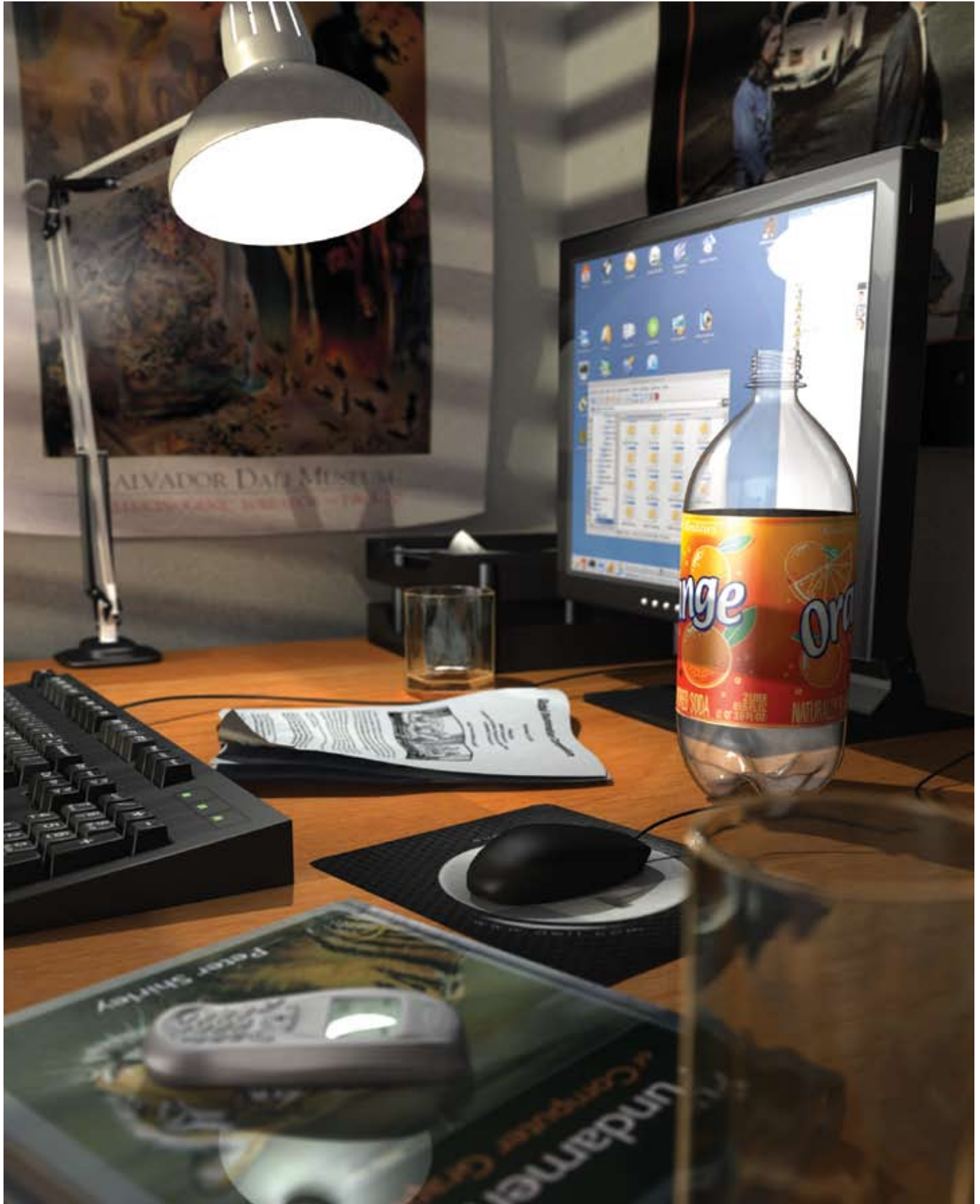


UCSD Computer Science and Engineering





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Department Statistics

Faculty Members	51
Annual Research Expenditures	\$8.7M
Undergraduates	823
Graduates	303
M.S. Students	104
Ph.D. Students	199

It is often said that growth is the engine of change. Nowhere is this maxim more true than at UCSD's Department of Computer Science and Engineering. Indeed, over the past seven years we've hired 27 new faculty members – a majority of our ranks! In turn, we have launched new programs in bioinformatics and computer engineering, created new research groups in computer vision, graphics, embedded systems and software, and have established leadership positions in fields ranging from networking to cryptography. Our junior faculty are routinely awarded NSF CAREER grants (18 in total) and Sloan Fellowships (five in the last five years alone), while 12 of our senior faculty have been named fellows of the ACM, IEEE, AAAS or National Academies. On the opposing page, we highlight seven of our most recent hires -- each a testament to this transformation and the quality of our program.

