of Mind.* His special concern is to try to make sure that no student works on a problem because it is currently popular. This is a terrible mistake for both teachers and students. If there are a lot of people working on it already, avoid it like the plague—because it is probably some kind of contagious disease.

He describes his work as research on design of multiple representations of commonsense knowledge, and knowledge-based problem solving.

Professor Minsky has continued to develop the theory of human thinking and learning called the "Society of Mind." This theory explores how phenomena of mind emerge from the interaction of many disparate agencies, each mindless by itself. For example, one aspect of the theory explains the combination of knowledge representations in different realms of thought as the basis for analogy; another aspect is a "re-duplication" account of natural language, in which grammatical forms are seen as emerging directly from expressive requirements rather than from conventions that communications are forced to fit.

Professor Minsky has continued his interest in the limits and potentials of "connectionist learning systems" and their role in distributed cognitive accounts like the Society of Mind. He is actively considering how such systems may be combined and interconnected in a way that avoids the serious scaling problems of unstructured connectionist systems.



Tomaso Poggio

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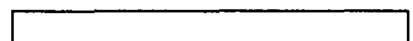
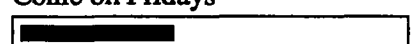
Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Learning meetings
Should you attend them	Come on Fridays
Seeking new students	
Must have your own funding	
Current students to talk to	Jim Hutchinson, Federico Girosi (postdoc), John Harris (postdoc)

Professor Poggio works on learning from examples in the domains of mathematics, parallel algorithms, and applications such as control, object recognition, graphics, financial time series, and brain theories. He says he already has a lot of students, but he is willing to take 1-2 new ones if they are very good and very interested.

Professor Poggio regards learning as a problem of approximating a multivariate function from sparse examples. Professor Poggio's group has developed a technique, based on *regularization theory,* that has roots in the classical theory of function approximation and that has illuminating relations with other fields. The computations center on what Poggio calls HyperBf functions, a generalization of radial basis functions. These functions dictate computations that are equivalent to those performed by of a certain class of multilayer networks.

Several applications have been demonstrated. The main ones are in 3D object recognition, in synthesizing vision algorithms for specific tasks, such as hyperacuity tasks, and in a new approach to computer graphics. In object recognition the problem is that a 3D object gives rise to an infinite variety of 2D images, because of the infinite number of possible poses relative to the viewer, and because of the potential for arbitrary illumination conditions. Poggio and his colleagues have shown that the HyperBf scheme provides a simple solution to the problem. The results have implications for computer vision and possibly for the understanding the process of object recognition in natural vision. During the past year, they have obtained interesting results about recognition from very few views by exploiting *a priori* information such as symmetry of the class of objects. In particular, for any bilaterally symmetric 3D object, one non-accidental 2D model view is sufficient for recognition.

Marc Raibert

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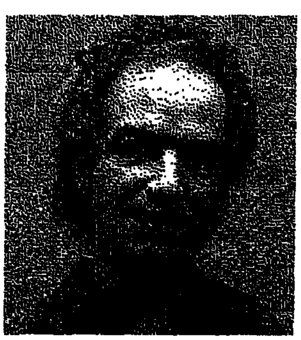
Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Yes
Should you attend them	See students first
Seeking new students	
Must have your own funding	
Current students to talk to	Rob Playter, Robert Ringrose, Yuri Bendana

Professor Raibert works on dynamic legged robots, robot gymnastics, and computer animation. He is considering taking one new student in computer graphics/animation. The best way to learn about his work is to visit the leg lab, room 006 in the basement, and talk with his current students. They can show video tapes of the robots and animation, provide papers, etc.

Professor Raibert and members of the Leg Laboratory have studied legged locomotion in a variety of legged systems, including laboratory robots and computer simulations of animal-like systems. During the past year, they have controlled the behavior of a three-dimensional biped robot with telescoping legs, computer and physical models of a kangaroo, and a computer simulation of an ostrich.



