University of Massachusetts Amherst
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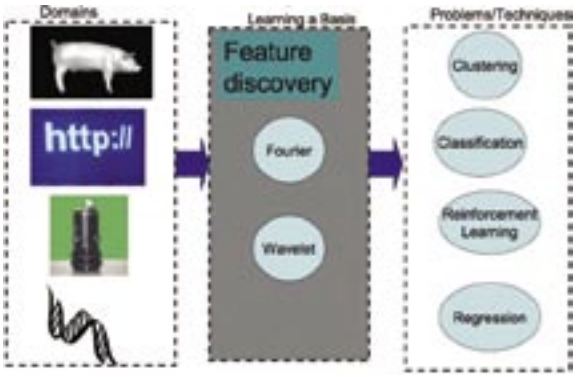
Significant BITS

Newsletter of the
Department of Computer Science

Representation Discovery: A new frontier of CS research



Representation discovery finds a new set of "features" (or basis functions) for describing digital datasets, by harmonic analysis of the nonlinear geometry of the space spanned by the data.

Representations are at the heart of computer science. To manipulate data in software, information must first be converted into a digital form. Finding a good representation for the converted data can make an enormous difference to the efficiency with which the data is processed and stored. Fueled by the remarkable growth in sensing and storage technology, digital data has proliferated greatly in diversity and size: examples range the gamut from digital movies and music, personal image galleries, problem-solving and sensor traces from autonomous decision-making programs and physically embodied devices such as robots and sensor networks, and collaboration graphs representing scientific and social networks. "This explosion in high-dimensional data makes it imperative to find efficient algorithms for extracting low-dimensional regularities," says Associate Professor Sridhar Mahadevan, co-director of the Autonomous Learning Laboratory.

Throughout human history, the development of new representations has had lasting significance. To take a simple example, consider the problem of representing numbers: 4, IV, 1111, and 100 all denote the number "four" using a different basis (base 10, Roman, unary or base 1, and binary or base 2). Positional representations, such as base 10 and base 2, are widely used in science and technology. Rapid growth in multimedia content necessitates sophisticated compression algorithms; today we use JPEG, but far more efficient representations will emerge in the next decade from recent theoretical breakthroughs in compressed sensing, adds Mahadevan.

Can representation discovery be automated? Are there mathematical principles by which computers can discover optimal data-dependent representations? Mahadevan and his Ph.D. students are investigating these challenging questions. His recent research, funded by National Science Foundation grants, has been published in a new book. The research applies mathematical tools from the field of harmonic analysis to digital data sets. Harmonic analysis decomposes all functions in a given space into atomic building blocks called basis functions.

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Fu awarded prestigious Sloan Research Fellowship

Assistant Professor Kevin Fu is among 118 researchers in the United States and Canada to be awarded a prestigious Sloan Research Fellowship by the Alfred P. Sloan Foundation.

Fu's research focuses on ensuring the security and privacy of pervasive devices that must withstand determined, malicious parties. His primary focus is on improving the security and privacy of pervasive healthcare and energy-constrained computational architectures such as RFIDs and implantable medical devices. "A unifying characteristic is the need to strike a balance between security and usability," says Fu. "Too much security can make a system ineffective and unusable. A highly usable system may fail to adequately protect sensitive resources. His approaches rely on a dual defense of energy-aware computation and cryptography."

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Venkataramani receives NSF CAREER award

Assistant Professor Arun Venkataramani has received a five-year Faculty Early Career Development (CAREER) award from the National Science Foundation for his proposal "A Robust Protocol Stack for Diverse Wireless Edge Networks."

"The growth and value of the Internet today are fueled by a variety of wireless edge networks including WiFi access points in homes and public places, wireless local area networks (WLANs) in workplaces, cellular data services such as 3G, multi-hop wireless mesh networks, wireless sensor networks, mobile ad hoc networks (MANETs), and delay-tolerant networks (DTNs)," says Venkataramani. "This diversity poses fundamental challenges to traditional network protocols that are fragile under highly fluctuating loss, delay, and topology characteristics, and completely break down in disruption-prone environments." The diversity increases management complexity—a network administrator must pick from an intimidating number of protocol options and optimizations tuned to one environment. These protocols have to be re-engineered in a different environment—stifling innovation and the long-term value of interconnecting diverse wireless edge networks.

With his CAREER award, Venkataramani is working on the architecture, analysis, and implementation of a simple network protocol stack that ensures robust performance across diverse wireless edge networks. In this project, he adopts an unusual approach: instead of trying to make protocols in otherwise well-connected environments robust to intermittent fluctuations or disruptions, he is designing for an extreme point in the design space—an always-partitioned network or a DTN—and working back from those insights to ensure robust performance of protocols even in well-connected mesh networks.

After receiving his Ph.D. in Computer Sciences from the University of Texas at Austin, Venkataramani held a visiting faculty position at the University of Washington. In 2005 he joined the computer science faculty at UMass Amherst, where he currently leads the Advanced Networked Systems Research Group.

The CAREER program offers the NSF's most prestigious awards for new faculty members. It 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. In addition to Venkataramani, fifteen members of the department's faculty have received previous CAREER awards.

FU NAMED SLOAN FELLOW – – – *continued from page 1*

The proliferation of low-power embedded computing has led to a change in how humans and computers interact. For instance, large numbers of people carry RFID-enabled car keys for anti-theft protection. Wireless pacemakers and implantable cardioverter defibrillators use low-power microcontrollers to maintain healthy heart rhythms. Yet security often remains an afterthought because of a lack of understanding of threat models and a belief that cryptography requires expensive, special-purpose hardware. A fundamental problem that Fu investigates is how to provide security and privacy under extreme resource constraints, such as computing with little or no battery power.