However, our growth has also created new pressures – and none more pressing than the demand for space. Thus, it is with great pleasure that we have occupied the new Computer Science and Engineering building in this summer of 2005. Totalling 148,000 square feet (87,000 assignable) across five floors, the building houses laboratories dedicated to undergraduate instruction and discipline-specific graduate research, a wide variety of flexible interaction spaces, as well as the private offices needed to accommodate increasing numbers of faculty, staff, students and visitors. On pages 8 and 9, you can see pictures of our new home and we invite you to visit us there.

Finally, the true legacy of all these changes, past and future, will be found in our students. Graduates of our undergraduate programs are being recruited into the top corporations in their field such as Google, Microsoft, and QUALCOMM. Many others are pursuing graduate studies at leading research universities including MIT, Stanford, and the University of Washington. Our graduate students are similarly competitive and recent grads have placed into tenure-track professorships at schools including Georgia Tech, Duke, Maryland and Wisconsin, and jobs at leading research labs such as IBM, Intel and Google. This year's graduating classes are among our strongest and we know that we'll be proud of what they accomplish in the future.

As you can tell, this is an exciting time for our department and its members. Please enjoy the rest of this brochure and the small window it offers into our new activities, research and accomplishments.

Jeanne Ferrante

Jeanne Ferrante
Professor and Associate Dean
Computer Science and Engineering
UCSD Jacobs School of Engineering



About the Cover

Cluttered Desk was the grand prize winner in Henrik Wann Jensen's CS168 Rendering Algorithms class. Created by grad student Wojciech Jarosz, the image depicts his own desk, and demonstrates a variety of advanced rendering techniques including irradiance caching, Fresnel effects, and distribution ray tracing.

New Faculty



Yoav Freund received his Ph.D. from UC Santa Cruz in 1993. From there, he joined the famed Artificial Intelligence group at AT&T Bell Laboratories until rejoining academia in 2003 with a Senior Research Scientist position at Columbia University. Freund is an internationally-known researcher in the field of machine learning, a field which bridges computer science and statistics. He is best known for his joint work with Robert Schapire on the Adaboost algorithm. For this work they were awarded the 2003 Gödel Prize in Theoretical Computer Science and the 2004 Kanellakis Theory and Practice Award.



Ranjit Jhala joined UCSD in 2004 after receiving his Ph.D. from UC Berkeley. Jhala is interested in ways to automatically analyze programs to uncover errors or to prove when a program is error-free. His dissertation, "Scalable Program Verification by Effective Abstraction", introduced a new analysis called "Lazy Abstraction" that scales to large, complex programs by using the insight that program-analysis precision can be localized. Jhala is also passionate about teaching and received the Outstanding Teaching Assistant award while at UC Berkeley.



Sorin Lerner will receive his Ph.D. from the University of Washington in June 2005 and join UCSD in early 2006. His interests concern compiler and programming language implementation, particularly the techniques for improving the soundness and reliability of software systems. Lerner's work on automatically proving the correctness of compiler analyses earned him a Microsoft Research Fellowship in 2002 (one of 13 awarded) and a Best Paper award at PLDI in 2003.



Beth Simon returns to UCSD after receiving her Ph.D. in Computer Science here in 2002. Over the last four years, Simon has been an Assistant Professor at the University of San Diego (USD). She is the recipient of a USD Teaching and Learning Grant for developing classroom assessment techniques in introductory computer science courses, and a USD Academic Excellence grant for supporting in-class activities with Tablet PC technology. Simon has interests in educational and information technology that span the campus and is already involved in the educational technology group at UCSD's Sixth College.



Tajana Simunic Rosing joined UCSD in 2004 after six years as a research leader at Hewlett-Packard Labs in Palo Alto, CA. Her research at HP and at Stanford University, where she received her Ph.D., has focused on the development of new wireless media technologies. Tajana filed five patents in 2003 with her HP colleagues on technologies ranging from wireless resource management in heterogeneous networks to server-driven power management. She has also devised algorithms that reduce the power consumption of small, portable, and inexpensive computing systems through the integration of intelligent hardware and software design.



