

Hemaspaandra Makes Complexity a Shield Against Election Manipulation



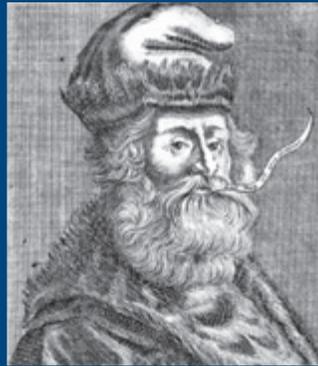
Lane A. Hemaspaandra

From Monday morning through Friday noon, Professor Lane A. Hemaspaandra and his collaborators use complexity theory to protect voting systems from bribery, manipulation, and control. But on Friday afternoons they go over to the dark side, putting their protections to the test by using such algorithmic techniques as network flows and tractable-case integer programming

to attack those same voting systems.

These days elections---aggregations of preferences over alternatives/candidates to choose a winner---happen not just among people but also in a wide range of electronic settings, sometimes with thousands of voters and candidates. The need for protection from manipulation has never been greater. Yet classic results from economics show that protection is impossible: Every reasonable voting system sometimes rewards manipulative voting. Happily, computer science can give hope where the dismal science counsels but despair. Lane's team protects elections by making manipulation be so computationally costly that the election will be decades past before the attackers can compute how to effectively attack it.

Among the team's advances, which have appeared in such top international forums as AAAI, ICALP, IJCAI, AI, and JACM, are pinpointing the complexity of Lewis Carroll's 1876 election system (see highlight box); completely characterizing which voting systems, among the most important election system family, make manipulation computationally infeasible; finding apportionments of the U.S. House of Representatives that are provably fairer, for every



Way-old voting system proved way-cool!

Control of elections refers to an agent trying to improve the outcome by adding/deleting/partitioning voters or candidates. Control models such real-world events as gerrymandering, vote suppression, and get-out-the-vote drives. There are ten standard types of control. No system was known that to be computationally resistant to all ten of these control-attack types. Then in IJCAI-07, in joint work with Edith Hemaspaandra and Jörg Rothe, Lane built an artificial election system that they proved resistant to all ten control attacks. However, it remained open whether any natural system might resist the attacks.

The same three authors, working jointly with Lane's graduate student Piotr Faliszewski, then resolved that. To do so, they had to look quite far... into the past. They proved that a lovely election system developed in the thirteenth century by the Catalan troubadour and mystic Ramon Llull (see photo above left) resists all ten control attacks. That election system, and a more modern variant of the system, are the only preference-based systems currently known to resist all ten attacks.

Chair's content

Table of Contents:

census in history, than those of the “geometric mean” method currently set by law; and constructing the first election system that makes every standard control attack computationally infeasible (see highlight box).

Lane’s computational social choice team is internationally and locally collaborative, with current grant collaborations with professors from eight countries and with student participation that has been at every level from high school to postdoctoral. The team’s student members have gone on to professorships in three countries. Lane, whose degrees are from Yale, Stanford, and Cornell and who was a Presidential Young Investigator, recently was selected for the Humboldt Foundation’s prestigious Friedrich Wilhelm Bessel Research Award for his work in complexity and computational social choice, and in 2007 was named a Distinguished Scientist of the ACM.

Voting Through the Looking Glass

The famous author Lewis Carroll was a mathematics professor at Oxford and a very important contributor to the theory of elections. In 1876, Carroll proposed an election system based on choosing which candidate was closest to beating each other candidate in head-on-head beauty contests.

Unfortunately, although his system is mathematically beautiful, it turns out to be computationally disastrous. To merely tell who wins a Lewis Carroll election is NP-hard, and indeed, as shown by Edith Hemaspaandra, Lane, and Jörg Rothe in a 1997 *Journal of the ACM* paper, it is the hardest problem solvable via parallelized access to NP.

