



# Significant

# BITS

Newsletter of the  
DEPARTMENT OF COMPUTER SCIENCE

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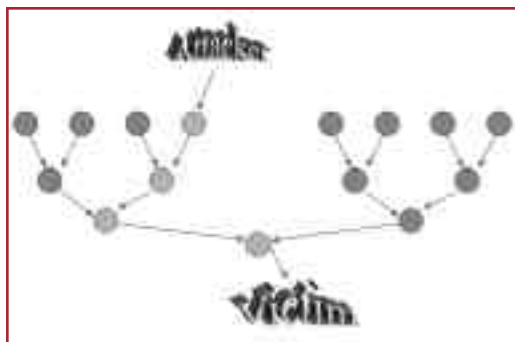
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## Tracking Internet vandals

**I**N THE LAST FEW YEARS, the Internet has experienced an alarming increase in a form of cyber crime known as Denial-of-Service (DoS) attacks. Such an attack consists of a malicious party sending a very large number of random messages to a server. With enough messages, this attack consumes so much of the victim's resources that legitimate users are denied access, or, in the worst cases, the victim's servers become so overwhelmed with traffic that they crash. Unfortunately, such attacks are easy to perform, and a number of well publicized ones have targeted popular Internet sites. Assistant Professor Micah Adler has developed a new technique for determining the source of such an attack that requires only adding a single bit of information to messages sent across the Internet.

"These attacks are a security expert's nightmare: with a relatively small amount of risk and effort, hackers are able to cause a large amount of damage," says Adler. "It is crucial to

**A malicious attacker sends packets along some path in the network to a victim.**



## Adler and Levine receive NSF CAREER awards

**A**SSISTANT PROFESSORS Micah Adler and Brian Levine of the Department of Computer Science have received National Science Foundation (NSF) CAREER awards for FY2002. The Faculty Early Career Development (CAREER) Program offers the NSF's most prestigious awards for new faculty members.

Levine received the award for his proposal "Advances in Peer-to-Peer Applications." He joined the CS faculty in 1999 and is interested in the areas of computer networks, network security, and group communication. "My research for the CAREER award will focus on new applications that are based on the decentralized cooperation of a large

*continued on page 3*

the continued success of the Internet that we develop tools to combat this form of cyber crime."

The Internet's vulnerability to DoS attacks came to the public's attention in early February, 2000. Over a two-day period, such attacks brought down a number of high-profile e-commerce web sites, including Yahoo, EBay, Amazon, and CNN, causing significant financial damage. In addition to the direct damage resulting from users being unable to access these sites for several hours, there was considerable indirect damage that is more difficult to quantify. This included deterioration of user confidence and perceived ease of use. At least one site (Buy.com) was attacked just hours after going public.

While the Internet research community has been aware of this problem for some time, during the last two years an enormous amount of effort has gone into developing techniques that prevent, or at least decrease the impact of, DoS attacks.

*continued on page 4*

## FROM THE CHAIR

By Bruce Croft

**T**HE PAST SEMESTER HAS BEEN A CHALLENGING ONE FOR THE UNIVERSITY. A succession of budget cuts and early retirement programs has made it difficult for departments to plan how to cover courses while maintaining academic excellence and strong research programs. Despite being relatively insulated from the worst of these concerns due to our continued success in attracting research funding (nearly 75% of our budget comes from research funds), the Computer Science Department has also had to consider some of these tradeoffs. Faced with record numbers of highly-qualified applicants for freshman admission (over 1,000), the largest number of applicants for MS/PhD degrees we have ever seen (nearly 1,600), increasing demand for specialized Masters degrees, and severe budgetary pressures, what are the appropriate priorities?

Our answer to that question is the same one that has brought us through previous budget crises and has served us extremely well – concentrate on building and maintaining excellence in the research program, and integrating this research program into a high-quality undergraduate curriculum. We are convinced that a computer science department with a national reputation for research provides the best environment for undergraduate and graduate students, and brings significant benefits to Massachusetts in terms of training the workforce and economic development. When we hire faculty with strong research credentials, they rapidly build up laboratories in exciting new areas of information and communications technology, and attract large amounts of federal and industrial funding. For example, in this issue of *Significant Bits*, we are announcing the award of NSF CAREER grants to Brian Levine and Micah Adler. Most of our junior faculty now have these prestigious awards and are using them as the basis for more collaborations and funding.



Having faculty that do leading-edge research also ensures that the undergraduate curriculum reflects the latest developments in computer science. Our numerous research laboratories offer invaluable experience for many of our undergraduates (about one third of our students work in a research laboratory at some point in their degrees). This means that our undergraduates are equally well prepared for a career in industry or entry to the best graduate programs. A significant percentage of our undergraduates go into the Massachusetts workforce. Over 40% of Computer Science graduates stay in Massachusetts.

We attract outstanding graduate students to the Department, and these students go on to successful careers in academia or industrial research laboratories. Many of them also end up contributing to the Massachusetts economy. For example, three of my most recent Ph.D.s are working in research groups at MITRE and BBN in Boston, and a fourth is an Assistant Professor at Mount Holyoke College.

In response to the current budget problems, we are looking for new ways to perform our teaching mission more effectively and efficiently. For example, we are exploring the use of technology to improve the teaching of courses both on-campus and through distance learning, we have taken a leading role in the CITI initiative to develop new information technology courses (see the article on Jim Kurose and Joe Goldstein on page 5 in this issue), and we are actively pursuing cross-listing of courses with Computer Engineering as an important part of keeping classes to a reasonable size.

Overall, the decision about how to set priorities has been an easy one – keep doing what we have been doing well for 30 years. We will continue to build excellence in the research program and we will continue to find innovative ways of using this excellence to support an outstanding undergraduate program.