Kenneth Salisbury

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Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Working meetings
Should you attend them	No
Seeking new students	
Must have your own funding	
Current students to talk to	Dave Brock, Brian Eberman

Dr. Salisbury says he'll be better able to fund new students starting in January, but he feels that good matches in skills, background and style are far more important than being fully funded when you approach him. He works on robotics, on the design of hands, arms, master devices, actuators, sensors control systems, catching (w/ professor Slotine in ME), virtual environments (w/ VETREC team in RLE), and robot gas stations if the funding comes through. His group tends to be mostly MEs who like to build and control robots that grasp and manipulate with hands and arms. Much of our work has focused on ways to control and interpret contact forces, though newer efforts address active vision for grasping and catching. He prefers to meet primarily with students who have a clear interest in robotics (design, control utilization, sensor interpretation, etc.)

The Salisbury articulated hand mounted on a PUMA arm serves as a test bed for a wide range of grasping and path planning experiments. Dr. Salisbury's group is currently using this hand/arm system to develop sensor reactive grasping strategies aimed at locally robust object acquisition in both terrestrial and zero-gravity environments. A variety of sensors including a palm sensor, 6-axes fingertip force sensors and piezoelectric intermediate link sensors are used to provide incrementally increasing knowledge of target objects.

A high performance cable driven arm (WAM), developed by Dr. Salisbury's group, has been the focus of a number of novel manipulation and control investigations. The arm takes advantage of its inherent force controllability in performing a new class of operations known as *whole-arm manipulation.* Because the arm is designed to perform useful operations with all its surfaces, not just its end-point, it is able to push, grasp, and operate upon objects in ways impossible for traditional robots. Professor Slotine's group, from MIT's Non-Linear Systems Laboratory, has developed and implemented a series of adaptive non-linear control systems for the WAM arm which permit significantly improved performance in free and constrained motions. In addition, they have developed an approach for robust and predictably stable force reflecting teleoperation in the presence of time-vision. The arm has successfully caught objects in cooperation with a stereo vision system. A new integrated hand/wrist system is being developed for the arm which will be used in robotic and telerobotic applications ranging from real-time catching of rotating objects to unstructured grasping.

Warren P. Seering

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Professor Seering will not be taking on any new students this fall, as his group is now full. If you would like to talk with one of his students, he suggests that either Andy Christian or Lukas Ruecker would do a fine job of describing their group's activities.

During the past year, Professor Seering's group has made advances in understanding the dynamic response characteristics of robot arms. The focus of the group's work has been on system identification and on exploring control strategies for improving robot performance under force control. Efforts are also ongoing on minimizing undesirable vibrations in dynamic systems. In collaboration with NASA the group has been working to improve the response of the space shuttle robot arm.

Professor Seering's students have also been looking for ways to use computers to help mechanical designers. As part of this activity, they have been working to capture design documentation so that it can be retrieved efficiently and at the desired level of detail by a designer. Some of this work builds on work on decision rationale representation initiated in Professor Winston's group.

Howard E. Shrobe

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Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	No
Should you attend them	Not applicable
Seeking new students	
Must have your own funding	
Current students to talk to	Leon Wong, Tom Stahovic

Dr. Shrobe works on understanding engineering design, particularly, but not limited to, mechanical systems. His group's ultimate goal is build a system capable of supporting design, analysis, reverse engineering and troubleshooting, expert and common sense reasoning about engineered devices. In the past he has worked on troubleshooting digital systems, the design of VLSI chips, and understanding programs. His research is conducted jointly with Randy Davis.

Professor Davis, Dr. Shrobe, and their associates are building knowledge-based systems that use models of structure, function, qand causality to perform a wide range of problem solving and reasoning tasks. The systems they have built can reason about how a device works and how it fails in a manner similar to an experienced engineer. This is an important advance in the art of knowledge-based systems construction, because it provides the system with a more fundamental understanding of the device than is possible using traditional approaches.

This work is based in part on the belief that the next major innovation in computer-aided design will be the construction of tools that understand (and can be told) how devices work and that can use this knowledge to support intelligent design modification. In order to be successful, such systems must already know a great deal of the basics of its design domain. A mechanical engineer takes it as given that a human colleague will understand terms such as "Scotch Yoke," "Four Bar linkage," and "Trip Mechanism," and would never employ a human assistant who did not know the meaning of these and hundreds of other basic terms, their common usages, and constraints on their application. Yet engineers endure such ignorance in their design aids daily.

