



Significant BITS

Newsletter of the
DEPARTMENT OF COMPUTER SCIENCE

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Computer Science
Homecoming 2006
Friday, October 20

A stimulating idea

RESEARCH SOMETIMES TAKES UNEXPECTED TURNS. Professor Andrew Barto has studied learning in machines and animals since the late 1970s. A founder of the Department's Autonomous Learning Laboratory, Barto is known for pioneering work that made one type of learning—reinforcement learning—a major component of modern machine learning research. Although he has always been interested in the psychology and neuroscience of animal learning, Barto makes no claims to being either a psychologist or a neuroscientist. With some exceptions, Barto and his students have justified their algorithms on the basis of how well they solved problems or on their mathematical properties. For the most part, the work has fallen squarely under the heading of artificial intelligence and engineering, not psychology or neuroscience. The surprise is that an algorithm



A simulated "playroom" designed to experiment with intrinsically motivated learning methods.

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Three faculty receive CAREER awards

Assistant Professors Oliver Brock, Deepak Ganesan, and Erik Learned-Miller have each received five-year National Science Foundation (NSF) Faculty Early Career Development (CAREER) program awards, the NSF's most prestigious award for new faculty members. Robot navigation, data gathered from smart sensors, and self-taught computer vision systems are the focus of their CAREER grants.

"Getting three CAREER awards in one year is outstanding, and indicates the quality of our junior faculty," said Distinguished Professor and Depart-

ment Chair Bruce Croft.

Brock received the NSF CAREER award for his proposal "Motion Capabilities for Autonomous Mobile Manipulation." His project explores the challenges involved in making robots independently mobile in various environments. Efforts in both industry and academia have led to quite advanced humanoid robots and mobile manipulators, said Brock, but there are still many factors that constrain these machines from fully operating in the everyday world. Brock will investigate generating robotic motion under these various constraints and will de-

velop sensing techniques that provide feedback to robots about their surroundings.

At the low end of the frequency spectrum, he proposes an application of techniques from active learning and utility theory to global motion planning. These techniques permit the exploitation of structure inherent in any real-world motion planning problem to increase the efficiency of motion planning, said Brock. The resulting planning methods will satisfy the feedback requirements of autonomous mobile manipulation.

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RESEARCH

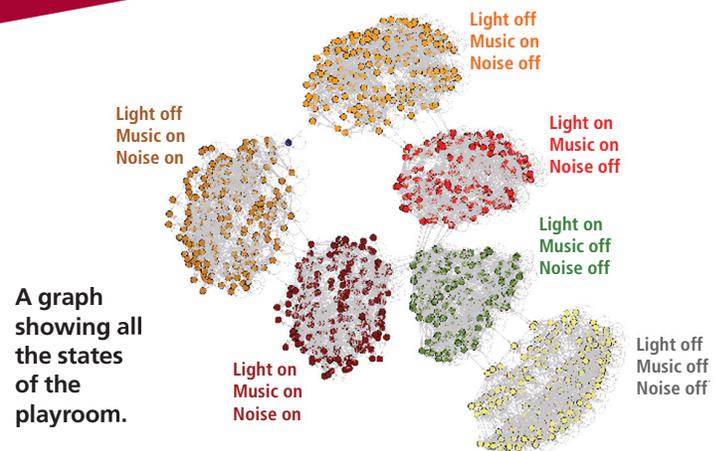
A stimulating idea (from page 1)

developed by Barto's research group, the Temporal Difference (TD) algorithm, is currently a leading model of the activity of dopamine neurons in the brain and is the basis of research being done by neuroscientists around the world.

The brain's dopamine system has long been associated with reward learning and reward-related behavior. A 1992 *Journal of Neurophysiology* paper from the laboratory of Wolfram Schultz, at the University of Fribourg in Switzerland, presented data showing the electrical activity of dopamine neurons observed in animals performing several learning tasks. The dopamine neurons showed bursts of activity in response to an unexpected reward (e.g., a morsel of food). As learning progressed, the activity of these neurons moved earlier in time to when the animal received a stimulus that regularly predicted the upcoming reward. Moreover, if an even earlier reward-predicting stimulus was introduced, the neurons shifted their activity from the later to the earlier stimulus. When the reward did not arrive as expected, the neurons decreased their activity. It looked very much like dopamine neurons were part of a system that learns to anticipate upcoming rewards.

Encouraged by neuroscience colleagues familiar with his group's research, Barto gave a talk at a 1994 Woods Hole workshop devoted to models of information processing in the basal ganglia, a group of brain structures that include a major collection of dopamine neurons as well as structures that receive input from them. His talk was a brief tutorial on the TD algorithm and an explanation of how the algorithm's behavior was remarkably parallel to the behavior of the dopamine neurons observed in Schultz's laboratory. This and another talk by neuroscience colleagues also suggested how a reinforcement learning system using the TD algorithm might be implemented by the neural circuitry. These talks resulted in the earliest publications, in a 1995 book based on the workshop, discussing the correspondence between dopamine neuron activity and the TD algorithm. Since then, many other researchers, both neuroscience experimentalists and theorists, have developed the connection in many interesting new directions. Although discrepancies between dopamine neuron activity and the TD algorithm's behavior have emerged, the view that the brain's dopamine system operates in accordance with the principles of reward prediction as laid out in the computational theory of reinforcement learning from Barto's group has become the "standard"—though not entirely uncontroversial—view of dopamine neuron activity.

What is surprising in all of this is that while the work in Barto's group was always inspired by animal learning and neural mechanisms, and some of their work did explicitly model animal behavior, for the most part their work remained *computational*. What mattered was the ability of an algorithm to efficiently solve useful and difficult learning tasks, not its ability to reproduce animal behavior or neural data. In fact, the TD algorithm appeared nearly ten years before the results from Schultz's laboratory, forming a key part of the 1984 dissertation of Barto's first Ph.D. student, Richard Sutton, who is now leading a group of reinforcement learning researchers at the University of Alberta. "So the TD algorithm did not result from an effort to model the activity of dopamine neurons. It was instead the result of trying to solve a computational problem. The correspondence exists because nature has had to solve this



A graph showing all the states of the playroom.

problem as well," suggests Barto.

Reinforcement learning is based on the common-sense idea that if an action is followed by a satisfactory state of affairs, or an improvement in the state of affairs, then the tendency to produce that action is strengthened, that is, reinforced. In some cases, the consequences of actions cannot be evaluated until a sequence of actions has been completed, for example, a reward may not arrive until the completion of a multi-step task. This makes learning the best decisions much harder because it is difficult to tell how the decisions in the sequence contributed to the outcome. "The challenge with reinforcement learning, which has a very long history in both psychology and artificial intelligence, has always been the difficulty of making it efficient enough to be useful in practice, especially in the case of delayed reward," noted Barto. "The TD algorithm, which is a descendant of a method used by Arthur Samuel in his famous checkers playing program of the 1950s, addresses this problem by forming predictions of future reward so that learning can proceed on the basis of predicted reward instead of waiting for the actual rewards."