## Computer Science ranked by *U.S. News* guide

**T**HE DEPARTMENT OF COMPUTER SCIENCE ranks 25th in the U.S. and 6th in the field of artificial intelligence in the *U.S. News & World Report's* 2003 rankings of "America's Best Graduate Schools" released this spring.

"We are pleased to be recognized for the strength of our programs," said interim Provost

Charlena Seymour. "These rankings indicate the University's national leadership in a wide range of disciplines and represent the advances the University is making and will continue to make. It is a tribute to the continuing high level of performance and quality of our faculty."

The rankings are in the magazine's April 15 issue. The rank-

ings are also available on the magazine's Web site ([www.us-news.com](http://www.us-news.com)).

Dean of the College of Natural Sciences and Mathematics Leon Osterweil said, "This ranking is a tribute to the hard work and dedication of the people in Computer Science, who are succeeding in an intensely competitive environment. American universi-

ties are currently pouring enormous investments into computer science departments, posing increasingly strong challenges. I take great pride in this very strong showing for the UMass Computer Science Department, which is obviously doing very well against very strong and well-funded competition."

NEWS

## Hava Siegelmann joins Computer Science faculty

**H**AVA SIEGELMANN HAS JOINED THE DEPARTMENT of Computer Science as an Associate Professor. She specializes in biologically motivated information processing systems, including neural networks and evolutionary algorithms, and in alternative models of computation (such as analog, distributed, and stochastic dynamics) that are relevant to natural systems. Professor Siegelmann's research involves theoretical aspects, development of novel algorithms, and various industrial and medical applications.

"The Department is very strong in machine learning, information systems, and theoretical computer science," says Siegelmann. "It is one of only a few departments in the nation that has such strengths in these three areas. Given that these three fields are the foundations for biological computation, UMass was the ideal choice for me to continue my career."

This semester, Professor Siegelmann has started a seminar on biological computation and bioinformatics in which she invites colleagues as guest lecturers to explain their work in this area. The seminar, supported by both the CS Department and the NSM Dean, has multidisciplinary interest. The seminar enrolls students and faculty from departments across the campus such as Mathematics, Physics, Biology, Engineering, and Computer Science.

Siegelmann has also authored a book, *Neural Networks and Analog Computation: Beyond the Turing Limit*, that is currently being used in graduate seminars at universities such as Berkeley and Caltech. The book is published by Birkhauser in the series

*Progress in Theoretical Computer Science*. It provides basic foundations explaining the computational power and capabilities of neural networks and analog models.

Professor Siegelmann received her B.A. from the Technion, M.Sc. from Hebrew University, and Ph.D. from Rutgers University – all in Computer Science. She was a 1995-1997 ALON Fellow (Israeli Presidential Young Investigator). Before joining UMass, Siegelmann was on the faculty of Industrial Engineering and Management at the Technion and served as the head of Information Systems Engineering.

Siegelmann has published in a variety of prestigious journals, including *Science*, *Theoretical Computer Science*, and the *Journal of Computer and Systems Science*, *IEEE Transactions on Information Theory*, *IEEE Transactions on Systems Man and Cybernetics*, and *IEEE Transactions on Neural Networks*. She has given numerous invited talks throughout her career. Siegelmann is very active in the research community and has served on many conference committees. In addition, she is working vigorously to advance women in science with a goal of bringing in more women undergraduate and graduate students and new faculty.

Says Siegelmann, "I really enjoy working with my colleagues at UMass. I've found that the people here are very open and interested in biological computation. It is helping to make biological computation a success at the University."



Siegelmann

AWARDS

### Adler and Levine . . . . . continued from page 1

group of devices or users. For example, peer-to-peer content sharing and information retrieval, anonymous routing, multi-player gaming, and secure ad hoc routing," says Levine. Levine graduated from University of California, Santa Cruz with his Master's and Ph.D. in Computer Engineering. He currently heads the Secure Internet and Group-Networking Lab (SIGNL).

Adler's proposal "Algorithms for Efficient Bandwidth Utilization in the Internet" was selected for the CAREER award. Professor Adler's research involves the design and analysis of efficient algorithms, especially for communication networks. He also has broad interests in theoretical computer science as well as parallel and distributed systems. "My current projects include research on algorithmic aspects of network security, algorithmic aspects of the World Wide Web, asymmetric communication channels, mobile and wireless communication, and bandwidth efficient multiprocessor computation," says Adler. See "Tracking Internet vandals" on the cover page for more details on his research. Along with Distinguished Professor Arnold Rosenberg and Associate Professor Ramesh Sitaraman, Adler co-directs the Theoretical Aspects of Parallel and Distributed Systems Lab (TAPADS). He received his Ph.D. from the University of California



Levine



Adler

at Berkeley and joined the Department in 1999.

Adler and Levine were selected on the basis of their creative career development plans that effectively integrate research and education within a context of the mission of UMass. 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.

## Vandals . . . (from page 1)

One of the main difficulties in dealing with DoS attacks is that information can be sent anonymously over the Internet. Messages are sent in bundles of bits called packets, and these packets are sent from their source to their destination along a series of routers. These routers do not store any information about past traffic, and in particular there is no record of the source of a packet. Furthermore, while there are bits in packet headers allocated to a “source address,” there is no authentication of these bits: the sender of a packet can easily place a forged address into these bits (this is called “spoofing”). These aspects of the Internet mean that there is little or no accountability for the source of a DoS attack, and that the process of halting an attack in progress is slow and can require significant resources, including human intervention.

Adler has developed an automated technique for tracing a stream of packets back to its source. The technique uses a single bit in the header of each packet, and requires each router along the path of attack to perform a simple randomized protocol on each packet to determine whether the value of that bit should be a 1 or a 0 when the packet is received by its destination. If the victim receives a large number of packets from the same source (as would occur in a DoS attack), then it is virtually guaranteed to be able to determine the identity of every router along the path of those packets. This means that the victim knows the source of the attack.