Michael Taylor joins UCSD from MIT where he received his Ph.D. in Electrical Engineering and Computer Science in June 2005. Before his graduate studies at MIT, he worked on microkernels at Apple Computer, and co-authored the first version of Connectix's x86-to-PowerPC emulator, Virtual PC. Taylor is best known for being lead architect of the MIT Raw microprocessor, an experimental parallel tiled microprocessor implemented in 180 nm VLSI. His research interests include novel computer architectures, microprocessor scalability, on-chip interconnection networks, VLSI design and physical limitations on computation.



Matthias Zwicker will join UCSD in early 2006, following a postdoctoral fellowship with MIT's computer graphics group. He received his Ph.D. from the Federal Institute of Technology (ETH) in Zurich, Switzerland where he was awarded the 2004 Medal for Outstanding Dissertation. Zwicker's research is focused on efficient techniques for representing, constructing, animating and rendering complex 3-D scenes. While his interests are broad, Zwicker is particularly well-known for his work using point-based graphics to manage highly complex models.

Simulating Skin

When the android played by Arnold Schwarzenegger in *Terminator 3* literally unscrews his own head, moviegoers left theaters asking “How did he do that?” The answer: the realistic-looking face and head were not Arnold’s, but rather a computer simulation. The sequence owed its verisimilitude in large part to a technique developed by **Henrik Wann Jensen** for modeling and simulating the way that skin looks under varying lighting conditions.

The Danish-born professor’s discovery began with a basic insight into the random way in which light scatters below any translucent surface. Jensen’s 2002 SIGGRAPH paper, “A Rapid Hierarchical Rendering Technique for Translucent Materials”, demonstrated how this observation could translate into a fast, yet accurate, rendering algorithm and sent ripples through the film industry. Special-effects companies rapidly incorporated or adapted Jensen’s algorithms into a new generation of synthetic “actors,” notably Gollum in the *Lord of the Rings* trilogy, and the character of Dobby in the *Harry Potter* movies. In return, Hollywood paid Jensen the ultimate compliment: In March 2004, he became the first Jacobs School professor to win an Academy Award.



*From Donner and Jensen
SIGGRAPH 2005*



Since then Jensen has tackled other challenges to creating photo-realistic humans on a computer, including the simulation of human hair. He is also working on techniques to make skin simulation even more efficient. So far only Hollywood has been able to put his rendering technique to work, because it requires more processing power than

is available on a single personal computer. But with improvements in both simulation techniques and new generations of high-speed graphics processors, Jensen expects realistic human characters to spread from the silver screen to the next generation of PCs and videogame consoles.

Academy presenter Jennifer Garner with Stanford’s Pat Hanrahan and UCSD’s Henrik Wann Jensen. Together with Steve Marschner (not shown) they received a Technical Achievement Award “for their pioneering research in simulating subsurface scattering of light in translucent materials.”



Guggenheim Fellow



Russell Impagliazzo was named a Guggenheim Fellow in April 2004 for his work on "heuristics, proof complexity, and algorithmic techniques." Fellowship recipients are chosen from 79 different fields and are

recognized for their distinguished achievement and exceptional promise for future accomplishment. Impagliazzo specializes in computational complexity theory, notably the classification of so-called "hard" problems that require a prohibitive amount of time or resources to solve. His research interests also include proof complexity, computational randomness, structural complexity as well as the theoretical foundations of cryptography – particularly the relationship between security and randomness.

Sloan Research Fellows

Serge Belongie, Henrik Wann Jensen, and Stefan Savage were named Sloan Research Fellows in 2004 and 2005. Belongie, Jensen and Savage were among eight UCSD faculty members to receive the awards over this period, awarded to 233 promising young academics across the nation. Belongie is known for his work in computer vision and Jensen (opposing page) for photorealistic rendering. Savage is best known for his work on large-scale Internet threats – including the analysis of and defenses against worms, viruses and denial-of-service attacks. Savage is also currently director for the NSF-funded Collaborative Center for Internet Epidemiology and Defenses.