His recent research introduced threat models for untraditional contexts such as wireless, implantable medical devices and RFID-enabled, contactless credit cards. As a result of fundamental flaws discovered in these devices, both the medical device industry and credit card industry have begun to embrace stronger models for security and privacy. Moreover, the FDA and FTC are reevaluating their regulations to ensure patient safety and consumer privacy respectively. Fu's work on medical devices further provides a number of zero-power defenses in the sense that no energy is drawn from the primary battery to perform security operations. Rather, the agent asking to be authenticated must provide wireless power that supplies the energy for the security operations. Related clinical results appeared at the American Heart Association Scientific Session (one of only two submissions out of 4,000 selected to educate the public through national television). His recent work dispelled the widespread misbelief that RFIDs need special-purpose hardware for cryptography. He demonstrated that a common block cipher is surprisingly feasible on an RF-powered, general-purpose Ultra-High Frequency RFID tag (RFIDSec). Previously, many RFID researchers invented lightweight cryptographic methods that were later completely broken by cryptanalysis. Further proving that special-purpose hardware is not necessary for RFID security, the FERNS random number generator allows an RFID tag to harvest physically random numbers from uninitialized SRAM because of process variation (IEEE *Trans. on Computers*).

Fu's planned research will investigate novel software abstractions and compiler optimizations for securely performing general-purpose computation on computational RFIDs—battery-free devices that must harvest RF energy for computation. A key challenge is to make forward progress of computation despite continual interruptions to power. Complete loss of RAM on the order of every 100 ms makes the notion of a computational checkpoint fundamental to this emerging model of computing. Long-running computations such as key derivation will benefit from such checkpoints. A second challenge is finding hardware-software abstractions that better match the energy constraints. For instance, a computational RFID draws energy from a continuously decreasing supply voltage from a small capacitor. Because processors today are designed for a discrete set of supply voltages, the processor will waste energy

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Lesser receives Research Excellence Award; named IEEE Fellow

Professor Victor Lesser received the 2009 International Joint Conferences on Artificial Intelligence (IJCAI-09) Award for Research Excellence, and the Institute of Electrical and Electronics Engineers (IEEE) has named Lesser as a Fellow.

The IJCAI lifetime achievement award is given to a scientist who has carried out a program of research of consistently high quality yielding several substantial results. Lesser is recognized for his seminal work on the foundations of blackboard control architectures and multi-agent systems and his foundational role in the formation of the multi-agent systems community.

According to IJCAI, past recipients of the Research Excellence honor are the most illustrious group of scientists from the field of Artificial Intelligence. They are: John McCarthy (1985), Allen Newell (1989), Marvin Minsky (1991), Raymond Reiter (1993), Herbert Simon (1995), Aravind Joshi (1997), Judea Pearl (1999), Donald Michie (2001), Nils Nilsson (2003), Geoffrey E. Hinton (2005), and Alan Bundy (2007).

By naming Lesser an IEEE Fellow, the organization recognizes his contributions to distributed intelligent systems and architectures. According to IEEE, the grade of Fellow recognizes unusual distinction in the profession and shall be conferred by the Board of Directors upon a person with an extraordinary record of accomplishments in any of the IEEE fields of interest.

Professor Lesser's research focus is on the control and organization of complex artificial intelligence systems. Lesser is considered a leading researcher in the areas of Multi-Agent Systems/ Distributed AI, Intelligent Distributed Sensor Networks, Real-time AI, and Blackboard Systems. He has also made contributions in the areas of speech and sound understanding, diagnostics, adaptive signal processing, intelligent user interfaces, and computer architecture.

Lesser's research accomplishments have been recognized by many major awards over the years. Most recently, he was named co-winner of the 2008 International Foundation for Autonomous Agents and Multi-Agent Systems (IFAAMAS) Influential Paper Award. In 2007, The IFAAMAS established the "Victor Lesser Distinguished Dissertation Award" to recognize his career-long contributions to the field.

Lesser joined the UMass Amherst Computer Science faculty in 1977 and is the director of the Multi-Agent Systems Lab (MAS). He received his B.A. in Mathematics from Cornell University in 1966, and his Ph.D. in Computer Science from Stanford University in 1973.

McCallum elected AAAI Fellow

Professor Andrew McCallum was elected as a Fellow of the Association for the Advancement of Artificial Intelligence (AAAI) "for significant contributions to the theory and application of information extraction, natural language processing, data mining, machine learning, and their integration." The AAAI will celebrate the newly elected Fellows at a dinner during IJCAI-09 in Pasadena, California on July 14.

His research interests are in information extraction, knowledge discovery from text, statistical natural language processing, machine learning, and graphical models. The main goal of McCallum's research is to dramatically increase our ability to mine actionable knowledge from unstructured text.

He is especially interested in information extraction from the Web, understanding the connections among people and between organizations, expert finding, social network analysis, and mining the scientific literature. Toward this end, he and his group develop and employ various methods in statistical machine learning, natural language processing, information retrieval and data mining—tending toward probabilistic approaches and graphical models. He is one of the pioneers in the development of conditional random fields. As a demonstration of his research, his group has created the research paper search engine at **www.rexa.info**.

McCallum is the Director of the Information Extraction and Synthesis Laboratory (IESL). Prior to joining UMass Amherst in 2003, McCallum was Vice President of Research and Development at WhizBang Labs, a company that uses machine learning for information extraction from the Web. In the late 1990's he was a Research Scientist and Coordinator at Justsystem Pittsburgh Research Center, where he spearheaded the creation of CORA, an early research paper search engine that used machine learning for spidering, extracting, classifying and citation analysis. McCallum received his Ph.D. from the University of Rochester in 1995, followed by a post-doctoral fellowship at Carnegie Mellon University.

We welcome your support

Gifts like yours help the department in many ways, from funding departmental seminars by outstanding scientists and assisting undergraduate research, to helping new faculty establish their research programs. General support in particular helps us continue activities that enrich our educational and research programs. Thank you.