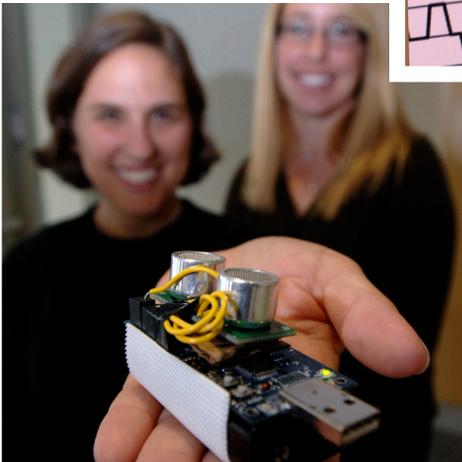
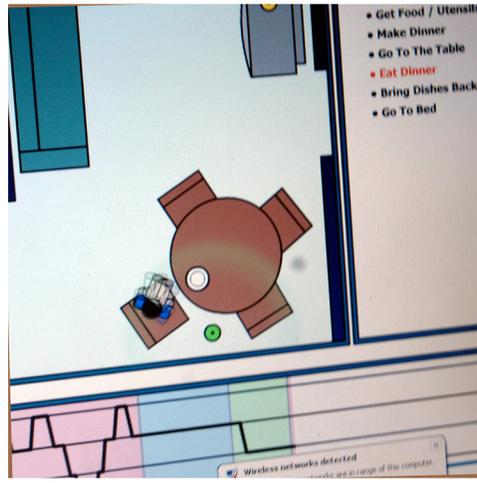
So this voting system clearly is of hopelessly high computational complexity. Or is it? In 1999, four talented URCS students in Lane’s CSC200 course, Daniel Berlin, Greg Goldstein, Kirill Osipov, and Nick Rutar, experimentally found that greedy attacks often clearly pinpointed the Lewis Carroll winner. Christopher Homan---who started this project while Lane’s graduate student and finished it as an RIT faculty member---and Lane eventually found a rigorous mathematical proof of this behavior. They did so by analyzing a stupider, weaker algorithm than that of the students, as the stupidity of the algorithm made it easier to analyze. They proved that when the number of voters exceeds the number of candidates more than quadratically and preferences are uniform, even the stupider, weaker algorithm succeeds all but an inverse-exponential portion of the time. This work will appear in the *Journal of Heuristics*.

UR Hosts Workshop on Intelligent Systems for Assisted Cognition

The University of Rochester and Microsoft Research (MSR) jointly sponsored the first Workshop on Intelligent Systems for Assisted Cognition, held at UR in October 2007. Assisted Cognition is an emerging field of research with the goal of developing new computer based technology to support independent living by persons with cognitive impairment due to aging or disease. More than 85 researchers in computer science, assistive technology, and healthcare gathered to hear 25 talks and 40 posters. A sample of the topics covered includes:

- Monitoring activities of daily living using RFID and other sensors
- Systems to support way finding and use of public transit
- Pervasive computing in smart homes
- Automated prompting and reminding systems
- Using the MSR SenseCam in therapy for memory loss
- Computing technologies for diagnosis and support of children with autism

The workshop was chaired by Prof. Henry Kautz of the UR Department of Computer Science. Keynote talks were by Michael Tanenhaus (UR Brain and Cognitive Science), Matthai Philipose (Intel Research), and Emma Berry and Georgina Brown (Microsoft Research, Cambridge, UK). Microsoft Research provided generous support for the workshop, and workshop participants were invited to compete for six \$50,000 research grants in a special Microsoft Research call for proposals.



Photos: Office of Communications/ University of Rochester

Deriving General World Knowledge

Len Schubert and his students are attempting to ease the infamous “knowledge acquisition bottleneck” in artificial intelligence. General language understanding and “common-sense” reasoning by computers is expected to require tens or hundreds of millions of items of general and specific factual knowledge, such as that many people drink coffee for breakfast, buildings have walls and roofs and can be entered, injuries are painful, and so on. Schubert’s research group seeks to accumulate large amounts of such knowledge by linguistically and semantically processing large bodies of text, including fiction. (Realistic fiction, more than newspaper reports or other nonfiction sources, tends to reveal the mundane facts of life).

The current knowledge extraction system, called KNEXT, begins by analyzing sentential structure using state-of-the-art parsers, and then transforms the analyzed sentences into meaning representations, at the same time attempting to abstract small, self-contained items of general knowledge. For example, from the sentence

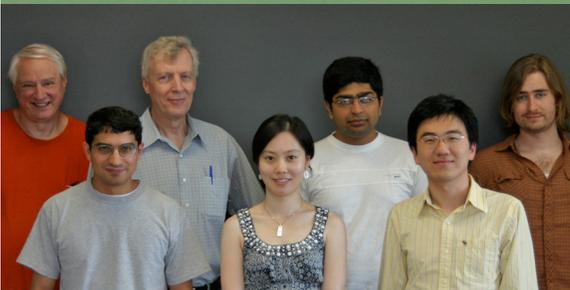
“The old man drank his coffee slowly”

(from Hemingway’s *The Old Man and the Sea*), KNEXT extracts three knowledge items expressed in a formal logical representation, and then provides English verbalizations of these items, as follows:

A MAN MAY DRINK A COFFEE.