Reinforcement learning systems using TD methods have been responsible for some impressive applications, and they have also brought important aspects of the learning and search methods of artificial intelligence together with methods widely used in control engineering and decision theory. In particular, efforts by many researchers have shown that the TD algorithm, and algorithms like it, are closely related to methods for solving stochastic optimal control problems. Consequently, there are now well-established connections leading from stochastic optimal control and decision theory, through computational reinforcement learning, to the brain's dopamine system. These connections provide a basis for a lot of interdisciplinary cross-fertilization that promises to yield significant advances in coming years. For example, since the dopamine system plays a key role in the action of most addictive drugs, researchers are beginning to explore new models of drug addiction based on these computational theories.

But the dopamine system is much more complicated than any of these models. Barto's most recent interest is related to the fact that predictors of events of obvious biological value, like the ingestion of food, are not the only stimuli that excite dopamine neurons. "They also respond to stimuli not directly related to basic biological needs at all, for example, to an unexpected

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Robin Popplestone memorial endowment established

PROFESSOR EMERITUS ROBIN JOHN POPPLESTONE's wife Kristin Morrison established an endowment in Professor Popplestone's name. These generous endowment funds will support a graduate student "Popplestone Fellow" for each academic year. The first award will be presented this fall.

"We greatly appreciate Kristin's generosity in establishing this fund," said Distinguished Professor and Department Chair Bruce Croft. "What a wonderful way to honor Robin's contributions to the Department. He is truly missed by all who knew him."

In 1985, Popplestone, one of the early pioneers in robotics and computer programming languages, joined the faculty of UMass Amherst as a Professor of Computer Science and Director of the Laboratory for

Perceptual Robotics. In 1990, Popplestone was selected as a Founding Fellow of the American Association for Artificial Intelligence (AAAI) in recognition of his seminal contributions to AI. Due to illness, he retired in 2001 as an Emeritus Professor, and returned to Glasgow, Scotland to be near his family and the sea. Popplestone died on April 14, 2004 after a 10 year battle with cancer. He was 65. For more on his career, go to www.cs.umass.edu/csinfo/announce/robin-popplestone.html.



Kristin Morrison and Robin Popplestone

Anyone wishing to contribute can send donations to: Dept. of Computer Science, UMass Amherst, 140 Governors Drive, Amherst MA 01003-9264. Make checks payable to UMass Amherst Computer Science and note Popplestone Endowment or go to www.cs.umass.edu/csinfo/donate.html.

Andrew Barto elected as an IEEE Fellow

PROFESSOR ANDREW BARTO is among a select group of recipients for one of the Institute of Electrical and Electronics Engineers' (IEEE) most prestigious honors, election to IEEE Fellow. This honor is in recognition of Barto's contributions to reinforcement learning methods and their neural network implementations.



Each year, following a rigorous evaluation procedure, the IEEE Fellow Committee chooses from those with an extraordinary record of accomplishments in the IEEE fields of interest for its highest grade of membership. The total number of IEEE Fellows selected in any one year does not exceed one-tenth percent of the total voting Institute membership.

Barto's research interests center on learning in both machines and animals. He has been developing learning algorithms that are useful for engineering applications while overlapping with the field as studied by experimental psychologists and neuroscientists. He has also had a long interest in artificial and real neural networks. Most recently he has been working on three projects. The first focuses on extending reinforcement learning methods so that agents can autonomously construct hierarchies of reusable skills. The second, being conducted in collaboration with neuroscientists and developmental psychologists, involves modeling how animals learn motor skills. The third applies machine learning methods to intelligent tutoring systems.

Barto is currently co-director of the Autonomous Learning Laboratory. He received the 2004 IEEE Neural Networks Society Neural Networks Pioneer Award for fundamental work on reinforcement learning. He is a Fellow of the American Association for the Advancement of Science (AAAS) and a member of the American Association for Artificial Intelligence and the Society for Neuroscience.

A stimulating idea (from page 2)

salient stimulus like a sudden change in lighting or a sound," said Barto. "This would make sense from a computational perspective if—in addition to their alerting effects—stimuli like these acted as temporary rewards to drive exploratory activity aimed at discovering what was going on; in other words, if they were the basis of curiosity." In one computational study of this idea, Barto teamed up with former Ph.D. student Satinder Singh, now a professor at the University of Michigan, to see if it was possible for an artificial agent to learn a hierarchy of skills using what they called *intrinsically motivated reinforcement learning*, where unexpected salient events generate rewards. Shown in the figure on page 1 is a simple simulated "playroom" containing a light switch, a ball, a bell, movable blocks that are also buttons for turning music on and off, and a toy monkey that can make

sounds. The agent has an eye, a hand, and a visual marker (seen as a cross hair in the picture). Even though the agent receives a "real" reward only when the monkey makes a sound, it generates for itself intrinsic reward when it makes noticeable events occur unexpectedly, such as unexpectedly turning on the lights. Ph.D. student Özgür Şimşek created a revealing representation of the playroom state space (figure on page 2). The dots, each representing a different state of the playroom, show clusters with the property that transitions between clusters are much rarer than transitions within clusters. It is these between-cluster transitions that generate intrinsic reward, while the overall goal is to reach a single specific state (shown as the blue dot in the left-most cluster). "Our goal," says Barto, "is to eventually show that intrinsically motivated reinforcement learning is a route to a truly open-ended form of machine learning. Maybe we'll learn something about the brain, too."

FACULTY

CAREER awards (from page 1)

“To obtain adequate feedback about the state of the environment, we will be developing novel sensing and modeling techniques to provide perceptual information,” said Brock. To address motion constraints that require high-frequency feedback, he plans to combine multi-objective control methods with planning approaches for constraint satisfaction. These planning methods overcome the susceptibility of control-based motion generation to local minima. Ultimately humanoid robots should be able to safely and reliably perform human-level tasks by themselves in unstructured environments.

Brock joined the Computer Science faculty in 2002 and co-directs both the Laboratory for Perceptual Robotics and the Bioinformatics Research Laboratory. He received his Ph.D. in Computer Science from Stanford University. His current research focuses on robotics, autonomous mobile manipulation, motion planning, and structural biology.

Ganesan’s proposal “Addressing Data and Energy Management Challenges in Hierarchical Sensor Networks,” garnered his CAREER award. In earthquake prone areas, sensors embedded in buildings to monitor vibration levels could predict if the building was becoming unsafe and inform people inside, but only if that information is stored properly, modeled accurately and easily accessible, said Ganesan.