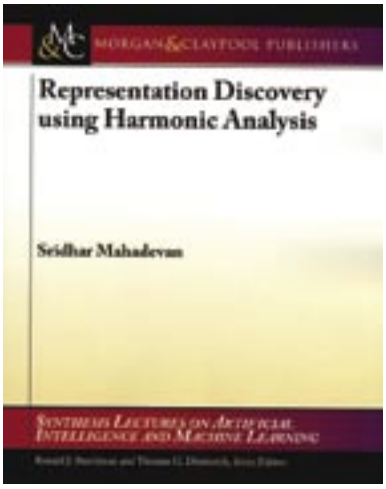
MAHADEVAN – – – – – – – – *continued from page 1*

In Fourier analysis, data over time or space is decomposed as a combination of frequency-oriented eigenvector bases; wavelet analysis uses multiscale bases that combine time and frequency or space and frequency. Traditional harmonic analysis is in the setting of Euclidean spaces. "Many real-world digital datasets have a non-Euclidean geometry, but are compressible since they lie on a lower-dimensional mathematical surface or manifold that can be modeled as a graph," says Mahadevan. "The challenge of applying harmonic analysis to digital data is that the basis functions are not pre-specified, but need to be themselves discovered from the graph representation of the data manifold."

Representation discovery is a pre-processing step that precedes conventional data mining or machine learning. Commonly studied problems in machine learning include classifying data into discrete categories, clustering data into groups without being given associated labels, taking optimal actions in solving sequential decision problems using reinforcement learning, and learning to predict real-valued functions by regression. Representation discovery facilitates all of these inference methods by constructing customized data-dependent representations that exploit the geometry of the space, and problem-specific objectives such as discrimination or decision-making.

Search engines illustrate the use of Fourier representations. Google™ uses the PageRank score for indexing web pages, derived by diagonalizing a matrix representing a random walk on the web graph. The eigenvector corresponding to the highest frequency or eigenvalue of the random walk matrix yields the PageRank scores. This 1-dimensional representation can be enhanced using additional eigenvectors, yielding a new set of coordinates that embeds the web graph into Euclidean space reflecting its nonlinear geometry. Mahadevan's research group is exploring a generalization of Fourier analysis on graphs in artificial intelligence. One application involves designing a new generation of autonomous agents that solve sequential decision problems by learning new representations of the state space during problem solving. Examples of such agents include game playing programs, robots that navigate around crowded home or office environments, and a variety of industrial applications in manufacturing and scheduling. Previously, such problems were solved by carefully constraining the search space using human-designed representations. Now, agents engage in a representation discovery phase by doing a random walk in the state space, building a graph of the visited states; harmonic analysis discovers a new representation of the state space. Such computer-discovered representations enable some optimization problems to be solved 50 times faster than previously hand-tuned representations.

Can Fourier representations such as PageRank be improved? A new mathematical framework called wavelets has emerged that addresses the limitations of eigenvector representations. Unlike Fourier analysis, wavelets are based on the principle of dilation. New multiscale representations emerge by analyzing the powers of the random walk matrix on graphs. Longer random walks reveal coarser properties, and correspond to slowly varying processes. Shorter random walks capture high-frequency variations. Mahadevan is collaborating with Professor Mauro Maggioni, a mathematician at Duke University, on a generalization of wavelets to discover multi-scale representations from digital data. One interesting application is extracting multiscale regularities from text documents or web pages by constructing wavelet embeddings of text documents, says Mahadevan. This approach automatically discovers topic hierarchies significantly faster than previous methods using parametric probabilistic models. Another exciting application is constructing new compression methods in 3D graphics. Wavelet-based methods outperform Fourier-based methods for approximating 3D objects on graphs; the latter uses global eigenvectors derived from the object's graph topology, while the former constructs multiscale basis functions that are much more adept at approximating sharp discontinuities.



Mahadevan's research into representation discovery has just been published in a new book

Can machines discover new representations that outperform human-engineered ones? Google relies on machine-discovered Fourier representations, as it is not feasible to index billions of web pages by hand! Similarly, the vast amount of data generated by a sensor network, a team of robots, the next-generation of 3D cameras and movies, genetic research, and a host of other applications will be so large that computer-discovered representations will be essential. "The challenge," says Mahadevan, "is to devise principled and scalable computational frameworks by which computers can discover new ways to represent data. The ultimate aim of algorithmic representation discovery is not just to facilitate efficient processing of digital data, but to also understand the internal representations and algorithms in our brains that guide our everyday decision-making.

Professor Mahadevan received his Ph.D. from Rutgers University in 1990. He worked at the IBM T.J Watson Research Center until1993. Prior to joining UMass Amherst in 2001, he was a faculty member in the computer science departments at the University of South Florida in Tampa, and at Michigan State University in East Lansing. Mahadevan has written two books, one on Robot Learning (published by Kluwer Academic Press in 1993), and the other on Representation Discovery using Harmonic Analysis, published by Morgan Claypool in 2008. He has authored over 90 papers in a variety of topics in artificial intelligence and machine learning. He is an Associate Editor for the *Journal of Machine Learning Research*. His recent research on representation discovery was presented in a number of invited tutorials at leading conferences in AI and machine learning.

McGregor joins CS faculty

Andrew McGregor joined the department as an Assistant Professor in January. His research interests are in algorithms for processing massive data sets and data streams; computing with noisy or incomplete data; clustering; communication complexity; coding and information theory.

"Processing massive data sets and computing with data that may be noisy or inconsistent are two of the major challenges that computer science faces today," says McGregor. "Traditional notions of 'efficient computation' need to be reconsidered when monitoring Gbps network traffic or mining petabytes of search engine data. New theoretical and practical challenges arise from constraints on how data is accessed and the need to process 'uncertain' data (e.g., data from conflicting sources, incomplete logs, noisy channels, and imperfect sensors)."