Adler’s technique is a variant of an approach known as probabilistic packet marking (PPM), introduced by Savage, Wetherall, Karlin, and Anderson. A number of previous PPM schemes have been proposed,

but these all require a significantly larger number of bits in the header to inform the victim of the source of the attack. For example, the Savage et. al. scheme requires 16 bits. An important concern and focus of recent research on PPM is minimizing the number of header bits required.

“It is surprising that you can get away with only a single bit in the header, and still transmit the entire description of the path to the victim of an attack,” says Adler. “What is perhaps even more surprising is that there is a fairly simple technique that allows you to do so.”

How is it possible to use only a single header bit? The basic idea is that for every packet there is some probability  $p$  that the single header bit received by the victim is a 1 and thus probability  $1-p$  that it is a 0. This can be thought of as a coin that can be flipped, where the probability of a flip coming up heads is  $p$ . The trick is to set up a randomized protocol at the routers, where if the value of  $p$  were written out in binary, the bits in this binary string describe the path taken by that packet. Then, we only need to “flip the coin” many times (i.e., receive many packets), and then based on the number of 1’s we see in these flips, we determine an estimate of  $p$ . If the number of coin flips is large enough, we are quite likely to have a very accurate estimate of  $p$ , and thus a description of the path used by the packets. The interesting portion of the protocol is actually ensuring that the routers cause the correct probability of

the victim receiving a 1.

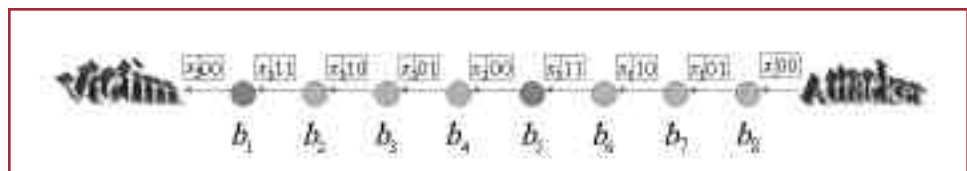
“As efficient as this one-bit scheme sounds, it also has its drawbacks,” explains Adler. “In particular, the number of packets required to reconstruct the path of attack can be quite large: it grows exponentially with the length of this path. Thus, for longer paths, the number of packets required is too large to make this scheme practical.” However, Adler also demonstrates that such an exponential dependence is necessary for any one-bit PPM technique.

This leads us to the question of what we can achieve by using a larger number of bits in the packet header. Adler also provides us with a good understanding of the kinds of tradeoffs we can achieve between the number of bits in the header and the length of the path. In particular, Adler has also designed an algorithm which allows us to smoothly trade off between bits in the header and the number of packets that must be received. With this new algorithm, the number of packets that must be received decreases doubly exponentially as the number of bits in the packet header increases. Thus, there is a big win for each additional bit in the packet header, and a very small number of bits compensates for the exponential dependence on the length of the path. This leads to a protocol that should be quite useful in practice. Adler also demonstrates that the doubly exponential dependence on the number of header bits is the best that could possibly be

achieved by any PPM protocol.

It turns out that the mathematics behind these and related techniques are interesting in their own right. There are still a number of important technological and mathematical obstacles to overcome before we have a complete understanding of these problems. Developing such an understanding lies at the intersection of mathematics and computer science, and is an exciting area of current research. Furthermore, the potential impact on the future of the Internet is quite significant. By finding efficient and reliable techniques for determining the source of a DoS attack, we shall be able to lessen the potential for hackers to cause damage, thereby making the Internet a safer place for legitimate users.

Professor Adler’s research involves the design and analysis of efficient algorithms, especially for communication networks. He also has broad interests in theoretical computer science as well as parallel and distributed systems. Current projects include research on algorithmic aspects of network security, algorithmic aspects of the World Wide Web, asymmetric communication channels, mobile and wireless communication, and bandwidth efficient multiprocessor computation. Adler co-directs the Theoretical Aspects of Parallel and Distributed Systems Lab (TAPADS). He received his Ph.D. from the University of California at Berkeley and joined the UMass Department of Computer Science in 1999.



**Determining the optimal tradeoff between header bits and packets required to reconstruct the path of attack.**

AWARDS

# Kurose honored by Massachusetts Telecommunications Council

PROFESSOR JIM KUROSE AND COLLEGE OF ENGINEERING DEAN JOSEPH GOLDSTEIN received the Massachusetts Workforce Leader of the Year award at the 6th annual Massachusetts Telecommunications Council (MTC) awards ceremony recently. The MTC is a nonprofit association representing more than 300 telecom, Internet, data communications, and affiliated organizations. Kurose and Goldstein received the award for their work on the Commonwealth Information Technology Initiative (CITI), a

Massachusetts Board of Higher Education-sponsored, UMass-led effort to improve and expand computer science and IT programs on the 29 campuses of public higher education in Massachusetts.

The Workforce Development Leader demonstrates leadership in addressing workforce issues and initiatives and has a positive impact on the telecommunications industry by helping to address our workforce needs. Kurose's and Goldstein's continued pursuit of innovative solutions to communications challenges is achieving success in the CITI project.

Launched in October 2000, CITI is a three-year program created in response to several studies and white papers initiated by the Board of Higher Education. These studies, which included both industry and academic perspectives, concluded that a number of public higher education programs in computer and information science and technology must improve in quality, curriculum relevance, faculty development opportunities, and technology infrastructure in order to meet the Commonwealth's work-

force needs. The study called on "the University, especially the UMass Amherst Computer Science program, and other campuses with exemplary programs, to provide leadership to the system..." The result was the CITI proposal – a collaboration among the University campuses, community colleges and state colleges, developed under the leadership of Goldstein and Kurose.