His project tackles prediction techniques and storage systems for data from such sensors. It takes a fresh look at challenges in sensor networks in light of recent technology trends and experiences in pilot deployments. Technology trends indicate that the capacities of flash memories will continue to rise while their costs and energy consumption continue to plummet, said Ganesan. This will make it possible to equip sensor nodes with energy-efficient, high-capacity flash memory storage. In addition, pilot deployments have shown that scalable sensor network architectures will be hierarchical, and comprise hundreds of resource-constrained sensors but only tens of resource-rich sensor proxies. This motivates the need to develop methods to exploit resources at proxies while respecting constraints at sensors.

Ganesan’s research includes the design, prototyping and evaluation of archival storage subsystems for sensor nodes, algorithms to enable efficient access of large distributed archival sensor data, and compression techniques for efficiently retrieving such data. “This research will address systems issues as well as analytical underpinnings of a hierarchical sensor storage architecture and has strong ties to the fields of embedded systems, distributed systems and signal processing,” said Ganesan. Additionally, his project proposes an uncertainty-driven energy management architecture that unifies energy optimization across sensing, communication, routing, data processing and query processing tasks.

Ganesan joined UMass Amherst in 2004 as an Assistant Professor and leads the Sensor Networks Research Group. He received his Ph.D. in Computer Science from the University of California, Los Angeles. Ganesan’s research interests include systems, networking and data management issues in sensor networks.

With his CAREER project, Learned-Miller aims to develop computer vision systems that are largely self-taught. Using modern learning techniques, it is now possible to teach computers visual concepts through example based learning. “But this process is time consuming and arduous,” said Learned-Miller. Often large data sets must be manually collected. Machines typically do not take advantage of previously learned knowledge when performing new tasks. And when confronted with a new situation, systems fail catastrophically. The goal of this research is to make it dramatically easier to teach vision systems new skills, and to design machines that can learn tasks faster by leveraging previously learned knowledge.

A central tenet of this work is that it is impractical to train vision systems one problem at a time, acquiring large training sets and developing training paradigms for each task to be learned. There are many scenarios in which training data are severely limited. And ideally, computer systems should be adaptive, and not have to be prepared for each new task, especially when these new tasks are similar to previous ones. Some specific areas of investigation include learning to recognize any particular car or face from a single example, simply by watching other cars or faces as they move about; developing software for robots to continuously explore the visual world and the interactions between vision and the other senses; and learning to recognize typewritten text in a font never seen before, without any training examples of that font. The common thread in these efforts is that they relieve the burden on the teacher of the computer. The final goal is to develop computers that can be taught simply and rapidly, and that can explore on their own.

Learned-Miller joined the Department in 2004. He received his Ph.D. in Electrical Engineering and Computer Science from the Massachusetts Institute of Technology. His research interests can be broadly categorized as applying ideas and methods from machine learning to problems in machine vision.

The CAREER program recognizes and supports the early career-development activities of those teacher-scholars who are most likely to become the academic leaders of the 21st century. Previous Department faculty CAREER award recipients include

Micah Adler (2002), Emery Berger (2004), Mark Corner (2005), Brian Levine (2001), Sridhar Mahadevan (1995; awarded at Univ. of S. Florida), Kathryn McKinley (1996; now at UT-Austin), Prashant Shenoy (2003), Ramesh Sitaraman (1997), and Shlomo Zilberstein (1996).



Oliver Brock



Deepak Ganesan



Erik Learned-Miller

RESEARCH

Weather tracking radar network developed

THE NEW 50-FOOT-TALL TOWER atop Orchard Hill on the UMass Amherst campus houses the prototype unit for a new radar network that can beam into a critical blind spot of the atmosphere that conventional radar systems cannot currently monitor, promising to transform the way human beings monitor weather and track storms.

“The MA1 radar, and the dense network of radars that CASA is developing, are exciting on many fronts,” said Distinguished Professor Jim Kurose, CASA Associate Director. “From a Computer Science standpoint, they represent a new breed of data-driven, networked, sense-and-response systems. The project is intellectually exciting in that it brings together computer scientists, radar engineers, meteorologists, atmospheric scientists, sociologists, and end-user specialists.”

As part of a DCAS (Distributed Collaborative Adaptive Sensing) radar network, the unit being tested on Orchard Hill can sense the lower three kilometers of the atmosphere—the crucial area where storms actually form. For the first time, DCAS technology can follow weather disturbances with the accuracy of an eye-witness emergency manager on the ground. When deployed in the field, DCAS radar networks will provide emergency managers with an invaluable new tool to save lives, carry out evacuations, evaluate potential flooding, and direct the emergency flow of traffic.

DCAS radar is the brainchild of the National Science Foundation (NSF) funded Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere (CASA), a partnership among 19 different institutions including UMass Amherst, the University of Puerto Rico Mayaguez, the University of Oklahoma, Colorado State University, Raytheon, Vaisala, Vieux and Associates, and the National Atmospheric and Oceanic Administration.

The six-foot-tall apparatus sits atop the CASA tower encased in a golf-ball-shaped radome of fiberglass and coated with a hydrophobic substance that repels water, thus protecting the radar from the elements. Its antenna is nearly 50 times smaller than each conventional high-power NexRad system now used by the National Weather Service.

“This step is the verification of our prototype,” says Michael Zink, head of the Technical Integration Thrust for CASA. As soon as the unit proves itself during its test phase, a four-radar DCAS network could be saving lives in the field by this spring in one of Oklahoma’s tornado alleys. The four-node testbed began rising above the southwest Oklahoma plains in January 2006, and will be operational by April of this year. Other test beds will be operated by the CASA collaborators in Colorado and Puerto Rico.

Today’s measurements of the lower three kilometers of atmospheric soup—swirling wind fields and super-cells that spit out tornadoes—are severely limited by existing technology. The system in use today features long-range high-power radars that scan a 200-kilometer radius above cloud level. Their high-power waves shoot straight toward the surrounding horizons, thus the curvature of the planet prevents these units from sensing the lower atmosphere. Current technology is also relatively insensitive to

storms, such as tornadoes, after they fall to earth.

DCAS, however, uses large numbers of low-power *Distributed* nodes with short beams that overcome the earth’s curvature. These tiny DCAS radars are *Collaborative* in the sense that they can cooperate to target their beams on one weather pattern—a tornado, for instance—thus triangulating on it and following its course with the precision of storm chasers in mobile units. The DCAS nodes are also *Adaptive* because they’re engineered to be rapidly reconfigured in response to quickly changing weather.

“This will monitor lower-atmospheric weather for 20 miles around,” explains David McLaughlin, director of CASA.