McGregor's research focuses on the design of efficient algorithms and the study of complexity in this new paradigm. This includes processing data streams and massive graphs, clustering data, and understanding underlying theoretical issues such as communication complexity and space complexity in stream computation. Other areas of his research include coding and information theory; network design and optimization; and priced information. His work appears in a range of applied and theoretical venues including those focused on databases, data mining, information theory, machine learning, and theoretical computer science.

Notably, McGregor's research has appeared in a Special Issue of *Journal of Machine Learning* for Best Papers from The Twentieth Annual Conference on Learning Theory (COLT 2007), a Special Issue of *Transactions on Database Systems* for Best Papers from the 27th ACM SIGMOD International Conference on Management of Data / Principles of Database Systems (PODS 2007), a Special Issue of *Theoretical Computer Science* for Best Papers from the 31st International Colloquium on Automata, Languages and Programming (ICALP 2004), and the ACM Special Interest Group on Algorithms and Computation Theory's (SIGACT's) "Significant papers on new areas" (1 of 13 from 2007).

Prior to joining the department's faculty, McGregor held postdoctoral researcher positions at Microsoft Research (Silicon Valley) and at the University of California, San Diego, Information Theory and Applications Center. He received his Ph.D. and M.Eng. in Computer Science from the University of Pennsylvania in 2007 and 2002, respectively. He also received a Certificate of Advanced Study in Mathematics and a B.A. in Mathematics from the University of Cambridge, in 2001 and 2000, respectively. During graduate school, McGregor spent a summer at the Rutgers' Center for Discrete Mathematics & Theoretical Computer Science (DIMACS) and three summers at Bell Labs.

"This is a great department and I am very happy to be here," says McGregor. "I think it is the perfect place to pursue my research goals and I am also very excited to be discovering new research opportunities as I get to know the faculty and students of the department. In fact, I doubt that you could find a happier and more collaborative environment!"

Ganesan named Lilly Fellow

The UMass Amherst Center for Teaching (CFT) named Assistant Professor Deepak Ganesan as a Lilly Teaching Fellow for the 2009-2010 academic year. Lilly Fellows are selected on the basis of their promise in teaching and research, their interest in undergraduate teaching and in developing innovative teaching skills, and their potential for making a positive impact on the teaching culture in their department, college, and broader campus community.

For his Lilly project, Ganesan plans to create an inter-disciplinary course on Green Computing that prepares students for designing next generation of energy-efficient computing systems. His course will cover 1) techniques in green computing across a myriad of computing devices that we interact with in our daily lives, including sensors, handhelds, laptops, personal computers, servers, and data centers, and 2) the role of green energy in computing, including use of micro-generators that harvest solar, vibration, thermal, WiFi, and wind energy, as well as new battery technologies such as micro fuel cells.

"As a semester-long project, students will be asked to design a green computing system such as a thermal-powered on-body sensor, fuel-cell based PDA, or a more efficient data center," says Ganesan. While the core focus of the course will be from a Computer Science viewpoint, it will draw on recent developments in renewable energy technologies from Mechanical and Electrical Engineering, and micro fuel-cell technologies from Chemical Engineering and Polymer Sciences.

Ganesan's course will position undergraduate students to be more competitive in this growing market. In addition, the course can be a facilitator for increased collaboration across several departments at UMass Amherst that are actively involved in research on renewable energy and new energy sources, including Computer Science, Engineering, Chemistry, and Polymer Sciences.

Previous Lilly Teaching Fellows include ten members of the department's faculty.

Department hosts distinguished lecturers

DLS speaker Richard Clarke told students: "For those of you studying computer science, you have continued employment for the rest of the 21st century."

As part of the 2008-2009 Distinguished Lecture Series, the department selected prominent researchers from academia and industry.

Richard Clarke, Chairman of Good Harbor Consulting and key advisor on national security for the last four U.S. Presidents, spoke in April on "The Missing Pieces of the Three 21st Century Wars: Iraq, Afghanistan, and Cyberspace." Clarke was this year's Sidney Topol Distinguished Lecture Series speaker. The Topol Series was established through the generosity of Sidney Topol, UMass Amherst alumnus, class of 1947. Topol is regarded as a telecommunications pioneer who helped forge the cable-satellite connection that triggered the growth of cable television in the United States.

Jack Wolf, Professor of Electrical and Computer Engineering at the University of California, San Diego spoke on "The Amazing Growth of the Storage Capacity of Magnetic Hard Disk Drives" in October. Dr. Wolf, a former faculty member at UMass Amherst, spoke on how times have changed from 25 years ago when a 1 gigabyte hard drive was the size of a washing machine and cost about $100,000 to the advances of the magnetic recording field today.

In November, Lydia E. Kavraki, Noah Harding Professor of Computer Science at Rice University, presented "Robots, Molecules, and Physical Computing." During the talk, she discussed how the experience gained through sampling-based methods in robotics has led to algorithms for characterizing the flexibility of biomolecules for drug discovery.

In April, Eric Horvitz, Principal Researcher and Research Area Manager, Microsoft Research Adaptive Systems & Interaction Group, spoke on "Intelligence, Interaction, and the Open World." His research interests span theoretical and practical challenges in machine reasoning and learning, decision making under uncertainty, human-computer collaboration, and information retrieval.

Joan Feigenbaum, Grace Murray Hopper Professor of Computer Science at Yale University, gave a presentation in May on "Approximation in Privacy Preserving Mechanisms." Her research interests include Internet algorithms, computational complexity, security and privacy, and digital copyright. More recently, she has worked on basic algorithms for massive data sets, particularly those generated in network operations and business-to-consumer e-commerce.