A MAN CAN BE OLD.

A MALE-INDIVIDUAL MAY HAVE A COFFEE.



Schubert’s KNEXT group: Front L-R: Fabrizio Morbini, Daphne Liu, Tian Qian; Back: Greg Carlson, Len Schubert, Alok Kothari, Benjamin Van Durme.

Recently KNEXT has been applied to a mixed-genre corpus of 100 million words, called the British National Corpus, deriving some 6 million knowledge items like those above (though because of parsing errors, many of the outputs are flawed in one way or another). Several million additional results of this type were obtained from 3 million miscellaneous sentences found on the web. A great deal of the group’s recent research, much of it led by doctoral student Benjamin Van Durme and abetted by undergraduate interns, has been devoted to methods of refining and filtering this knowledge. Note,

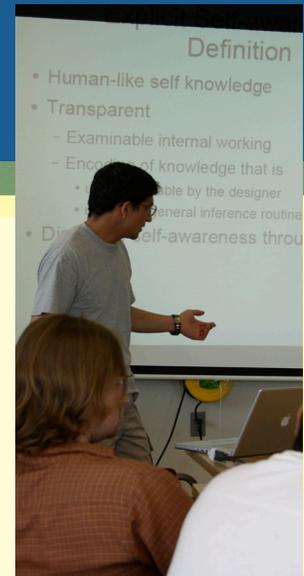
from Online Texts

Building a Self-aware, Self-motivated Dialog Agent

One of the most exciting future applications for a large body of general knowledge is in self-aware, self-motivated agents capable of conversing and common-sense reasoning.

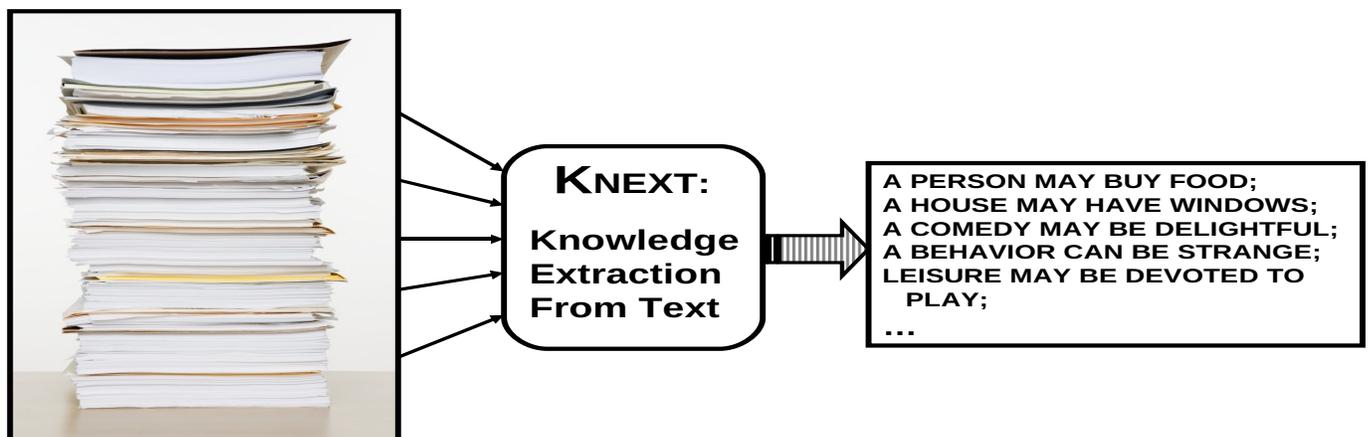
Len Schubert has defined a notion of “explicit self-awareness” suitable for such agents, and he and his students are endeavoring to implement this notion in a working system. A self-aware agent knows the scope and limitations of its own knowledge, its own “biography” and current situation, its own preferences and intentions (e.g., to acquire knowledge, or to help a user accomplish a goal), and it can foresee to some extent the consequences of its potential actions, and plan accordingly.