"The CITI initiative is a wonderful example of how the state's institutions of higher education – the University of Massachusetts, the state colleges, and community colleges – can collaborate to help better serve our students, and the Commonwealth's knowledge-based industry," says Kurose. "Working with faculty and administrators from these various institutions was a fabulous experience."

In addition to the MTC award, Professor Kurose recently received an Outstanding Investigator Award from the DARPA Active Networks program. He also presented several Distinguished Lectures over the past few months. He gave the Keynote Address at the IEEE Internet Performance Symposium, and Distinguished Lectures at University of Toronto and Ohio State University.



UMass Professor Jim Kurose (*bottom row, from left*) is shown with other MTC award honorees: Jim Dolce and Kurt Melden, Unisphere Networks; Frank Heart and Bob Metcalfe, hall of fame inductees; and Cheng Wu, Acopia Networks. *Back row, from left*: Dean Joseph Goldstein, UMass; Hiawatha Bray, Boston Globe; Mark Sternman, representing Senator John Kerry; Michael Zak, Charles River Ventures; and Jim Lane, Telica.

## Research open house

The Department will be hosting a research open house in Fall 2002 to showcase the exciting research areas from labs across the Department. Poster sessions and demonstrations are planned for the day-long event. Details are forthcoming on our web site at [www.cs.umass.edu](http://www.cs.umass.edu).

During the open house, a ribbon cutting ceremony will also take place to unveil the new Windows-based Education lab. The Edlab will contain 35 machines and a server donated by Microsoft Corporation. The donation was a result of the efforts of Assistant Professor Prashant Shenoy who submitted the educational proposal for the lab equipment.

Can you identify this person?



See page 11 for the answer.



# ALUM Matters

A newsletter for alumni of the Department of Computer Science

## Using NLP to extract information

With virtually unlimited amounts of information at our fingertips via the World Wide Web, there is an increased need for systems that can efficiently find relevant answers to our questions. This research area has risen to the forefront, partially due to the increased emphasis on developing technology to combat terrorism. University groups like the UMass Center for Intelligent Information Retrieval (CIIR) are leading the way in this language technology research. Associate Professor Ellen Riloff (Ph.D. '94), one of Professor Wendy Lehnert's students, is working on natural language processing (NLP) research at the University of Utah's School of Computing to develop systems for identifying terrorist activity as well as applications for the corporate world.

Professor Riloff has developed information extraction (IE) systems that can recognize news stories about terrorism from a variety of incoming news reports and identify the perpetrators, victims, and physical targets involved in the attack, the date and location of the incident, and the type of weapons used. The extracted information could be automatically added to a database, which would be a central repository of all terrorist information being accumulated from around the world. If the information required immediate attention, the IE system could instantly notify appropriate personnel.

"Natural language processing is essential for this task because there are no magic keywords to identify perpetrators and victims," says Riloff. "The information extraction system must look for sentences containing phrases associated with terrorism, such as 'was bombed,' and ex-

tract information from syntactic positions surrounding the phrase."

The goal of natural language processing research is to endow computers with the ability to understand language. Currently, most text processing software uses superficial techniques such as keyword search to retrieve and process textual information. At Utah's Natural Processing Laboratory, Riloff is developing the next generation of information extraction systems, which will incorporate syntactic and semantic knowledge to understand what a text actually means.

Current systems have problems dealing with ambiguity and synonymy in natural language. Ambiguity is pervasive in language because most common words have several meanings. Synonymy, in which words and phrases have the same general meaning, is a major problem for current software because only the search terms provided by the user are matched against the texts. "Most people are aware of the successful matches found by their system, but are blissfully unaware of how much relevant information their software did not find," says Riloff.

To understand the meaning of a sentence, a computer must have both a syntactic and semantic representation of the text. The main bottleneck in achieving this goal has been a lack of computer knowledge: an NLP

system needs syntactic and semantic information for every word that it might encounter. In the last few years, natural language processing researchers have begun to overcome this knowledge engineering bottleneck by focusing on two things: 1) NLP applications that operate in a specific domain, such as "information extraction" tasks, and 2) the development of techniques that can automatically learn syntactic and semantic knowledge from existing text resources.

Riloff's NLP Laboratory is at the forefront of research on the information extraction problem. Along with the application to combat terrorism, IE technology also has many applications in the corporate world. Riloff and her researchers have created IE systems to extract facts about joint ventures and corporate acquisitions. These systems could be connected to an incoming news feed so that corporate executives can be notified immediately when a new joint venture or acquisition is announced.

Over the last few years, a new research area called empirical natural language processing has emerged, which is essentially a form of text mining. Empirical techniques collect samples of language and identify patterns and associations in the data. Empirical NLP techniques have been stunningly successful, producing substantially better coverage and accuracy than the previous generation of systems.

The NLP group at Utah has been actively engaged in



Riloff

research on bootstrapping methods to acquire semantic information automatically. The idea behind a bootstrapping algorithm is to give the computer a small amount of information that it can use to automatically discover new information (i.e., pull itself up by its own bootstraps). Riloff's group has developed several bootstrapping algorithms that enable the computer to automatically acquire semantic knowledge.

"The field of natural language processing has undergone enormous change in the last ten years, and we are now able to contemplate some scenarios that seemed impossible just a short time ago," says Riloff. One area of growing importance to NLP is question answering. One of NLP's long-term goals is to develop search engines that would allow users to type in specific questions instead of keywords, not the keyword search in disguise that is currently used in some Web sites that allow users to type in questions. While intelligent question answering is probably still a long way off, researchers are beginning to make substantial progress in handling certain types of questions, such as who, where, and when questions.

"We can expect to see natural language processing working its way into more commercial products and opening up new possibilities for intelligent text processing," says Riloff. "The next generation of text analysis software will allow users to manage large text collections more effectively and more efficiently, and with greater confidence that the proverbial needle in the haystack can indeed be found."