Yahoo! partners with CS faculty to advance cloud computing research

Yahoo! Inc. has expanded its partnerships with four top universities to advance cloud computing research. The University Massachusetts Amherst, with Carnegie Mellon University, University of California at Berkeley and Cornell University, will use Yahoo!'s cloud computing cluster to conduct large-scale systems software research and explore new applications that analyze Internet-scale data sets ranging from voting records to online news sources. Professors David Smith, James Allan, and R. Manmatha will use the Yahoo! Cluster for their project "Mining a Million Scanned Books: Data-Intensive Processing for Better Search, Analysis, and OCR."

Until now, academic researchers have had limited access to Internet-scale supercomputers for conducting systems and applications research. To help overcome this obstacle, Yahoo! is granting these universities access to the Yahoo! cloud computing cluster, also known as M45. The cluster has approximately 4,000 processor-cores and 1.5 petabytes of disks.

Jim Kurose, dean of the College of Natural Sciences and Mathematics, says, "Our vision is to improve upon current technology through the processing of large data sets. Using Yahoo's supercomputing cluster, we will enable data-intensive research using a collection of over a million scanned books gathered by the Internet Archive. This collection includes 8.5 terabytes of text and half a petabyte of scanned images, a data set which we would not be able to undertake without the use of M45."

FU NAMED SLOAN FELLOW – – – *continued from page 2*

on slack time of combinational logic blocks when the clock frequency is lower than necessary for a given supply voltage. "The mismatch between today's hardware abstractions and continuously fluctuating supply voltage leads to inefficient execution—making advanced cryptography and complex computations more difficult to achieve," says Fu.

Fu's research received best paper awards from USENIX Security and the IEEE Symposium on Security and Privacy, and appeared in the *New York Times* and the *Wall Street Journal* among other national and international media exposure.

"I am looking forward to using the Sloan Fellowship to more aggressively carry out my research to improve security and privacy in energy-sensitive problem domains ranging from Internet-enabled pacemakers to contactless credit cards to battery-free computers embedded in critical infrastructure," says Fu.

First Annual Awards Ceremony a success

On Friday evening, May 1, 2009, alums, students, faculty, friends and family filled the Mullins Center Massachusetts Room for the department's First Annual Outstanding Achievement and Advocacy (OAA) Awards Banquet. The event was established to recognize the outstanding accomplishments of students and graduates of the department's degree programs and to acknowledge the support of important friends of the department.

Department Chair Andrew Barto and James Kurose, Dean of the College of Natural Sciences and Mathematics, welcomed the attendees and gave an overview of the department.

Professor Leon J. Osterweil, chair of the OAA awards committee, presented awards to the following 2009 OAA awards recipients:

• Outstanding Achievement in Management: P. Anandan (Ph.D. 1987), Managing Director of Microsoft Research India

• Outstanding Achievement in Technology Development: **Carol A. Broverman** (Ph.D. 1991), Senior Corporate Manager, Enterprise Medication Informatics and Decision Support, Clinical Informatics Research and Development, Partners Healthcare Systems, Inc, Boston, MA

• Outstanding Achievement in Research: **Michael J. Franklin** (B.S. 1983), Professor, Electrical Engineering and Computer Sciences, Computer Science Division, University of California Berkeley, and co-Founder of Truviso, Inc.

• Outstanding Support for the Department: **Joyce L. Plotkin**, President Emerita, Massachusetts Technology Leadership Council

• Outstanding Achievement in Education: **Debra J. Richardson** (Ph.D. 1981), Professor of Informatics and the Ted and Janice Smith Family Foundation Dean of the Donald Bren School of Information and Computer Sciences at the University of California, Irvine

• Outstanding Achievement in Research: **Tuomas Sandholm** (Ph.D. 1996), Professor of Computer Science and Director, Agent-Mediated Electronic Marketplaces Laboratory, Carnegie Mellon University, and Founder of CombineNet, Inc.

• Outstanding Achievement in Entrepreneurship: **Steven Willis** (B.S./BDIC 1978), Founder of Wellfleet Communications and Argon Networks

• Outstanding Contributions to Society: **Bryant W. York** (Ph.D. 1981), Professor, Computer Science Department and Co-Director, Laboratory for Learning and Adaptive Systems, Portland State University

"It was a privilege and a pleasure for the department to have this opportunity to recognize the outstanding achievements of these truly distinguished alums and advocates," says Osterweil. "We wanted to let our entire community know how proud we are of these people and the work that they have done. We look forward to doing this annually."

The award citations and more details on the careers of the OAA awards recipients, along with photos of the event, are posted at www.cs.umass.edu/oaa2009.

During the evening celebration, current students and recent alums were also recognized. The undergraduate and graduate awards were generously sponsored by Yahoo!, a member of the department's Industrial Affiliates Program. Professor Robbie Moll, Department Associate Chair, presented the following Outstanding Undergraduate Awards to students in this year's graduating class:

- Overall Achievement in Computer Science: Michael Krainin
- Achievement in Artificial Intelligence: David Smith
- Achievement in Networking: Justin Aquadro
- Achievement in Software: Patrick Correia
- Achievement in Systems: Matthew Laquidara
- Achievement in Theory: David Maletz

Professor James Allan, Graduate Program Director, presented the following Outstanding Graduate Student Awards for 2008:

- Outstanding Doctoral Dissertation Award: Peter Desnoyers
- Outstanding Doctoral Dissertation Award: Charles Sutton
- Outstanding Synthesis Project Award: Dov Katz
- Outstanding Synthesis Project Award: Marek Petrik
- Outstanding Teaching Assistant Award: Zongfang Lin
- Outstanding Teaching Assistant Award: Philipp Weis

Alums and friends also spent the afternoon of May 1 at a poster session showcasing the research activities of the various laboratories within the department, and at a round-table discussion at which the OAA awards recipients discussed their careers and reflected on their time at UMass Amherst.