One doctoral student, Fabrizio Morbini, is currently revamping a highly expressive knowledge representation and reasoning system called EPILOG as the “brains” of such a self-aware system, and another, Daphne Liu, is building action operators and extending the planning capability of a simple simulated character in a “Gridworld” that is also being equipped with simple dialogue capabilities.



for example, that “having a coffee” is ambiguous, as it could in principle mean owning it (as in “having a car”), not only consuming it.

Eventually such knowledge in combination with other technologies will be useful in AI systems that can converse intelligently and “know their way around the world”, and as such can assist people in various ways. For example they will assist by helping to accomplish useful online tasks through dialogue, or enlivening computer games, monitoring news, or providing help in problematic situations in the home (e.g., health emergencies).



Galen C. Hunt

Featured Graduate Alumnus

Altman, Art (M.S. '87) - "My work is at the intersection of algorithms, software design, financial derivatives valuation and risk assessment, and energy markets. I manage research and development in energy derivative valuation and risk management for the Electric Power Research Institute in Palo Alto, California."

Balasubramonian, Rajeev (Ph.D. '03) - Shurik Neel Rajeev was born March 30th 2008, weighing in at 7 lbs 3 oz. Amazingly, dad has not yet shoved a golf club in his hands (yet)!

Bhotika, Rahul (Ph.D. '03) - "Anshika, my wife, gave birth to our first child (a boy), Nikunj Arav Bhotika, on March 1st, 2008. Also, a team that I led at GE Research on detecting precancerous lesions in CT scans won the "2007 Dushman Award" (an internal GE award) for the best research commercialized by GE and sold as a product."

Carceroni, Rodrigo (Ph.D. '01) - "I'm working at Google and living with my wife and 2 daughters in Mountain View, CA."

Goswami, Aditi (M.S. '07) - "I have been working with Yahoo! Sunnyvale since November 2007 as software systems development engineer."

He, Bijun (M.S. '04)- "I am still working in Google but have moved to Cambridge office. In my new project, my manager is Leonidas I. Kontothanasis, Michael's PhD who graduated in 1996! When I worked in NYC and Mountain View, I also met Robert J. Stets and Corinna Cortes. Since last year, Ming Zhong, Shan He, and Hao Zhang have joined Google. It is such a source of pride to see URCS alumni growing."

Ioannidis, Sotiris (M.S. '98) - Is an

associate researcher for FORTH-ICS.

McCallum, Andrew (Ph.D. '96) - "I'm the program chair of the 25th International Conference on Machine Learning (ICML-2008), taking place in Helsinki, Finland. After this I'll really be ready for my sabbatical, perhaps at XRCE in Grenoble, France, (where Rochester's own Aaron Kaplan is also)!"

Mitchell, April Slayden (M.S. '02) - is continuing her work in user experience research and design at Hewlett-Packard Labs where she was recently promoted to Senior Research Engineer. She and her husband Jeff are expecting their first child, a baby girl due this November.

Quiroz, Cesar (Ph.D. '91) - "I have joined Intel as a Principal Engineer. I will be working on server processors architecture, starting with a focus on modeling methodology."

Smith, Ed (Ph.D. '82)- "This last spring I was accepted into the MFA in Film Production program at the School of Film and Television at Loyola Marymount University in Los Angeles. I now live in LA near Santa Monica and will be starting school in the Fall. I'm getting tan."

Tao, Yiyang (M.S. '99) - "I graduated from Harvard Business School in June and will start working at Merrill Lynch in Hong Kong in September."

Vallino, Jim (Ph.D. '98) - Jim reports that he has been promoted to Professor in the Department of Software Engineering at RIT.

Zhang, John (Zheng) (M.S. '97) - "I have left Xerox to join Corning Inc. as Director, Corporate Business Development for Asia."

UR CSC Students “GOT GAME”