“It will allow us to test the functionality of the low-power radar concept, the signal processing, and its communications. It’s the sensing part of the operation.”

DCAS radars are expected to usher in a new era in very low power, very low cost radar designs. “This new radar transmits less than one-tenth the power of a light-bulb,” says doctoral student Francesc Junyent, one of 10 CASA engineers (more than half of them graduate students), who created the first DCAS prototype. “Ultimately, we’ll be able to make these radars using low-cost microwave and digital chips the same way we currently make computer boards.”

The work has been funded by a \$17 million NSF grant, \$5 million from the Commonwealth of Massachusetts and \$18 million from CASA’s industry and university partners. Recent funding includes \$2.5 million from the state of Oklahoma, \$650,000 from Colorado State University and \$100,000 from NASA.

This completed DCAS network will track touched-down tornadoes more precisely than ever before possible, cut down on the high percentage of false alarms and comprehensively map the thermodynamic state of the lower atmosphere. According to CASA consultant Luko Krnan, DCAS networks could even help emergency managers with rainfall and flooding prognostication related to hurricanes such as Katrina.



Radar network tower being installed on UMass Amherst campus

Homecoming 2006

The next annual Computer Science Homecoming event will be held on Friday, October 20, 2006. We want to host an event that appeals to all of our alumni and friends, so we’d like to hear from you. Contact us at alumni@cs.umass.edu with your suggestions on what type of Homecoming event would entice you to attend. Find more on Homecoming at www.cs.umass.edu/homecoming2006.

UMass Amherst Computer Science Ph.D. Alumni Where are they now? Here's where...

CALIFORNIA

Poornima Balasubramanyam, Researcher, U. of Cal. Davis

Supratik Bhattacharyya, Res. Scientist, Sprint Lab

Richard Brooks, Sr. Mgr., Genetech, Inc.

Brian Burns, Scientist, AI Ctr., SRI Intl.

Shenze Chen, Tech. Staff, Hewlett-Packard

Jefferson Coelho, Soft. Design Eng., Agilent Tech.

Jeffrey Conklin, Director, CogNexus Inst.

Christopher Connolly, Comp. Scientist, SRI Intl.

Jay Corbett, Sr. Soft. Eng., Google

Michael Duff, PostDoc, U. Cal. Irvine

Rabi Dutta, Patent Agent, Konrad Raynes & Victor

Tom Fawcett, Senior Research Scientist, Stanford U.

Zhengzhu Feng, Soft. Eng., Google

Mahesh Girkar, Oracle

Tom Gruber, CTO & Founder, RealTravel.com

Vijaykumar Gullapalli, Sr. Design Consult., Synopsis

Althea Iberall, Independent Contractor

Mohan Kamath, Sr. Tech., Bus. Proc. Mgmt., Oracle

Anton Leuski, Res. Assoc., U. of S. Cal.

John Lowrance, Program Director, SRI Intl.

Roger Mailler, Comp. Scientist AI Ctr., SRI Intl.

Eric McCall, Eng., Yahoo!

Fanya Montalvo

Jasmina Pavlin, Dept. Mgr., Analysis & Control Tech., Intel

Cristobal Pedregal-Martin, Consult. Member Tech. Staff, Oracle

Jeremy Pickens, Res. Scientist, FX Palo Alto Labs

Jay Ponte, Res. Scientist, Google

Naghi (Maram Nagedra) Prasad, V.P. Eng., Autonomy

Toni Rath, Soft. Eng., Google

Debra Richardson, Dean, School of Info. & CS; Prof., U. of Cal. Irvine

Penelope Sibun, Researcher, Xerox Palo Alto Res. Ctr.

Andrew Singer, CEO, Rapport, Inc.

Jeff Teeters, P-T teaching, Soft. Dev., Consulting

Leonard Wesley, Prof./President, San Jose State U./Intellex

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Charles Anderson, Assoc. Prof., Colorado State U.

J. Ross Beveridge, Assoc. Prof., Colorado State U.

Tim Chamillard, Asst. Prof., U. of Colorado, Col. Springs

Amer Diwan, Asst. Prof., U. of Colorado, Boulder

Bruce Draper, Assoc. Prof., Colorado State U.

Adele Howe, Prof., Colorado State U.

Alexander Wolf, Prof., U. of Colorado, Boulder

John Woods, Retired, TRW

CONNECTICUT

Andrew Cromarty, Strategic Consult. Partner, Robert Frances Group

John Ridgway, Visiting Asst. Prof., Wesleyan U.

Bing Wang, Asst. Prof., U. of Connecticut

DELAWARE

Keith Decker, Assoc. Prof., U. of Delaware

Inigo J. Thomas, Dir., Tech. Solutions, Diamond State Port Corp.

FLORIDA

Jeffrey Bonar, Founder and Chairman, Jump-Start Wireless

Yuan-Chieh (Randy) Chow, Prof., U. of Florida

Arthur Karshmer, Prof./Chair, U. of South Florida

GEORGIA

Ronald Arkin, Regent's Prof., Georgia Inst. of Tech.

HAWAII

Philip Johnson, Prof., U. of Hawaii

Daniel Suthers, Assoc. Prof., U. of Hawaii

IDAHO

Lynn Ruggles, Sr. Eng., Hewlett Packard

ILLINOIS

Shashidhar Buluswar, Assoc. Partner, McKinsey & Co.

Ugo Buy, Assoc. Prof., U. of Illinois

Norman Carver, Assoc. Prof., Southern Illinois U.

David Lewis, Consultant

Kishore Swaminathan, Researcher, Accenture Tech. Labs

INDIANA

Antony Hosking, Assoc. Prof., Purdue U.

IOWA

Ralph Bunker, Adjunct Assoc. Prof., Mahari-shi U. of Mgmt

KANSAS

Raymond Niehaus, Assoc. Prof., U. of Kansas

KENTUCKY

Michael Bradshaw, Visiting Asst. Prof., Centre College

Christopher Jaynes, Assoc. Prof., U. of Kentucky

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Suad Alagic, Prof., U. of S. Maine

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Bruce MacLeod, Prof., U. of S. Maine

Charles Welty, Prof./Chair, U. of S. Maine

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Bob Krovetz, Princ. NLP Eng., CodeRyte

Dawn Lawrie, Asst. Prof., Loyola College

Tim Oates, Asst. Prof., U. of Maryland, Baltimore Co.

Matt Schmill, Researcher, U. of Maryland, Baltimore Co.

MASSACHUSETTS

Scott Anderson, Lecturer, Wellesley College

Krishnamoorthy Arvind, Architect/Consulting Eng., EnteraSys Networks

Jonathan Bachrach, Res. Scientist, MIT CSAIL

Duane Bailey, Prof., Williams College

Lisa Ballesteros, Asst. Prof., Mt. Holyoke College

Daniel Barrett, Sr. Tech. Mgr., VistaPrint

Daniel Bernstein, Sr. PostDoc, UMass Amherst

Malini Bhandaru, Princ. Soft. Eng., Covergence, Inc.