Nominations are now being accepted for the 2010 Outstanding Achievement and Advocacy Awards. Nominations should be sent by email to Leeanne Leclerc (leclerc@cs.umass.edu) and should consist of:

- The name, title, email, phone number and organizational affiliation of the nominee,
- The name(s), email(s), phone number(s) of the nominator(s),
- A brief biography summarizing the nominee's career (no more than one page),
- A statement of the nominee's outstanding achievements in the award category,
- A very brief (no more than 25 word) suggested citation to be written on the OAA winner's award plaque.

The department would like to thank all those who participated in these successful events. We look forward to seeing more alums at next year's event.

Faculty News

Professor **Jack Wileden** was appointed Associate Dean for Advising of our College of Natural Sciences and Mathematics.

In June, Professor **Andrew Barto** gave a keynote address at the Multidisciplinary Symposium on Reinforcement Learning in Montreal. He will also give a keynote address at the Conference on Pattern Recognition and Machine Intelligence (PReMI-2009) to be held in Delhi, India in December.

Distinguished University Professor **Bruce Croft** gave a keynote address at the 2009 31st European Conference on Information Retrieval (ECIR) in April. In addition, Croft received a Yahoo! Research Faculty Research Grant for his work on transforming long queries.

Distinguished University Professor Emeritus **Arnold Rosenberg** gave an ACM Distinguished Speaker presentation at Oklahoma State University in April. In addition, he recently completed his textbook, *The Pillars of Computation Theory: State, Encoding, Nondeterminism,* to be published in the Springer Universitext series.

Professor **James Allan** received an IBM Open Collaborative Faculty Award and an IBM UIMA Innovation Faculty Award in recognition of his research achievements.

Assistant Professor **Deepak Ganesan** was named to the Chancellor's new Junior Faculty Fellows Program. Faculty members across schools and colleges will meet with the Chancellor to discuss new campus initiatives, problem solve areas of concern, and serve as a voice for their colleagues on issues of importance to UMass Amherst's junior faculty.

Dispute resolution workshop

Leon Osterweil, Lori Clarke, and Norman Sondheimer of the Computer Science Department, along with Legal Studies Professor Ethan Katsh, organized and hosted a workshop on "Dispute Resolution in a Connected Health Care World" in May in Washington, D.C., upon request by the National Science Foundation and the U.S. Department of Health and Human Services. The workshop was aimed at anticipating the need and opportunities for online dispute resolution as electronic medical records, a high priority of the Obama administration, are implemented more widely. The workshop is part of a multi-year research collaboration between the National Center for Technology and Dispute Resolution and the Electronic Enterprise Institute, both based on campus.

In March, Assistant Professor **Andrew McGregor** was an organizer of the DIMACS/DyDAn Working Group on Streaming, Coding, and Compressive Sensing: Unifying Theory and Common Applications to Sparse Signal/Data Analysis and Processing held at Rutgers University.

Associate Professor **Brian Levine** and Assistant Professor **Gerome Miklau** organized the First Annual Northeast Digital Forensics Exchange Workshop held in New York City in July. The second annual workshop will be held at UMass Amherst in 2010. They are working on the workshops with CS alum Ping Ji (Ph.D. '03) and partners from John Jay College and U. of New Hampshire. Levine and Miklau have received a campus Research Leadership in Action Grant for their workshop.

The Massachusetts Executive Office of Public Safety and Security invited **Levine** to serve as a member of the office's Privacy Working Group (PWG), chaired by State Secretary Kevin Burke.

In other news, **Levine** and his wife Amy welcomed their first child, Elena, to the world on November 16, 2008.

Assistant Professor **Kevin Fu,** working with graduate student Shane Clarke, received Institute for Information Infrastructure Protection (I3P) Scholar Program funding for the project "Research on securing medical cyberinfrastructure." In May, **Fu** and his wife Teresa announced the birth of their first child, Henry.

Assistant Professor **Erik Learned-Miller,** his wife Carol, and big sister Sierra announced the arrival of Emma on January 17.

Adjunct Professor **Kathryn Mckinley** was named an ACM Fellow for contributions to compilers and memory management. McKinley is a Professor of Computer Sciences at the University of Texas at Austin.

The Defense Advanced Research Projects Agency (DARPA) awarded a mathematical challenges grant to Adjunct Professor **Ileana Streinu** for her project "Algorithmic Origami and Biology." In other news, Streinu's recent solution to the *"reach problem,"* a long-standing open problem in robotics, with numerous practical ramifications, was publicly announced at the Discrete Differential Geometry meeting held at the prestigious Oberwolfach Mathematical Research Institute in Germany. Streinu and her Linkage Lab have also organized the Workshop on Geometric constraints with applications in CAD and biology.

Adjunct Professor **Lee Spector** was named Editor-in-Chief of the *Genetic Programming and Evolvable Machines* journal. In addition, Spector is co-PI on a grant to Hampshire College from the Sherman Fairchild foundation for a program integrating innovation in technology, art and design.

Researcher News

In May, **Sebastian Riedel** joined the Information Extraction & Synthesis Laboratory (IESL) as a Postdoctoral Research Associate.

Guilherme Dutra Gonzaga Jaime is a Visiting Scholar with the Networks Lab. He is a Ph.D. student at the Federal University of Rio de Janeiro.

Dongmei Chen, Associate Professor and Director of the Engineering Department at Ningxia University in China, is a Visiting Professor with the Center for Knowledge Communications.

Matteo Leonetti, a Ph.D. student from the Sapienza University of Rome, is a Visiting Scholar with the Autonomous Learning Laboratory.

Andre Schulz joined the Linkage Lab as a Postdoctoral fellow, funded by the German Science Foundation.