by T. F. Pawlicki

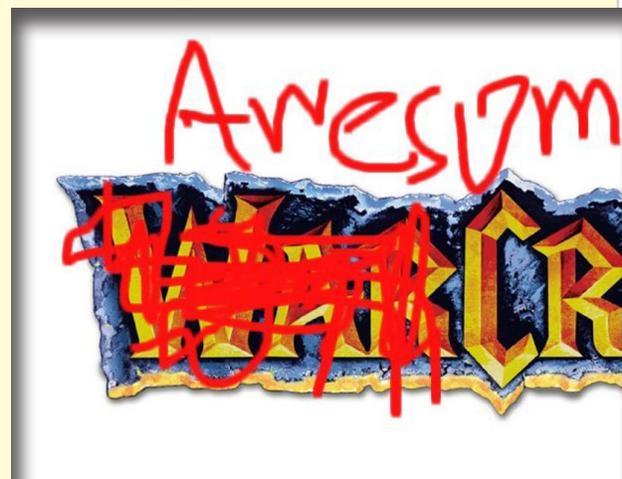
Video game development is an inherently multi-disciplinary activity where artistic, economic, musical, literary, historical, psychological and cultural topics meet cutting edge computer science technology to yield a sublime and ephemeral end-user experience commonly known as “fun”. Entertainment computing has always been a part of Computer Science. Since the early versions of “Spacewar!” in 1961, computer games have grown to become a \$40 billion/year industry – rivaling Hollywood in terms of societal significance and cultural impact. In recent years, video game design and development has become a popular subject of investigation for Computer Science students at the University of Rochester. Classic games like “Conway’s Life”, “Mastermind” and “Breakout” are often featured as term projects in the department’s introductory programming courses. The publicly available “Quake III” game engine is used as a virtual

test bed for projects in the artificial intelligence course.

Many CSC majors choose to enhance these experiences by

“What I learned about game design at Rochester was largely trumped by what I learned about working in a team environment. Anyone can learn to write a game (or any piece of software) by themselves - it gets a whole lot harder when multiple people are involved. I learned about working out dependencies, scheduling conflicts, and differing opinions. The work I did on AwesomeCraft and BloodWraith, my two independent study game courses, was likely the unique experience I needed to land a job at Microsoft. Microsoft’s interview questions were centered around design and teamwork, and those games gave me more than enough experience with both to sail through my interviews.”

Tom O’Neill ‘07
Program Manager, Outlook
Microsoft Corp.





designing their own games. Since 2003, over fifty undergraduates in the department have developed video games as either independent studies or senior projects. Computer games intrinsically present a host of interesting technical challenges to a computer scientist including graphics, user interface design, networking, multi-threading, artificial intelligence, and the design of efficient algorithms.

The practical development of video games is more often than not a creative group effort involving the collaboration of several students with different technical strengths and interests. The team aspect of video game development offers these students an excellent opportunity to study and learn first hand the real world benefits of solid software engineering practice. Several alumni who developed games as senior projects reported that their first job interviews focused on the challenges of such projects. Evidently, industry employers value these experiences for the creative team problem solving skills that they develop. Future plans look toward increasing collaboration with

faculty in media studies and psychology faculty in order to enhance the University of Rochester's expertise in this exciting and expanding application of Computer Science.



“The URCS department allowed me to get my hands dirty in AI, Theory, and Systems. I got to learn from and work with the faculty, who continually push the limits of CS. I was part of a genuinely impressive class of CS students. There wasn't a single person, faculty, grad, undergrad, or otherwise, that I worked with who didn't allow me to broaden my skills in CS and it is that range of experience that has put me in a position to make an impact on the game industry.”

Michael Silverman '08
USC Graduate Student
Interactive Media Division

Undergraduates Near & Far

Blumberg, Josh '97 - "I am happy to announce that I am recently engaged to Mieko Ozeki. The wedding is planned for August 15-16th 2009. Josh Pincus will be my best man. Both Mieko and I are leaving our jobs and looking for what is next. I am looking for jobs involving educational software or learning within an organization."

Bodek, Haim '95 - I recently started Trading Machines LLC as the CEO and cofounder. We trade equity options using proprietary trading models and algorithms. We have four alumni from U of R, including myself and three quantitative analysts with physics degrees.

Calarese Baird, Diana '03 - Tyrone Baird '01 and I are expecting our first baby, due on Feb 5.

Canton, Jeff '08 - has been hired as a software engineer at Amazon.com in Seattle.

Clever, Jacob '03 - Life in New Hampshire is very busy for this URCS alum. Responsibilities as a Program Manager at the defense contractor Insight Technology have shown to get in the way of having fun with my two kids: Owen (3) and Geneva (9 months). We are settling nicely into our new home. It's hard to believe that it has been 5 years since graduation - time sure does fly when you're having fun!

Clubb, David '06 - "In September 2008 I graduated from King's College London with a Master of Science degree in Computing and Internet Systems. Following graduation I returned to the United States to begin working again."

Fischer, Luke '03 - "I received an MBA in June from the Simon School and took a new position with The College's Dean's Office as a Senior Analyst."