Carla Brodley, Prof. & Dept. Chair, Tufts U.

Carol Broverman, Corp. Mgr. Med. Informatics, Partners Healthcare

Daniel Corkill, Res. Scientist, UMass Amherst

Robert Crites, Sr. Scientist, Unica Corp.

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Victor Lavrenko, Sr. PostDoc, UMass Amherst

Benyuan Liu, Asst. Prof., UMass Lowell

Dirk Mahling, CTO, WebGen Systems

R. Manmatha, Res. Asst. Prof., UMass Amherst

Ruth Maulucci, MOCO, Inc.

Marie Meteer, Vice President, BBN Technologies

Alan Morse, Dev. Staff Coach, Ab Initio Software Corp.

Daniel Neiman, Dir., Tech. Dev., River Logic, Inc.

Brian Pinette

Thomas Probert, Founder; CTO, LydiaLearn

Srinivas Ravela, Postdoc, MIT

Scott Reed, Sr. Soft. Architect, Avacoda, LLC

Khashayar Rohanimanesh, Post Doc, CS & AI Lab, MIT

Michael Rosenstein, Postdoc, MIT

Chia Shen, Assoc. Dir./Sr. Res. Scientist, Mitsubishi Electric Res. Lab

H. Shrikumar, CTO & Founder, IPSIL, Inc.

David Stemple, Prof. Emeritus, UMass Amherst

Mia Stern, Advisory Software Engineer, IBM Research

William Verts, Asst. Prof., UMass Amherst

Rukmini Vijaykumar, Princ. Member, Tech. Staff, Verizon

Steven Vinter, OpenWave

Fuxing Wang, President, Co-founder, Primeon, Inc.

Xiaoguang Wang, Sr. Soft. Eng., Cognex Corp

Charles Weems, Assoc. Prof., UMass Amherst

Robert Whitehair, Chief Res. Officer/Founder, River Logic, Inc.

Thomas Williams, V. Pres./Chief Eng., Millivision

Beverly Woolf, Assoc. Res. Prof., UMass Amherst

Jinxi Xu, Scientist, BBN

Ping Xuan, Asst. Prof., Clark U.

David Yates, Asst. Prof., Bentley College

Xiaoqin Zhang, Asst. Prof., UMass Dartmouth

MICHIGAN

Mohammad Dadashzadeh, Prof., Oakland U.

Laura Dillon, Prof. & Dept. Chair, Michigan State U.

Edmund Durfee, Prof., U. of Michigan

David Haines, Sys. Res. Programmer, U. of Michigan

Jonathan Shapiro, Asst. Prof., Michigan State U.

Satinder Singh, Assoc. Prof., U. of Michigan

Elliot Soloway, Prof., U. of Michigan

Zhenlin Wang, Asst. Prof., Michigan Technological U.

Terry Weymouth, Assoc. Res. Scientist, U. of Michigan

MINNESOTA

Abhishek Chandra, Asst. Prof., U. of Minn.-Twin Cities

Zhi-Li Zhang, Assoc. Prof., U. of Minn.-Twin Cities



MISSISSIPPI

Eric Hansen, Assoc. Prof., Mississippi State U.

MISSOURI

Alan Garvey, Assoc. Prof., Truman State U.
Margaret Thompson, Instructor, Pediatrics, School of Med., Washington U.

NEBRASKA

Matthew Dwyer, Prof., U. of Nebraska

NEW HAMPSHIRE

Edward Fisher, Oracle
Joydip Kundu, Sr. Mgr. Soft. Dev., Oracle
Lory Molesky, Sr. Researcher, Oracle, Inc.
Zachary Rubinstein, Asst. Prof., U. of New Hampshire

NEW JERSEY

B. Badrinath, Prof., Rutgers U.
Tian Bu, Member, Tech. Staff, Bell Labs, Lucent
Peter Burt, Sr. Tech. Dir., Vision Tech., Sarnoff
Davey (Yong-Qing) Cheng, MCI
Jody Daniels, Eng., Lockheed Martin
Zihui Ge, Tech. Specialist, AT&T Research
Oscar Gonzalez-Gomez, Tech. Staff Member, Bell Labs, Lucent
Alan Kaplan, Lead Scientist, Panasonic R&D
Rakesh Kumar, Tech. Director, Sarnoff Research Ctr.
Zhihong Lu, Sr. Tech. Consultant, IBM
Ramesh Nagarajan (ECE), Res. Staff, Bell Labs
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IN MEMORIAM

Jane Hill
Karen Huff
Rolando Lara
Fred Lenherr
Jack Porterfield
James Schmolze

For a list in alphabetic order and a map showing the geographic locations of our Ph.D. alumni, go to www.cs.umass.edu/csinfo/alumni/phdwhere06.html. We apologize if we have omitted anyone or have incorrect career details. Please send updates to alumni@cs.umass.edu.



Undergraduate Matt Marzilli takes research project by STORM

COMPUTER SCIENCE undergraduate Matt Marzilli has spent much of his spare time for the last few months helping the National Mediation Board (NMB) decide how to use computers to facilitate labor-management dispute resolution. His efforts focus on developing STORM, a prototype tool developed as part of a National Science Foundation-funded project, aimed at studying how process definition and analysis technologies can help build trust between parties to labor-management disputes.

The NMB, established in 1934, is responsible for resolving all labor-management disputes in the transportation industry (airlines and railroads). While many disputes deal with collective bargaining agreements, NMB is also charged with minimizing work stoppages. As the industry and volume of its disputes continue to grow, the number of NMB mediators is not keeping pace, so NMB constantly seeks new ways to facilitate dispute resolution. The UMass Amherst team suggested that NMB start by studying their processes. "NMB is very interesting to those of us who study processes, because theirs are very rigorous and formalized, but incorporate quite a bit of flexibility," said Professor Lee Osterweil, the NSF project PI. "Many might think such processes are difficult to define formally and automate, but we believe our process definition language does indeed provide flexibility with rigor, and is thus a strong basis for defining and automating NMB's online dispute resolution systems."

In addition to Osterweil, the team includes Dan Rainey (NMB Director of the Office of Alternative Dispute Resolution

Services), Lori Clarke (CS Professor), Norm Sondheimer (co-director of the UMass Amherst Electronic Enterprise Institute), and Ethan Katsh (Legal Studies Professor). This diverse team is attempting to gain insight into such fundamental issues as where computers can facilitate the dispute resolution process and where face-to-face interactions are better.