Dr. Riloff joined the Computer Science faculty at the University of Utah in 1994. In 1997, she received a National Science Foundation CAREER award for research in building conceptual natural language processing systems for practical applications. More information on Professor Riloff and her research can be found at: [www.cs.utah.edu/~riloff](http://www.cs.utah.edu/~riloff).

## Rubenstein receives NSF CAREER Award

Columbia University Assistant Professor Dan Rubenstein (Ph.D. '2000), of the Electrical Engineering and Computer Science Department, received the National Science Foundation (NSF) CAREER award for his proposal "Flexible, Large-Scale Best-Effort Quality of Service in the Internet."

Rubenstein's research will investigate how to implement a service on top of existing Internet networks that attempts to meet specific needs of applications, such as delay-bounded delivery of data, or coping with limited receiving capabilities of client devices. "This service differs from the traditional approach considered over the past several years that attempts to deploy such a service within the guts of the network," says Rubenstein. "The challenge will be to find ways to scalably coordinate access to these services from the large set of network users that wish to use them."

Professor Rubenstein focuses his research on building protocols that allow large numbers of users to communicate effectively. He is very interested in devising solutions to alleviate problems associated with network flash crowds, a situation where a large number of users suddenly and unexpectedly overwhelm a particular network site with traffic. Such a problem occurred on September 11, when news web sites were overloaded with requests for network traffic.

Says Rubenstein, "One of the nice things about being at Columbia is that it gives me plenty of opportunities to come back and visit UMass. This has allowed me to continue to get advice firsthand from my advisors Jim Kurose and Don Towsley, and from Brian Levine and Micah Adler."



## Alumni Connections

In January 2002, **Wei Zhao** (Ph.D. '86) received "the spirit of technology transition award" from DARPA for his work in the DARPA fault tolerant networking program. In February 2002, two of his graduate students won 2nd place in the ACM International Graduate Research Competition. He currently is an Associate Vice President for Research at Texas A&M University, College Station, TX.

The Department is trying a distance education experiment this semester. In a partnership between The MITRE Corporation and the UMass Center for Intelligent Information Retrieval (CIIR), Assistant Professor **James Allan** is coordinating a new class this semester that is being taught by members of a team of MITRE researchers. The lectures for Statistical Natural Language Processing (CMPSCI 691L) are presented by those researchers, with some course sessions presented by live video feed from MITRE. Supervision of class projects is shared between UMass and MITRE. UMass alums **Jay Ponte** (Ph.D. '98) and **Warren Greiff** (Ph.D. '99) are two of the MITRE lecturers.

The UMass Alumni Association provides a connection between alumni, faculty, friends, and the University. Stay connected by becoming a Member.

**Membership matters.**

800-456-UMASS (8627) [umassalumni.com](http://umassalumni.com)

**Thank you** to all who so generously gave to the Department of Computer Science. For a recent list of who you generous people are, please see the back page of this issue of *Significant Bits*.



Popplestone

## Robin Popplestone retires

**P**ROFESSOR ROBIN POPPLESTONE retired this winter and has returned to Scotland to enjoy his retirement. He joined the Department in 1986 after serving as Reader in Artificial Intelligence at the University of Edinburgh, Scotland.

At UMass, Popplestone became the co-director, along with Associate Professor Rod Grupen, of the Laboratory for Perceptual Robotics. His pioneering work in

robotics and computer language design was recognized when he was selected to be one of the founding fellows of the American Association for Artificial Intelligence (AAAI). Popplestone is credited with a central creative role in the development of the POP11 programming language – a premier language for AI practitioners.

Popplestone's research areas include dexterous manipulation (reaching and grasping), mobile robot navigation, geometric reasoning, assembly planning, visual servoing, and the application of learning theory to robotics.

"We will all miss Robin very much as his retirement plans take him away from us here at UMass," says Professor Grupen. "Robin is a legendary figure in our community; technically, as a personality, and as a sage mentor. He inspired new research topics for budding dissertations literally until the day he departed. We wish him well and hope he will visit often."

## All's well with ALL

**C**OINCIDING WITH THE ARRIVAL OF NEW FACULTY MEMBER SRIDHAR MAHADEVAN in 2001, the Adaptive Networks Laboratory (ANW) was restructured as the Autonomous Learning Laboratory (ALL) with a revised focus. The new name better reflects the most recent developments in this active field of research.

Formed in 1984 by Professor Andy Barto and Richard Sutton (Ph.D. '84), then a Postdoctoral Researcher, ANW focused on learning algorithms, primarily in the form of artificial neural networks. ANW researchers became pioneers in developing what is now known among AI researchers as reinforcement learning.

The Autonomous Learning Laboratory, "the lab formerly known as ANW," is co-directed by Professor Andy Barto and Associate Professor Sridhar Mahadevan. ALL carries out foundational interdisciplinary research on machine learning and computational models of biological learning. Autonomous learning refers to what a self-reliant agent must do to learn from its own experiences. The long-term goals of the laboratory are to develop more capable artificial agents, to improve our understanding of biological learning and its neural basis, and to forge stronger links between studies of learning by computer scientists, engineers, neuroscientists, and psychologists. Areas of interest include robotics, active perception, industrial optimization, cognitive science, and computational neuroscience. More information on the new lab can be found at [www-all.cs.umass.edu](http://www-all.cs.umass.edu).

## Act now to support UMass

Your University is at risk. The budget has been cut twice this year and declining state revenues could further jeopardize UMass. Join alumni, parents, and friends in an all-out effort of support and advocacy. Please act now!

Visit [www.umass.edu/actnow](http://www.umass.edu/actnow) or call 800-772-6155 for more information on how you can get involved. You know that UMass adds value to the Commonwealth and education is the best investment the state can make. Contact your elected officials; make UMass visible in your workplace and in your community. Your voice in support of UMass is critical!