George, Michael '03 - "I'm still plugging away at my PhD at Cornell."

Hamilton, Jeff '01 - "I recently moved with

my wife Amy (also class of 2001) from Austin, Texas to Menlo Park, California. I'm working at Google on the Android project. I've been working on Android from home in Austin since January 2006."

Inamdar, Peenak '00 - "I was recently promoted to a role as a Software Architect (job title is



Class of 2008 Bachelor's Degrees: Front L-R: Max Abernethstein, Jeff Canton, Hilario Coimbra, Alex Friedman, Jeff Keesner, Pamela Vong, Mike Tilton, Andrew Sveikauskas, David Laird, Corey Proscia. Not Pictured: Binh-An Giang, Nick S

Web Architect) for the McGraw-Hill Companies. I am happily living in Alphabet City in Manhattan with my fiance of 3 years. Please feel free to contact me if you are in the area and feel like getting a drink."

Kim, Beom Jin '02 - Financial Analyst Intern at CoKinetic, Inc (in White Plains, NY) CoKinetic

develops In-Flight Entertainment application for airlines.

Kollar, Tom '04 - I'm now engaged to Beth Whitwell and we plan to get married next summer. Otherwise, I'm still at MIT working toward my PhD.



*y, Niall Begley, Steven Bozak, David Brais, Matthew Bron-
som, Matt Leventi; Back L-R: Nick Wrem, Matthew Wag-
Staley, Michael Silverman, Sagar Rawal, Daniel Quirk, Ed
edney, Chris Tice.*

Ku, Jason '01 - I completed my MBA this past December in France and have returned to London and signed on with McKinsey & Co. I am currently staffed in Shanghai and should be here through the Olympics. In the few moments of free time that I've had, I've successfully ran the original marathon route from Marathon to Athens, floated

in the therapeutic Dead Sea and became a new uncle to my sister's daughter!

Kwon, Andrew '02 - I started work at Cincinnati Financial Companies last Monday as... an actuary. Not so sure that's a natural progression from compsci, but that is indeed what I'm doing.

Laird, Ed '08 - I'm currently working with Northrop Grumman's Electronic Systems Division in Rolling Meadows, IL (near Chicago) as an embedded software engineer.

Leselrod, Mike '99 - We just had a new baby. His name is Bennett and was born on 5/16. My other son, Edward is 3. I run an online t-shirt store for geek kids. It's www.clevercuties.com.

Leung, Vun (Hector) '00 - I received my masters degree in Computer Science from Syracuse last December. I am also in the PhD program at Syracuse now.

Lewis, Steven '00 - In October 2007, I co-chaired HighEdWebDev 2007. I was recently given primary information security responsibilities at The College at Brockport, and my title is now Web Manager / Information Security Coordinator.

Luis, Cristina '01 - I have two news items of note: 1). promotion to Captain 2). being selected as an alternate for the 2008 US Orienteering Team for the World Orienteering Champs in Olomouc, Czech Republic. I'll be traveling with the team as a team official.

McCann, Brian '03 - I'm down here in Austin TX working on my PhD in Psychology / Vision. I'm working with Bill Geisler and Mary Hayhoe. Our work involves understanding the human visual system by understanding the constraints imposed on its evolution. Specifically we look at the statistics of natural images within the context of natural tasks to build "ideal" models of human visual performance.

(continued on Page 14)

More Undergraduate News.....

Meeker, Brian '07 - "I will be getting married on May 17, 2009."

Merz, Evan '04 - "This fall I am starting my masters in computer music at Northern Illinois University. I recently got engaged to a PSU student that I met while she was interning at UR: Erin Woodhead."

Meyer, Jason '00 - is pursuing his MBA at NYU.

Moldover, Jonathan '99 - "I'm still loving life in San Francisco and recently started working at Shaba Games (part of Activision) on a Spiderman Console title. Good times!"

Moore, Justin '05 - "I just got married to Wendy Resselmann (from Rochester) and started a new job as a quantitative analyst at TwoSigma, a hedge fund in downtown NYC, this past spring."

Osisek, Eric '07 - "I began working for the UR Rush Rhees Library in late January as a Software Engineer on the eXtensible Catalog Project. The eXtensible Catalog, or XC Project, is developing a set of software tools for libraries to make it easier to find library resources on the web. XC will also make it easier for libraries to manage metadata about all kinds of library resources, both digital and non-digital. We're working with a group of other partner institutions (libraries and other open source projects), and will be releasing XC as a set of open source software "toolkits" in July 2009."