Graduate fellowships and awards

Graduate students Jacqueline Kenney and Benjamin Ransford have received 2009 National Science Foundation Graduate Research Fellowships, and Henry Feild received Honorable Mention in the competition. The Graduate Research Fellowship provides three years of support for graduate study leading to research-based master's or doctoral degrees and is intended for students who are in the early stages of their graduate study. The competitive Graduate Research Fellowship Program (GRFP) invests in graduate education for a cadre of diverse individuals who demonstrate their potential to successfully complete graduate degree programs in disciplines relevant to the mission of the National Science Foundation.

In another recent award, Robotics Lab graduate student Scott Kuindersma has been awarded a prestigious NASA Graduate Student Research Program Fellowship for his proposal entitled, "Dexterous Mobility and Manipulation." With this Fellowship, he will receive funding for up to three years while pursuing his Ph.D.

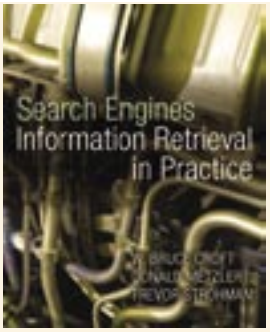
Graduate students Greg Druck and Henry Feild are recipients of 2009-2010 Yahoo! Key Scientific Challenges (KSC) Program Awards. Druck and Feild are two of twenty students honored nationwide with this competitive award created to support a limited number of outstanding Ph.D. students who Yahoo! believes are doing research in very important and challenging areas.

Bo An was chosen for a University Fellowship for 2009-10, one of ten graduate students chosen from the campus.

Computer Science graduate student Marwan (Moe) Mattar was named as one of the seven 2009-10 Isenberg Scholars. In 1994, Mr. Eugene M. Isenberg, alumnus of the UMass Amherst School of Management, and CEO of Nabors Industries, Inc., established these prestigious awards to aid graduate students who demonstrate academic merit and a commitment to the integration of science, engineering, and management.

Incoming graduate student Hee-Tae Jung received this year's Robin Popplestone Fellowship in Robotics & Artificial Intelligence. Jung received his M.S. at Stanford University and his B.S. at Yonsei University in Korea.

Croft publishes information retrieval textbook



Distinguished University Professor Bruce Croft recently published a textbook with Addison-Wesley entitled *Search Engines: Information Retrieval in Practice*. The book is a collaboration of Croft and two UMass Amherst Computer Science Ph.D. alums, Donald Metzler ('07) and Trevor Strohman ('08).

This is the first book on search engines and information retrieval (IR) that is aimed primarily at undergraduates. It is designed to give students the understanding and tools they need to evaluate, compare, and modify search engines. The programming exercises in the book make extensive use of Galago, a Java-based open source search engine developed by Strohman.

Croft received a UMass Amherst Samuel F. Conti Faculty Fellowship Award in 2007-08 and spent a significant amount of that time working on the book. Metzler is a research scientist in the Search and Computational Advertising group at Yahoo! Research, and Strohman is a software engineer in the Google search quality division.

Student News

Graduate student **TJ Brunette** received the Best Poster Award at the 8th Community Wide Experiment on the Critical Assessment of Techniques for Protein Structure Prediction (CASP8).

Daniel Amirault was selected for Honorable Mention in the Computing Research Association's (CRA) Outstanding Undergraduate Award competition for 2009. Amirault was also named a William F. Field Alumni Scholar for 2009.

Gregory Walter, an undergraduate majoring in Computer Science and Mathematics, received the Luise Bronner Scholarship for spring 2009 in recognition of his outstanding performance in academics and research.

Graduate students **Michael Bendersky** and **Michael Wick** each received a Yahoo!-sponsored Award for Accomplishments in Search and Mining.

The first New England Undergraduate Computing Symposium (NEUCS), held at Wellesley College in Wellesley, Massachusetts, brought together nearly 100 students and faculty from the region. Two UMass Amherst CS undergraduates participated in the event. **Matthew Laquidara** presented "OPENPKMN: Lessons learned from an eight-year software project," and **John McDowell** presented "Codename: Vargach – A game."

Graduate students **Jeff Dalton** and **Dubi Katz** were this year's winning team at the Annual CS Foosball Tournament sponsored by Yahoo!.

University of Massachusetts Amherst
Spring / Summer 2009

ALUM Matters

A newsletter for alums of the Department of Computer Science

Franklin's database career spans academia and industry

Michael Franklin (B.S. '83) recalls a time when he would feel obliged to start his Introduction to Database Systems course by explaining that computers had important uses beyond number crunching. "Now, students come to class experienced in using computers for data management, having grown up using them to handle everything from their music and video collections to their interactions with friends. This shift is a result of the pervasive spread of data-intensive applications on the web and mobile devices," says Franklin, Professor of Computer Science at the University of California, Berkeley, and a Founder and CTO of Truviso, Inc., a Silicon Valley developer of data analytics solutions.

In a career spanning academia and industry, Dr. Franklin explores how the core lessons learned from large-scale database systems can be applied across a spectrum of data-intensive applications including: large-scale analytics, pervasive computing, distributed systems and information integration.

Database systems provide two somewhat miraculous features, says Franklin. First, they provide guaranteed correctness and durability of data manipulation operations. Second, through an abstraction principle called "Data Independence", they enable long-lived applications to run efficiently as the underlying data, software, and hardware evolve and as the applications themselves change over time. Unfortunately, for years these benefits were locked inside of complex and cumbersome systems that were expensive to buy and maintain. Franklin's research has been focused on liberating this technology.

An example is the HiFi project. The idea for HiFi came to Franklin while he was attending a meeting of a group tasked with standardizing interfaces for RFID-enabled systems. Group after group described the data structures and API of their layer of the system. "To me, it was clear that each group was presenting their own data model and query language, but each one was different," says Franklin. "This lack of consistency was leading to a complex architecture and a baroque set of standards."