## Who's in the news?

**T**HE DEPARTMENT HAS HAD CONSIDERABLE NATIONAL MEDIA EXPOSURE over the past few months. Research Assistant Professor **David Jensen**, director of the Knowledge Discovery Laboratory, was quoted in three news stories recently, including a story about data mining on *National Public Radio* with Joe Palca. Jensen was also quoted in Larry Rivais' column in the *Springfield Union-News* and featured in a *U.S. News & World Report* article by James M. Pethokoukis about technology that could be used to scan databases for potential terrorist activity. Jensen also participated in a data mining and counter-terrorism meeting at the White House Conference Center.

A *Business Week* article by Stephen H. Wildstrom featured Assistant Professor **Micah Adler's** research on tracing the source of Internet denial-of-service (DoS) attacks that can shut down web sites with excessive traffic. This research was also covered in the *Springfield Union-News*, *Greenfield Recorder*, and *NewsFactor Network* ([sci.newsfactor.com](http://sci.newsfactor.com), an Internet news site).

Research Associate Professor **Beverly Woolf** was highlighted in the *Boston Sunday Globe* article "When the tutors and computers are inseparable." The article detailed Woolf's work on intelligent multimedia tutoring systems. Woolf is the director of the Center for Computer-Based Instructional Technology (CCBIT) and the Center for Knowledge Communication (CKC).

**David Hart**, Executive Director of CCBIT/CKC, also appeared on a local television program, *Real to Reel*, to discuss the Deerfield History Project. In a pre-Thanksgiving segment on colonial New England, he described the *American Centuries: View from New England* project's pedagogical goals and the innovative technologies CCBIT employed.

Finally, Center for Intelligent Information Retrieval graduate student **Victor Lavrenko** was interviewed by Bill Alpert for a *Barron's* article that described Lavrenko's topic detection research and a system called AAnalyst. An electronic analyst of financial markets, AAnalyst was developed by graduate students Lavrenko, Dawn Lawrie, and Matt Schmill, and then-undergraduate Paul Ogilvie to predict stock market changes. AAnalyst was initially a class project for the Information Mining course (CMPSI 791M) taught by Professors James Allan and David Jensen. The students received an "A" on the project.



## CENTERS

# It's all Greek to CCBIT

*Use of CCBIT instructional technology expands*

THE CENTER FOR COMPUTER-BASED INSTRUCTIONAL TECHNOLOGY (CCBIT) has worked closely in the last year with the UMass Art History Department to improve the delivery and effectiveness of a series of multimedia curriculum modules for Art History survey classes. Art History Professor Laetitia La Follette developed the modules as an interactive complement to large lecture classes, where limited resources make grading homework impractical and students seldom read the textbook except before exams. One of her modules is entitled “*Sacred Space: The Greek Temple*,” and uses slides and text to present an overview of temple architecture and the role of the temple in Greek life.

The original modules lacked the interactivity that students expected in an online activity, according to Dr. La Follette. They were modeled after the traditional Art History lecture, an erudite presentation accompanied by a slide show in a darkened auditorium. In addition, the originals were created in a format that was difficult for students to access, so that many gave up rather than complete the activities. Evaluation of their use showed no difference in students’ learning between the group that used these modules versus a control group who did not. In the summer of 2001, La Follette worked with CCBIT instructional designers to tackle these problems.

First, the modules were embedded in CCBIT’s Online Web-based Learning (OWL) system so that students could easily access them from the Web around the clock. In addition to providing convenient access, OWL

has the advantage of storing a record of student activity – something that wasn’t possible with the original modules. Second, a series of engaging interactive activities were created for each module under the direction of CCBIT Multimedia Director Matthew Mattingly. Developed using Macromedia’s Flash, these activities challenged students to work with the online material as they learned it, testing their knowledge and stimulating critical thinking as they went through each module. For example, a series of activities were added to the Greek temple module that allowed students to visually quiz themselves on the architectural components of a temple, pointing and clicking to identify target correct answers. A more sophisticated exercise engages students in the process of interactively assembling a temple from a set of components such as pedestals, columns, and cornices – with the goal of selecting components from only one of several contemporary styles (e.g. Doric, Ionian). Once the selection process is complete, the system constructs and displays a 3-D version of the new temple and tells the student whether it is stylistically consistent.

Evaluation of these enhanced modules during the fall of 2001 showed overwhelming enthusiasm from students, many reporting that it was the most engaging series of homework assignments they had ever experienced. “Why can’t all homework be this way?” several students responded. In addition, students who used the enhanced modules in the fall of 2001 performed 50% better on an exam essay specifically covering these

modules than students from the fall of 2000 who used the original modules – strong evidence of their effectiveness.

In another use of the OWL system, Brooks/Cole Publishers (formerly Harcourt, Inc.) is completing a successful pilot study of OWL for Chemistry this spring. Developed by CCBIT in collaboration with Chemistry and Physics instructors, OWL is already used by over 12,000 UMass students annually. Brooks/Cole has licensed the Chemistry version of OWL for use with its popular General Chemistry textbook line. Over 5000 students at two dozen colleges and universities used Brooks/Cole’s OWL during the past year. This figure is expected to increase significantly next year as Brooks/Cole markets it more widely.

In other CCBIT news, the

Center has just been awarded three new grants for research into the use of technology in education. Research Associate Professor Beverly Woolf is the Principal Investigator on a three-year award from the U.S. Department of Education Fund for the Improvement of Post-secondary Education (FIPSE) to study the development of inquiry-based learning systems modeled after a pedagogy for teaching science pioneered at Hampshire College. Several Hampshire faculty members are co-investigators. Woolf and Carole Beal (Psychology) are PIs on a new three-year award from NSF to continue developing math tutoring programs designed to encourage girls to pursue careers in math and science. In addition, Woolf and David Hart are co-PIs with Associate Professor Robbie Moll on a new award from NSF to incorporate use of the OWL system into the Department’s Java programming and data structures classes.