Making automated design tools powerful and easy to use will require constructing a very large knowledge base of engineering "know how." Such a system will contain roughly an order of magnitude more knowledge than existing commercial knowledge based systems and will lead to a new level of flexibility and power.

See also information under Randy Davis.

Lynn A. Stein

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Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Yes, AP group
Should you attend them	If you plan to join the group
Seeking new students	
Must have your own funding	
Current students to talk to	Mark Torrance, Holly Yanco

Professor Stein is extremely willing to meet with new students either before or after they have developed a clear idea of what they may want to work on. If you plan to ask Professor Stein to be your advisor, she recommends that you try to learn something about her research by reading her papers and talking to her current students, or that you come in with an idea of some project you'd like to work on.

Professor Stein's group works on integrated architectures for intelligence. The goal is to understand how an agent can exhibit a capacity for abstract reasoning, even though the agent is limited by the sensory and computational realities that govern the operation of robots in physical, rather than simulated worlds.

In one project, a society of robots performs a task for which communication and coordination is a prerequisite. In order to communicate, the society as a whole must agree on a conceptualization of the world and a mapping from communication signals onto this conceptualization. Thus, symbolic intent emerges from interaction with the world and with the agent's society. Another project addresses the issue of abstracting away from interactive tasks by allowing the agent to learn by imagining. Reusing its existing hardware and software, a navigating agent learns to interpret directions by imagining that it is acting in the world. A second mode of cognitive ability is thus built on top of the first.

In addition to the work on integrated agents, Professor Stein is involved in building a "competence theory" for commonsense reasoning.

Gerald Sussman

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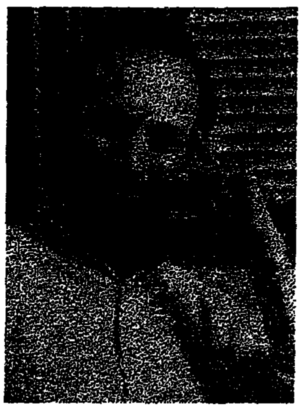
Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Perhaps starting this fall
Should you attend them	Yes, if they start
Seeking new students	
Must have your own funding	
Current students to talk to	Andy Berlin, Feng Zhao, Liz Bradley

Professor Sussman finds this survey a bit formal. He usually advises students to go around and talk to everyone to see what they are up to. After all, he says, he wouldn't want to work for an unfriendly person (if he were a student). He expects students to get to know him and his work before they make commitments to each other. He figures out how to support each student on an individual basis.

Professor Gerald J. Sussman and Professor Harold Abelson lead work aimed, in part, at creating sophisticated problem-solving partners for scientists and engineers studying complex dynamic systems.

The research of the MIT Project for Mathematics and Computation (Project MaC), under the direction of Professors Abelson and Sussman, is working to demonstrate breakthrough applications that exploit new computer representations and reasoning mechanisms that they have developed. These mechanisms enable intelligent systems to autonomously design, monitor, and understand complex physical systems, through appropriate mixtures of numerical computing, symbolic computing, and knowledge-based methods. They call this mixed approach *intelligent simulation.*



Pete Szolovits

Office: NE43-416 Phone: x3-3476 email: psz@medg

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	Yes
Should you attend them	All are welcome
Seeking new students	
Must have your own funding	
Current students to talk to	Scott Hofmeister, Ira Haimowitz, Yeona Jang

Professor Szolovits is the director of the Clinical Decision Making Group. The overall goal of the Clinical Decision Making Group is to create sophisticated and useful computer programs to assist doctors and nurses to provide better health care. This goal requires the development and application of new methods of artificial intelligence for use in medical systems for diagnosis and therapeutic management. Since the mid-1970's, we have developed various conceptual models and computer programs that embody them for diagnosis of kidney diseases, diagnosis and therapy of heart disorders, design of cancer therapy protocols, etc. We have also developed numerous technical approaches to allowing programs to explain their knowledge, strategies and conclusions, and to teach based on that same knowledge.