When the team realized the need to stimulate NMB's thinking by creating something "real," Marzilli stepped in to create a prototype that provides a visceral sense of the look and feel of a computer negotiation intermediary. Working with Clarke and Osterweil, Marzilli, a dual Computer Science and Physics major in his junior year, designed a prototype. "Matt is a great example of one undergrad whose research ability stands out. He provides a strategically important piece of the research project," noted Clarke.

With guidance from LASER software engineer Sandy Wise on how the prototype's user interface should look, Marzilli worked primarily on his own to build the new system. Sondheimer helped fine tune

the prototype to get it ready to show to Rainey and the NMB. Marzilli not only provided the behind-the-scenes programming, but also continues to refine the prototype based on input from Rainey and the evaluations of prototype testers, including faculty and students from Legal Studies and the Isenberg School of Management -- even Marzilli family members that Matt recruited to test the prototype.

The STORM prototype (named for NMB's "brainstorming" process) enabled Rainey to see important advantages over current commercial products. For example, Rainey can now visualize how different process variations can use automation to support human negotiators in different ways, suggesting different variants for future research and refinements to STORM. Rainey has shown STORM at national conferences and has used it in teaching classes to both UMass Amherst students and to professional mediators. "It was one of the most exciting experiences for me to see students in front of forty computer screens all with the STORM interface during an

actual class," said Marzilli.

Marzilli and CS graduate student Dan Gyllstrom went to Washington D.C. to train NMB mediators to use STORM, and came back with pages of comments and ideas for enhancements. This will help point the way to using the LASER process definition language and STORM to support the various negotiation process definitions needed by NMB. "I've never written a program before that really mattered. But real people are depending on STORM," said Marzilli. "It is a great experience using what I know and applying it to the project."

While working on STORM this past summer, Marzilli also held a full-time physics research position. As shown by his 3.9 grade point average, Marzilli has no problems juggling his dual majors. "I chose physics, because, like computer science, I find it challenging," said Marzilli. "Physics is another disciplined and mathematical way of thinking, though computer science is my first love." For his educational accomplishments, Marzilli received a campus nomination for the 2006 Barry M. Goldwater Scholarship to be awarded by the Goldwater Foundation later this spring. "One can identify only a handful of young people who can add value to your research, and can also go off and do great things with the knowledge they gained. Occasionally, they can really make an important difference to the world. Matt is in a good position to be one of this small group," said Osterweil. Clarke concurred, "Matt has a nice future ahead of him. He has already shown an aptitude for research, and this is just a start for him."



Matt Marzilli (left) points out some of STORM's latest refinements to NMB's Dan Rainey.

AWARDS

Two Microsoft Fellowships go to CIIR students

MICROSOFT RESEARCH has selected Center for Intelligent Information Retrieval (CIIR) doctoral students Aron Culotta and Don Metzler as Microsoft Research Fellows in recognition of their research accomplishments. According to Microsoft, “competition for the Fellowship was extremely intense.” They received over 150 very highly qualified applicants from across the United States and Canada for 22 awards in 2006.

Both Culotta and Metzler are among ten specially funded Microsoft Research (MSR) Fellows sponsored by Live Labs, a new research partnership between MSN and MSR that focuses on applied research for Internet products and services at Microsoft.

The two-year Fellowships cover 100 percent of tuition and fees, provide a stipend for living expenses and include an allowance for attending professional conferences and seminars. Each fellowship recipient also gets a TabletPC and is invited to participate in a 12 week paid internship. Culotta, an Information

Extraction and Synthesis Laboratory student, and Metzler, an Information Retrieval Laboratory student, will be honored during an awards ceremony in Microsoft’s Redmond, Washington facility.

Culotta is interested in machine learning techniques applied to language processing tasks such as information extraction, co-reference resolution, social network analysis, and data mining.

One of Culotta’s current research projects is the development of a system that will extract relations between people and organizations from the Web and perform data mining to discover informative patterns and hidden connections between entities. Applications of this research include uncovering fraud and corruption, and enabling Web search over implicit information.

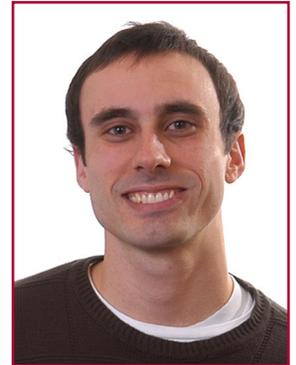
Culotta’s previous work includes an interactive information extraction system that uses machine learning techniques to help users quickly train an extraction system and efficiently correct any errors in its output. He received an honorable mention for Best Paper Award at the 2004 American Association for Artificial Intelligence Conference for his paper “Interactive Information Extraction with Constrained Conditional Random Fields.”

Culotta’s advisor is Associate Professor Andrew McCallum. Metzler’s primary research interests are machine learning, information retrieval, and their intersection. In particular, he is interested in applying statistical techniques to retrieve and model various types of data, such as text and images. He is also interested in question answering and web retrieval.

One of Metzler’s current research projects is with Indri, an efficient, scalable open-source search engine. Indri synthesizes and enhances the Lemur (UMass Amherst and CMU collaboration) and InQuery (developed by UMass Amherst) search tools to provide state-of-the-art indexing and search capabilities. His research focuses on the development of the underlying retrieval model and query language.

Metzler is also working to develop a better understanding of how phrases and other textual features can be used to improve search results, especially on terabyte-sized collections of documents. Metzler received the Best Student Paper Award at the 2005 ACM Special Interest Group in Information Retrieval (SIGIR) Conference for his paper “A Markov Random Field Model for Term Dependencies.”

Distinguished Professor Bruce Croft, who chairs the Department of Computer Science and directs the CIIR, is Metzler’s advisor. “This is quite an honor for Aron and Don,” said Croft. “We are very proud of their accomplishments.”



Aron Culotta (top) and Don Metzler

Corporate Support

THE DEPARTMENT RECEIVES SUPPORT from a wide range of companies including recent contributions from IBM, Sprint, Sun Microsystems, BBN Technologies, Nortel Networks, Verizon, Honeywell, and some that are described below.

Intel provided funding to Associate Professor Eliot Moss in support of his research on transactional memory. Associate Professor Prashant Shenoy also received a gift from Intel for his research on Internet data centers.

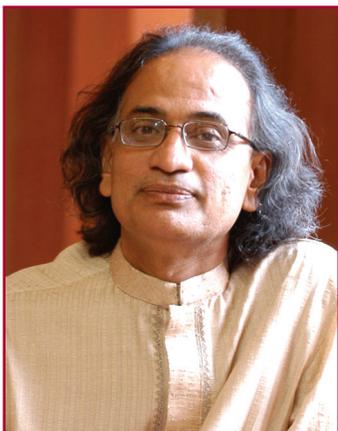
UpToDate, a leader in the market of providing point-of-care, clinical information to health care professionals throughout the world, recognized the work of Distinguished Professor Bruce Croft and Associate Professor James Allan with a gift to the Center for Intelligent Information Retrieval.