Oussayef, Karim '04 - "I just graduated magna cum laude from Boston University School of Law in May. This fall I'm working for Ropes & Gray, a law firm in NY to do IP work."

Parent, Matthew '06 - "I'm still working at

VideoMining Inc. and have since been promoted to Lead Vision Engineer."

Prithviraj, Preethum '05 - "I got married in May '08, and we've been settling into a new house. My wife is starting her residency, and I've been promoted from field Paramedic to EMS Supervisor for the agency I work for just outside Cleveland, Ohio. I started a small software development company (run mostly by myself for the moment) dedicated to software for EMS and other Emergency Services. . Hope everyone's doing well!"

Reisfeld, Daryl '03 - "I left Infosys Consulting, after almost four years there, in early July. This fall I'll be attending Columbia Business School for an MBA. Before starting school, I spent one month in Asia visiting Hong Kong, Shanghai, Seoul, Osaka, and Tokyo with business school classmates. I'm looking forward to traveling and starting school."

Riffle, Mike '07 - "I guess news for me is that I'm heading off to England this fall to get my MFA in Performance at the "Arts Educational Schools London" in Chiswick."

Sankel, David '02 - "Life is good, very good! I've moved back to Rochester and we now have a new addition to the family, Sarah Maria Sankel. Business is flourishing with our CAD/CAM program in production with Robocasting Enterprises and next generation 3D artist software being actively developed for a Belgian company called Anygma."

Schwanda, Kurt '03 - "This fall I'll be starting my fourth year of teaching math at Gorham High School in Gorham, Maine. I'm really enjoying teaching as well as coaching cross country and track and field."

Shahi, Anand '03 - "I work at Merrill Lynch as a Financial Advisor (where I've worked

Join the **facebook** group for our alumni and stay connected to fellow students and old friends. Post job openings, upload photos, find lost classmates, make plans for Meliora Weekend. Find **URCSD Alumni** and join today!



Fall 2000 Picnic - Do you recognize anyone?

since graduation). I'm also a Certified Financial Planner (R) professional as of October 2007."

Tang, Chris '05 - "I am completing my master's degree in computer science and just started a job at BAE Systems in San Diego."

Chris Tice '08 - has moved to Menlo Park, CA and is working at Facebook as a Software Engineer.

Thomas, Thomas '07 - "I'm working for David Knill at the Center for Visual Science here at the University. I'm the lab programmer and technician, so I create new experiments and maintain old ones. Some of this is software programming with OpenGL and scientific equipment, and some of it is hardware maintenance and design. Overall I enjoy the pretty relaxed atmosphere and the wide variety of responsibilities."

Turner, Jenine '03 - completed an internship at Nokia Research in Cambridge MA. doing NLP research.

Vayanis, Andrew '05 - "I am still working at AOL, however, in the past year I was promoted from an Associate Software Engineer to Software Engineer, and I am also now married."

Vanyukov, Vladimir '05 - "I just began a new job at Fenway Partners. They are a private

equity firm with a focus on logistics and consumer products. As far as life events, I got married on August 8th, to Kristin Martin (a Rochester Alumna)."

Ventura, Scott '97 - As of the beginning of May, I'm working for Allworx Consulting, sharing an office wall with Liudy Bukys.

Wang, Alex '07 - I am still at Draper Laboratory (Jan. 2008) working on two different projects. My main project is working on development and testing for the Timeliner language, which is used on

the International Space Station and will be used on the Ares Crew Launch Vehicle. The other project I am working on is a program that takes forecasts from the Air Force Weather Agency and determines when the Earth Observing-1 (EO-1) satellite has a clear opportunity to take pictures at a certain location. My job is to make that existing code accessible over a web interface.

Williams, Jonathan '05 - Currently I'm working at Limewire in New York City on various projects related to video podcasting and BitTorrent.

Senior Honors Research Theses

Matthew Leventi

"WeBWork: A New Benchmark"

Advisors: Kai Shen, Michael Scott
High Research Honors

Michael Silverman

"Scalable Multi-threaded Games Engines Using Transactional Memory"

Advisors: Michael Scott, Christopher Pal
High Research Honors



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Multicast

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Hemaspaandra, Henry Kautz, Ted Pawlicki
and Len Schubert

Alumni Giving Information