Medicine provides formidable challenges to computer science and AI technology. The complex cases that most require assistance and monitoring from computers demand the ability to describe the normal functioning of the human body, the causes and mechanisms of disease, the body's response to external and internal derangements, the abilities of tests to probe aspects of the internal reality, and the expectable reactions of the body to complex interventions. Simply to encode the required knowledge in a computer requires the ability to represent knowledge whose character is at once temporal, spatial, probabilistic, and taxonomic. We must also be able to represent typical and routine plans and actions, and preferences of both the patient and the treating physician for different interventions and outcomes. The wealth of knowledge that is potentially relevant to making a medical decision makes it imperative that reasoning strategies help focus and narrow a reasoner's attention to just those issues and that knowledge that is in fact likely to be useful in a particular setting.

Shimon Ullman

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Professor Ullman will be away from the lab this coming academic year, so he's afraid he cannot help much with the orientation for new graduate students.

Professor Ullman does research in computer vision.

Work directed by Professor Ullman is exploring the problem of three-dimensional object recognition. This research has been divided into two main topics. The first topic is that of image partitioning and selection. The goal of this processing stage is to select from the image a portion that is likely to contain an object of interest. The selection processes gives the recognition system a capacity that is similar to the use of selective attention in human vision: it allows the system to concentrate its computational resources on the selected structure and apply to it additional processing stages that will lead eventually to recognition. Professor Ullman has developed a method for grouping together image edges and contours that are likely to correspond to a single object. This method appears to capture some basic properties of the grouping processes used by the human visual system.

The second topic is the representation of three-dimensional objects in memory, and the matching of these memory models with two-dimensional objects in the image. Towards this end, Professor Ullman has developed an approach by which objects are recognized without storing three-dimensional object model. Instead, objects are recognized by using combinations of two-dimensional views. The method is based on a theory that shows that any view of a three-dimensional object can be approximated by the linear combination of a small number of its views.

Karl Ulrich

Office: NE43-835A Phone: x3-5217 email: ulrich@ai

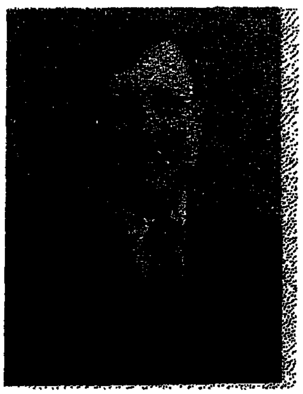
Professor Ulrich says his group is fully staffed, so he will not be speaking with any new students this fall.

Professor Ulrich and his students research computational tools for product design and manufacturing. The philosophy underlying their research is that close involvement with industrial practitioners is essential to effective problem definition. Accordingly, the group has research partnerships with The Boeing Company, United Technologies Corporation, and The Stanley Works.

One project aims at creating simple, powerful, and intuitive tools for solving parametric design problems. The project is motivated by the observation that approximately 75% of all mechanical engineers use commercially available business spreadsheets to do their parametric engineering problem solving, yet these tools only support a limited unidirectional problem solving metaphor. This work has led to the development of an "engineers' spreadsheet," which is being used to design a novel power tool in collaboration with Stanley.

Professor Ulrich and his students are also exploring ways to integrate statistical data from production processes into engineering design decision making. This general problem is being addressed for the specific case of wing fastener design on the Boeing 777 airplane.

Patrick Winston



Office: NE43-816 Phone: x3-6754 email: phw@ai

Willingness to talk to students before they are sure of their area	
Amount of preparation required	
Has group meetings	No
Should you attend them	Not applicable
Seeking new students	
Must have your own funding	
Current students to talk to	Sajit Rao, Gary Borchardt

Patrick Winston is the Director of the Artificial Intelligence Lab.

Professor Winston's group has concentrated recently on developing representations that enable learning and reasoning by analogy. During the past year, considerable progress was made on the particular problem of representing change qualitatively, such that a remembered sequence of changes can be used as a precedent for understanding how some subsequent situation is evolving.

A key insight is that there is much to be gained by viewing the world from a transition-centered perspective, rather than a state-centered perspective. In principle, a world's state embodies enough knowledge of the world to determine its future evolution, but this state-centered perspective has led to all sorts of practical obstacles (including the "frame" problem and the "context" problem). In contrast, from the transition-centered perspective, transitions *cause* transitions. Accordingly, the *transition-space* representation focuses on what is changing rather than on the static properties of things. Using transition space, the recently implemented Pathfinder program combines background knowledge with descriptions drawn from the Encyclopedia Americana to answer questions about, for example, how rockets work.