## Deerfield history site receives recognition

A NEW WEB RESOURCE DEVELOPED BY CCBIT in collaboration with the Pocumtuck Valley Memorial Association (Deerfield, MA) and the Frontier Regional/Union 38 Schools, *American Centuries: View from New England*, was officially released in November and has gained recognition from well-known review services. Since its release, the Deerfield History Web site has been highlighted by *ResearchBuzz* and the *Scout Report*, and was also chosen as *Family Tree Magazine’s* Site of the Day for February 9th. The *ResearchBuzz* reviewer said, “I really like the way this exhibit manages to make a whole lot of information available in enough layers to make presentation enlightening instead of overwhelming. And of course the My Collection feature is just cool. Nicely done. Take a look.” The Deerfield History site combines a digital museum collection, an online exhibit, teacher-created curriculum activities and interactive children’s activities to provide an online archive of New England history. Visit the site at [www.americancenturies.mass.edu/](http://www.americancenturies.mass.edu/).

# Asynchronous learning with CD-MANIC

**L**EDBY PROFESSORS RICK ADRION AND JIM KUROSE, the Research in Presentation Production for Learning Electronically (RIPPLES) project is investigating how to most effectively use the World Wide Web and CD/DVD-ROM to deliver lectures and course materials outside of the classroom. Its focus is on asynchronous learning environments in which students proceed at their own pace and are not assumed to be accessing the same material at the same time. Students can access lectures as digital audio or video, synchronized with slides, overheads, or other materials. However, it is not always convenient or feasible to deliver streaming media over the Web. RIPPLES seeks to be as adaptable and as universally applicable as possible, and has therefore developed CD-MANIC, a version of the Multimedia Asynchronous Networked Individualized Courseware (MANIC) engine that can run from a CD-ROM.

The CD-MANIC system uses the same audio and HTML source files as the Web version. The student accesses these files via a special browser, included on the disk, that handles the audio synchronization and visual display. The browser can provide feedback and student tracking information to the instructor. The CD-MANIC software resides on the student's local computer, but also takes advantage of many Internet resources. These include sending updates of course materials from a remote server to the student's computer, anonymously logging user navigation and usage data, and providing Web links embedded in the instructor's slides, such as class home page, chat room, or threaded discussion forum. Other features include a navigable slide index and a function to search across all slide text included on the CD. The CD-MANIC version of one course, "Computer Networking" taught by Professor Kurose, also includes the entire course textbook on the CD. Upon playback, the textbook material is synchronized with the rest of the course content and is fully searchable and randomly accessible using a clickable table of contents.

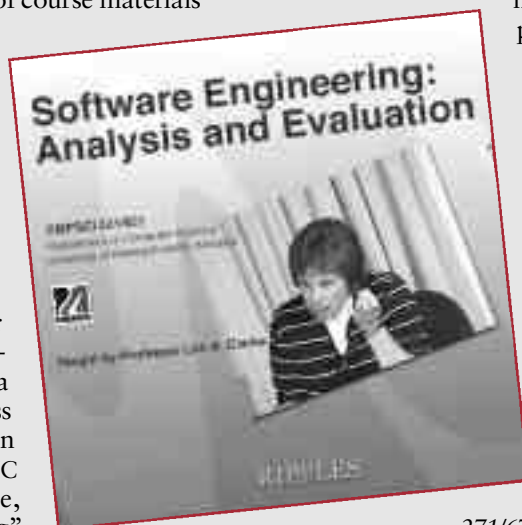
A typical semester-long course is delivered as a 5-CD box set or as 1 DVD. The first course to be delivered using CD-

MANIC was Kurose's "Computer Networking." Its first trial was in Summer 2001 with off-campus students through the UMass Video Instructional Program. Subsequently, "Computer Networking" was offered using CD-MANIC on the five campuses of North Carolina State University as well as at Polytechnic University in Westchester, New York. Judging from a student survey completed at the end of the course, student response has been overwhelmingly positive.

In collaboration with Associate Professor Wayne Burleson of the Electrical and Computer Engineering (ECE) Department this past fall, the RIPPLES team has developed five full

courses using CD-MANIC. The RIPPLES team is currently tracking log data from the courses to study how usage of this technology varies across diverse student groups, how the effectiveness of this delivery mechanism can be improved, and how this technology impacts student learning.

Full Computer Science courses currently available using CD-MANIC include Professor Kurose's previously mentioned "Computer Networking" (CMPSCI 553), and Professor Lori Clarke's "Software Engineering: Analysis and Evaluation" (CMPSCI 521/621). In addition, the following ECE full courses are available: Associate Professor Dennis Goeckel's "Communication Systems I" (ECE 566), Associate Professor C. Andras Moritz' "Parallel Computer Architecture" (ECE 669), Assistant Professor Russell Tessier's "Reconfigurable Computing" (ECE 697C), and Professor Wayne Burleson's "VLSI Design Principles" (ECE 658). Other available courses include "Multimedia Architecture" taught by Professor C. Mani Krishna, "Multimedia Systems - Excerpts from ECE 197H" by Burleson, and "Video Supplement to Entomology 271/671" by John Stoffolano, Professor of Entomology. More information about CD-MANIC and the RIPPLES Project can be found at <http://ripples.cs.umass.edu>.