In a collaboration with Dublin City University Professor Alan Smeaton and University of Buffalo Professor Venu Govindaraju, Research Assistant Professor R. Manmatha received funding from Google for their research project on information retrieval from handwritten manuscripts.

Radio star

NATIONAL PUBLIC RADIO PUZZLEMASTER Will Shortz quizzed undergraduate Jeff Terrace, a computer science and mathematics major, during the national Sunday radio show on Nov. 27. Terrace was one of only five people out of almost 100 entries who solved the initial challenge perfectly. He created a three-by-three square composed of the symbols of nine chemical elements in which each of the three rows across and each of the columns down spells a word. For his radio appearance, Terrace had to name familiar two word phrases or names in which the first word ends in the letter “o” and the second word starts with “p.” An example that Terrace answered correctly was the name of an Italian explorer of the Far East: Marco Polo. Terrace can be heard at www.npr.org/templates/story/story.php?storyId=5028506

Anandan receives Distinguished Alumni Award



THE UNIVERSITY OF MASSACHUSETTS AMHERST ALUMNI ASSOCIATION will present a Distinguished Alumni Award to Dr. P. Anandan (Ph.D. '87) on April 3 during ceremonies at the Massachusetts State House.

The award is being bestowed on Anandan for his professional achievement. After graduating from UMass Amherst (advised by Professors Allen Hanson and Ed Riseman), Anandan became

an assistant professor of computer science at Yale University where he built the computer vision group from the ground up. He later joined Sarnoff Corporation, working as a research manager directing projects in airborne video surveillance and video stabilization technology. He then served seven years at Microsoft Research as a senior researcher where he worked primarily in the areas of computer vision and video

processing.

In 2005, Anandan was named the managing director of Microsoft Research India. A central issue being explored in the new lab is the basic question of how information technology can be made accessible, affordable, and relevant to the rural populations of emerging markets such as India.

Anandan will also give a presentation on April 6 as part of the Department's distinguished lecture series.

High tech teaching

THIS PAST FALL, ASSOCIATE PROFESSOR ELIOT MOSS changed his teaching style to use a Tablet PC in the classroom.

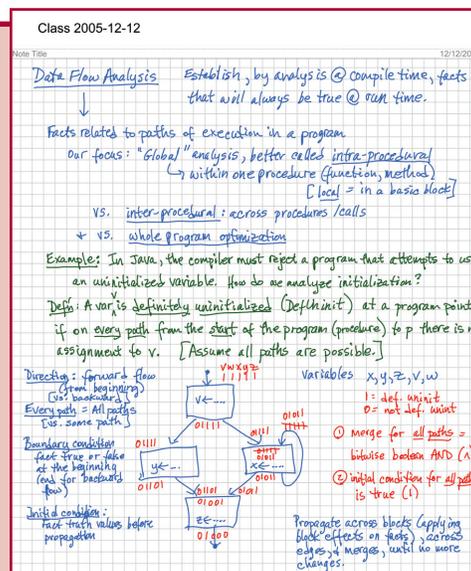
"In the past, for the compiler course, I relied mostly on writing on acetate overhead sheets with colored markers," said Moss. "Compared with using PowerPoint or PDF based presentations, this kept the interaction at a better pace for students to absorb and take notes, and was much more spontaneous and interactive." But he added that it had its drawbacks because there was no easy and cost-effective way to provide color copies of the overheads to the students. "With the programs on a Tablet PC, I can post the notes to a Web page for all the students to download and view. They really like it because they know that they don't have to duplicate what I am writing in their own note taking, but can concentrate on their own remarks, and focus more on the material," said Moss.

While it seems a small step, this change in presentation technology made a big impression on the students, as shown by anonymous student course evaluations. "I like the use of the tablet PC; it worked much better than PowerPoint would have," wrote one student. "The tablet is GREAT -- I can learn and not take my own notes," wrote another.

The Tablet also includes the capability to markup PowerPoint, Word, or PDF documents during a presentation. "You can do more than just emphasize or comment, you can leave intentional blank space for writing things down or solving

example problems on the fly," noted Moss. "There's a lot that I hope to explore over the next few semesters as I become more familiar with the technology and work it into my courses."

Moss received his Tablet PC as part of the UMass Amherst TEACHnology Fellows program, administered through the Center for Teaching. "I am grateful for the Dean's support in providing the funds for the Tablets, and for the TEACHnology Fellows program in bringing faculty together to master the technology and wrestle with all the issues of pedagogy that it brings," added Moss. "Most instructors are conservative about introducing new technology, especially in courses they feel already work well. This has been a great experience, showing that careful use of new tools can make a good course even better."



Tablet PC class notes example

New information theory course

ASSISTANT PROFESSOR ERIK LEARNED-MILLER will be teaching a new graduate course, Applied Information Theory, in the fall. "Information theory is finding more and more applications in modern research," said Learned-Miller. "It is fundamental to signal processing, but is becoming an essential tool in machine learning, networking, and even in such areas as computer vision and databases." Unlike many traditional information theory courses, which are heavily theoretical and proof-oriented, his course will focus on applying information

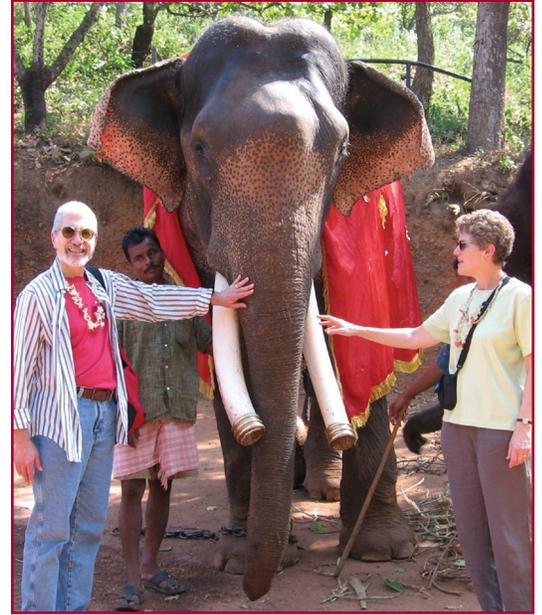
theory to real data and practical problems. In addition to learning basic results about entropy, mutual information, and coding theory, the class will address the statistical issues in estimating these quantities from data samples, a topic often omitted from information theory courses. "I hope that this course will give students the basic tools they need to use information theoretic methods in their research, and give them strong intuitions about these very powerful tools," added Learned-Miller. "I am working currently with Professors Don Towsley, Deepak Ganesan, Micah Adler, and others to make sure that the course addresses the needs of a broad range of research areas."