Earlier project developments in the Berkeley Database group included a "streaming" SQL processor (SQL is the standard language for accessing Relational Database Systems) and an SQL interface to dynamic, wireless sensor networks. "It occurred to me that we had already developed most of the technology needed to create an end-to-end distributed SQL-based system that would manage RFID and other sensor data. So the HiFi project was created to build the infrastructure required to put such a system together," adds Franklin. Using SQL to cross all the layers had multiple benefits. First, the system was able to leverage years of database systems technology, rather than having to build it from scratch. Secondly, the Data Independence assumptions underlying SQL made it easy to write applications that were independent of the underlying network topology. Finally, since sensor-rich applications would ultimately have to integrate with other components of enterprise IT infrastructure, speaking SQL was a natural fit since most of the back end systems also speak SQL.

"The main impact of HiFi and its related projects was to get people to think differently about how the key insights of database technology could be exploited in non-traditional environments," says Franklin.

In 2006, Franklin took a leave of absence from his faculty position to start Truviso, Inc., a company he founded with his former Ph.D. student Sailesh Krishnamurthy. "Since database research is aimed at addressing real-world problems, impact is ultimately measured by real utility rather than by paper count," Says Franklin. "The amount of data that companies have to deal with is growing faster than Moore's Law. That means, if you are dealing with data, your computers are effectively getting slower every year," adds Franklin.

"It turns out that Database systems have a fundamental bottleneck. Namely, that you need to first store the data before you can do anything with it," says Franklin. "In a world where all data is on the move, traditional database systems are basically an end-point rather than a part of the dataflow." Truviso addresses this problem through a technique called "Continuous Analytics", and has convinced a number of high-profile traditional database users to switch to this new way of handling their data. "Companies in high-growth

industries are seeing data volume growth of up to10x a year," he adds.

Franklin, who resumed his duties at Berkeley in 2008, credits his entry into the database field to his undergraduate education at UMass Amherst and to a promise he made to his parents to finish his studies on time, even after taking time off. "I spent my Junior year studying abroad at Hebrew University in Jerusalem," says Franklin. "I decided to leave that program early to live on a Kibbutz (a collective farm – I harvested bananas mostly) and backpack around the region and Europe."

In order to graduate on time, Franklin needed to earn credits during winter intersession. He started knocking on faculty doors looking for a project, and Dave Stemple offered him an independent study with the Database lab, given his prior experience in Bruce Croft's database course. "That experience led directly to my first job upon graduation, a database development position at Wang Laboratories, and I have been working in the database field ever since," adds Franklin.

After obtaining a Masters degree, Franklin took a programmer position at MCC, working on large-scale parallel database systems. "The group I joined pioneered many of the techniques that underlie modern data-parallel processing approaches such as Map-Reduce and Massively Parallel Data Warehousing," says Franklin, who then went on to complete his Ph.D. at the University of Wisconsin-Madison, and from there joined academia. He is an ACM Fellow and a recipient of the NSF Career Award and the ACM SIGMOD "Test of Time" Award. At Berkeley, one of Franklin former students was Yanlei Diao, an Assistant Professor in our department.

All in the *Franklin* family

Franklin family of CS alums (l. to r.): David, Sherryl, and Michael

It was definitely a family affair in the 1980s with three Franklin siblings in the CS Department (then COINS) at UMass Amherst. Michael Franklin (B.S. '83), his brother David Franklin (B.S. '87), and his sister Sherryl Franklin Radbil (B.S. '82) are enjoying successful careers in computer science after graduating from the department. Two more people from the next generation of Franklins also came to UMass Amherst.

Michael is a Professor of Computer Science at the University of California, Berkeley (see previous page).

David is the Product Manager and Technical Support Manager for Boston-based Proxy Networks, Inc., a leading provider of software for management and remote control and access. Prior to this position, he was with start-up company Epoch Systems before it was acquired by EMC Corporation, where he remained as Principal Software Engineer for over 15 years.

Sherryl is a software developer in the Test & Measurement group of The MathWorks, makers of MATLAB and Simulink. "My very practical training at UMass Amherst allowed me to really hit the ground running fresh out of college at my first job at a large aerospace company," says Radbil. Her career led her through jobs at a computer manufacturer to ATE (Automated Test Equipment) to her current position.

Two of Sherryl's four children joined their mother's alma mater. They both were accepted in the UMass Amherst Isenberg School of Management as part of Commonwealth College. Leor graduated in 2008, and Tomer will graduate in 2009.

Tuomas Sandholm (Ph.D. '96) was named an ACM Fellow for his contributions to combinatorial auctions and mechanism design.

Brent Heeringa (Ph.D. '06), Assistant Professor of Computer Science at Williams College, was awarded a National Science Foundation grant for his work on "Models and Methods for Information Organization."

Andy Podgurski (Ph.D. '89) received media attention in *Science Daily* for his research on electronic health records. Professors Arnold Rosenberg and Lori Clarke co-chaired his Ph.D. thesis committee.

Virtual Iron Software, Inc. announced that Steve Beckhardt (M.S. '74) was named as a founding member of the company's advisory board. Beckhardt is president of Red Brook Harbor Consulting, a software consulting and design firm. Previously, he was vice president of software engineering at ThingMagic, a company working in the area of RFID and intelligent embedded control systems.

Daniel Barrett (Ph.D. '98) has published *MediaWiki*, his seventh book, with O'Reilly Media, on programming and administering the software engine that powers Wikipedia. Barrett is currently Director of the Learning & Knowledge Management group at VistaPrint (www.vistaprint.com).

EnterpriseDB, a leading enterprise open source database company, announced that Larry Alston (B.S. '85) was named vice president of marketing and product management. Previously, he was the vice president and general manager at IONA. Earlier in his career, Alston was the vice president of products at Pantero. Prior to that, he was corporate officer and executive vice president of product management and marketing at eXcelon.

Mark Smucker (Ph.D. '08) and his wife Amy are pleased to announce the birth of their daughter Vivienne, born on November 8, 2008.

Significant Bits

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