## Faculty News

Distinguished Professor **Donald Towsley** has been selected to be an Associate Editor of the Journal of the ACM in the area of networking. In addition, he was elected as Chair of the International Federation of Information Processing (IFIP) Working Group 7.3 on Computer System Modeling. The Working Group is the premiere international group concerned with problems dealing with the performance of computing and communication systems. Along with Assistant Professor **Brian Levine**, Professor Towsley is a guest co-editor of the special issue on Network Support for Multicast Communications of the *IEEE Journal on Selected Areas in Communications* (J-SAC). ■ Associate Professor **Shlomo Zilberstein** was elected to the Editorial Board of the *Journal of Artificial Intelligence Research* (JAIR). ■ Assistant Professor **Brian Levine** will serve as co-chair of the Fourth International Workshop on Networked Group Communication to be held in Boston in October 2002. Professor Levine is also a guest co-editor of a special issue of the *Computer Communications* journal on network security. ■ Professor **Jim Kurose** will chair a one-day ACM-sponsored workshop in August on Computer Networking: Curriculum Designs and Educational Challenges. ■ Distinguished Professor **Bruce Croft** gave the keynote address “The Future of Web Search” at the Australian Computer Science Conference on January 29 in Melbourne, Australia. ■ Associate Professor **Sridhar Mahadevan** is an area chair for the International Conference on Machine Learning (ICML 2002) to be held in Sydney, Australia in July. He has also been invited to be a keynote speaker at the Symposium for Abstraction and Reformulation (SARA 2002) to be held in Alberta, Canada in August. ■ Recently, Professor **Andy Barto**

was an invited speakers at the NSF Workshop on Reinforcement Learning and Dynamic Programming in Cancun, Mexico. ■ The book *Topic Detection and Tracking: Event-based Information*, edited by Assistant Professor **James Allan**, was recently released by Kluwer Academic Publishers, Boston. ■ Co-authors **Matthew Wright**, Assistant Professor **Micah Adler**, Assistant Professor **Brian N. Levine**, and Clay Shields (Georgetown University) received the Outstanding Paper Award at the 2002 Network and Distributed System Security Symposium (NDSS) for their paper “An Analysis of the Degradation of Anonymous Protocols.” ■ During the last 15 years, over a million people have learned to program through the use of textbooks written by co-authors Associate Professor **Chip Weems** and University of Texas at Austin Professor **Nell Dale**. Recently, Dale was presented with the ACM Karl V. Karlstrom Outstanding Educator award for her series of textbooks and her work on educational programs at the University of Texas at Austin. ■ Professor **Lori Clarke** is this year's recipient of the annual ACM Special Interest Group on Software Engineering (SIGSOFT) Distinguished Service Award for her years of dedication to the software engineering community.

## Research News

The Multi-Agent Systems Laboratory (MAS) welcomed **Claudia Goldman-Shenhar** as a Senior Postdoctoral Research Associate. ■ **Yong Liu** joined the Computer Networks Research Laboratory as a Senior Postdoctoral Research Associate.

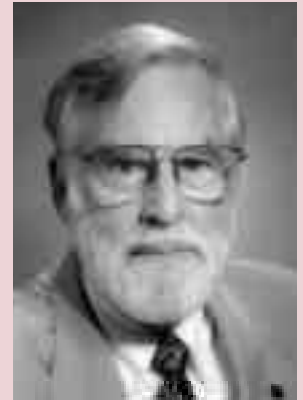
## Student News

Graduate student **Max Horstmann**, a member of Associate Professor Shlomo Zilberstein's Resource-Bounded Reasoning Laboratory, has been accepted into the highly competitive

## Who was that?

(from page 5)

It's none other than our own Professor Emeritus Robert Graham, in a photo taken at a NATO Software Engineering Conference in Germany in October 1968. In the Fall 2001 *Significant Bits*, Professor Graham was regrettably omitted from the list of ACM Fellows. Graham was named an ACM Fellow in 1996 (just a “few” years after the NATO photo).



Graham, recently

NASA Ames/RIACS Summer Student Research Program for the summer of 2002. Hortsman follows another member of Professor Zilberstein's lab, **Daniel Bernstein**, who participated in the program in the summer of 2000. ■ Undergraduate **Thomas S. Armstrong** is one of the recipients of the UMass Senior Leadership Awards for his great work on the *Turns of the Centuries* project and his all around initiative and good cheer. Armstrong worked with the Center for Computer-Based Instructional Technology (CCBIT) on the project. ■ The Center for Intelligent Information Retrieval's (CIIR) summer 2001 Research Experience for Undergraduate (REU) students, **Shaun Kane**, **Andrew Lehman**, and **Elizabeth Partridge**, received the third place award in the final round of the ACM International Student Research poster competition for their research submission “Word Spotting of George Washington's Handwritten Documents.” **Michael Branstein**, **Ryan Coleman**, and **Matthew King** also participated in the poster contest with their entry “QuASM: Question Answering using Semi-Structured Metadata.” Held during the 33rd SIGCSE Technical Symposium on Computer Science Education, the Student Research Competition accepted

fifteen undergraduate student posters from entries across the country to present at the conference. ■ The paper “Relevance Models for Topic Detection and Tracking,” authored by CIIR REU students **Edward De Guzman**, **Daniel LaFlamme**, **Veera Pollard**, and **Steve Thomas** with graduate student **Victor Lavrenko** and Assistant Professor **James Allan**, appeared in the Proceedings of the Human Language Technologies Conference held in San Diego, California in March. ■ An REU-authored paper will appear in the Proceedings of the Joint Conference on Digital Libraries (JCDL 2002) in Portland, Oregon in July. “QuASM: A System for Question Answering Using Semi-Structured Data” was written by CIIR researcher **David Pinto**, REU students **Michael Branstein**, **Ryan Coleman**, and **Matthew King**, graduate students **Wei Li** and **Xing Wei**, and Professor **Bruce Croft**.

## Staff News

The Department welcomed **Laura Bishop** as the Undergraduate Program Manager. ■ **Ramana de Graaf** joined the Experimental Knowledge Systems Laboratory (EKSL) and the Knowledge Discovery Laboratory (KDL) as their Clerical Assistant.



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### GIFTS

## Thanks for your support

THE FOLLOWING ALUMNI AND FRIENDS have actively supported the Department of Computer Science from October 2001 through March 2002. 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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