Faculty News

“Analyzing Myopic Approaches for Multi-Agent Communication,” by graduate student **Raphen Becker**, Professor **Victor Lesser**, and Professor **Shlomo Zilberstein**, received the Best Paper Award from the 2005 IEEE/WIC/ACM Intelligent Agent Technologies Conference held in Compiègne, France. ■ Graduate student **Xiaotao Liu**, Associate Professor **Prashant Shenoy**, and Assistant Professor **Mark Corner** won the Best Paper Award at the ACM Multimedia 2005 Conference in Singapore for their paper “SEVA: Sensor-Enhanced Video Annotation.” At the same conference, the paper “SensEye: A Multi-tier Camera Sensor Network” authored by graduate student **Puru Kulkarni**, Assistant Professor **Deepak Ganesan**, and **Shenoy** was a Best Student Paper Award finalist. ■ **Sami Rollins**, Assistant Professor of Computer Science at Mount Holyoke College, joined the Department as an Adjunct Assistant Professor. ■ The Indian Institute of Technology (IIT) Madras selected Professor **Krithi Ramamritham** for a 2006 Distinguished Alumni Award. He is the head of the School of Information Technology at IIT Bombay and an adjunct professor in our Department. ■ Professor **Shlomo Zilberstein** joined the Editorial Board of *Annals of Mathematics and Artificial Intelligence*. ■ Associate Professor **Brian Levine** became an Associate Editor of *IEEE/ACM Transactions on Networking*.

■ Associate Professor **Eliot Moss** is the Program Chair for the 2006 International Symposium on Memory Management, to be held in Ottawa in June. ■ Associate Professor **Prashant Shenoy** will serve as Program Chair for the World Wide Web 2007 conference. ■ Assistant Professor **Oliver Brock** received a nomination for the campus-wide Outstanding Academic Advisor of the Year (OAAAY) Award. Winners will be announced in May. ■ Along with co-authors **Lilla Zollei**, **Eric Grimson**, and **William Wells**, Assistant Professor **Erik Learned-Miller** received a Best Paper Award for their paper “Efficient Population Registration of 3D Data” at the Workshop on Computer Vision for Biomedical Image Applications: Current Techniques and Future Trends. The workshop was held at the 2005 International Conference of Computer Vision, in Beijing, China. ■ Associate Professor **Andrew McCallum** gave an invited talk at the Neural Information Processing Systems (NIPS 2005) Workshop on “Bayesian Methods for Natural Language Processing.” He also gave an invited Broad Area Colloquium talk at Stanford University Computer Science department entitled “Information Extraction, Social Network Analysis and Joint Inference.” ■ Assistant Professor **Emery Berger** recently released a program called **DieHard** that automatically makes programs less buggy and more secure from a hacker attack. More at www.cs.umass.edu/~emery/diehard/.

Distinguished Professor Arnold Rosenberg was the keynote speaker at the 12th International Conference on High Performance Computing (HiPC’05) in Goa, India. During their visit to India, he and his wife **Susan** got a chance to pet an elephant.



Visitor News

Victor Emanuel UC Cetina, a Ph.D. student at Humboldt University in Berlin, Germany, is a Visiting Scholar working with Professor **Andrew Barto**.

Research News

Gideon Mann joined the Information Extraction and Synthesis Laboratory as a Senior Postdoctoral Research Associate this fall. ■ **Daniel Bernstein** (Ph.D. ’05) is a Senior Postdoctoral Research Associate in the Resource-Bounded Reasoning Research Group. ■ **Dr. Norman Sondheim** joined the Laboratory for Advanced Software Engineering Research (LASER) as a Research Scientist. ■ The Center for Computer-Based Instructional Technology (CCBIT) has a new name and a new location. Now called the Center for Educational Software Development (CESD), the group reports to **John Dubach**, the campus’ Chief Information Officer, and is located in the Lederle lowrise. CCBIT/CESD staff who have moved to Lederle include **David Hart**, **Matthew Mattingly**, **Cindy Stein**, and **Stephen Battisti**. **Rachel**

Lavery will work half-time for CESD.

Student News

The first annual undergraduate award recipients for 2005 are **Mark Gruman** (AI), **Matthew Brandwein** (Security), **Subhash Patel** (Theory), **Andrew Tolopko** (Networking), **Bradley Hawkes** (Software), and **James Cipar** (Systems). Each of the honorees graduated in 2005 with a B.S. in Computer Science. ■ Graduate student **Benessa Defend** received an NSF East Asia and Pacific Summer Institutes (EAPSI) grant to spend this summer at Kyushu University in Japan working on RFID security. ■ CIIR graduate student **Mark Smucker** and his wife **Anne** welcomed the arrival of their son **Leo Mark** on December 20. ■ PRISMS graduate student **Tom Heydt-Benjamin** and his wife **Ava** are the proud parents of their daughter **Ivy Frost**, born on December 30.

Staff News

Working with the Information Extraction and Synthesis Laboratory, **Adam Saunders** was promoted to Software Engineer I.

In Memoriam

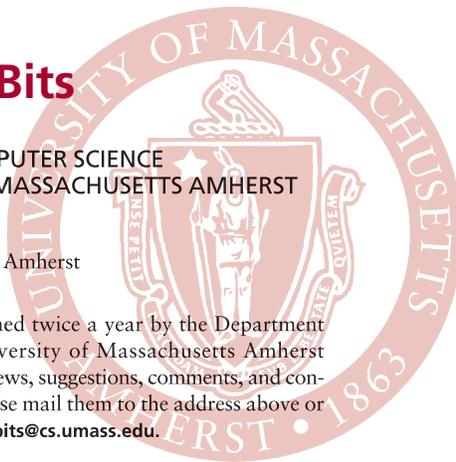
James G. “Jim” Schmolze (Ph.D. ’86), 52, of Newton, MA, died on February 27th of complications from cancer. Jim was an Associate Professor of Computer Science at Tufts University. His specialty was Artificial Intelligence. He was Department Chair of Electrical Engineering & Computer Science at Tufts from 2000-2002. Jim loved skiing, hiking, traveling, snorkeling, and scuba diving with his family.

Significant Bits

NEWSLETTER of the
DEPARTMENT OF COMPUTER SCIENCE
at the UNIVERSITY OF MASSACHUSETTS AMHERST

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Thanks for your support

THE FOLLOWING ALUMNI AND FRIENDS have actively supported the Department of Computer Science from October 2005 through January 2006. Such financial support is greatly appreciated and helps maintain a world-class instructional and research program. Contributions of alumni and friends help to fund important special activities that are not supported through the state budget.

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