Alin Deutsch, Sanjoy Dasgupta, Alex Snoeren (above) and **Serge Belongie** (below left) received NSF CAREER awards from the National Science Foundation. Each grant totals approximately \$500,000 over five years and supports creative, career-development plans that effectively integrate research and education. Sanjoy Dasgupta's grant, "Algorithms for Unsupervised Learning" will fund the development of core machine

NSF CAREER Awards

learning algorithms with rigorous performance guarantees. In the area of information integration, Alin Deutsch will create "XML Middleware for Privacy-preserving Database Publishing" to help data owners deal with the ever-increasing issue of publishing proprietary data on the Web. Deutsch's work will help data publishers ensure that they do not inadvertently violate privacy laws. Alex Snoeren's research project, "Decoupling Policy from Mechanism in Internet Routing," will separate packet forwarding policies from route discovery in the Internet. This will allow users to select among different available network paths, thus enabling ISPs to more effectively manage the end-to-end behavior of their traffic. This research has the potential to significantly improve the performance, reliability, and robustness of the Internet. Finally, Serge Belongie's award, for "Algorithms for Nonrigid Structure from Motion," will fund computer vision research for identifying dynamic shapes such as animals, fish and humans. These objects are orders-of-magnitude harder for a computer to "see" because they change form so rapidly.

Senior Fellows

Andrew Chien: 2004 ACM Fellow for "contributions to high-performance computing systems."

Jeanne Ferrante: 2004 IEEE fellow for "contributions to optimizing and parallelizing compilers."

Rajesh Gupta: 2003 IEEE Fellow for "contributions to high-level synthesis and computer-aided design of digital circuits and systems."

Spotlight on Bioinformatics

In just four years, UCSD's interdisciplinary bioinformatics program has become an international powerhouse. Centered in CSE, the program combines the research expertise of faculty ranging from biomedical science to mathematics. Driving this activity are CSE faculty **Vineet Bafna**, **Eleazar Eskin** and **Pavel Pevzner**. In the last year alone, the group's work was highlighted by cover articles in *Science*, *Nature* and *Genomics Research*.

As part of the International Chicken Genome Sequencing Consortium, Pevzner and his UCSD colleague Glenn Tesler (of mathematics), developed the techniques to compare changes in the chicken genome with those in the human, mouse and rat. The results—published in the December 9, 2004



Pavel Pevzner



issue of *Nature* – confirm that humans and chickens share more than half of their genes, but their DNA sequences diverge in ways that may explain important differences between birds and mammals. A previous study, with the Rat Genome Sequencing Consortium, made similar comparisons with the rat genome and appeared in the April 1, 2004 issue of *Nature*. In the contemporaneous issue of *Genomic Research*, Pavel, Tesler and Guillaume Bourque of the University of Montreal, used this data to map the evolution of the X chromosome in rats, humans and mice from a common ancestor over 80 million years ago. "It contributes to the solution of the so-called original synteny problem in biology," says Pevzner. "While scientists routinely find bones that lead to often unrealistic reconstructions of dinosaurs and other prehistoric animals, this is the first rigorous reconstruction of the genomic makeup of our mammalian ancestors."

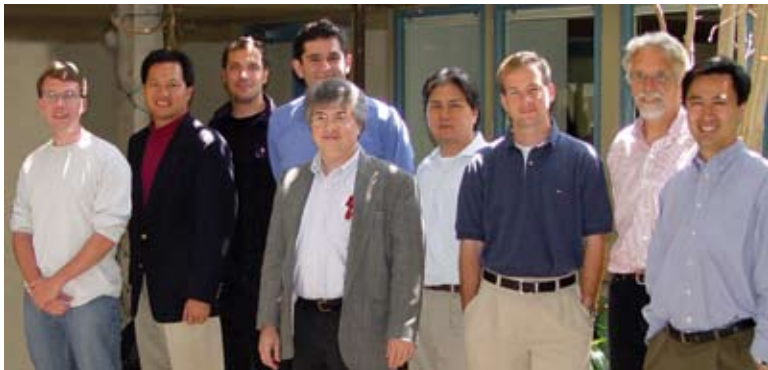
While Pevzner and his colleagues have focused on mapping genomic differences between species, Eskin, together with researchers from ICSI and Perlegen Sciences, Inc., has been researching changes between different human populations: European American, African American, and Han Chinese. Their study—the cover story in the February 18, 2005 issue of *Science* – could speed efforts to pinpoint DNA variations that are associated with disease or a patient's response to a drug. Together with Berkeley researcher Eran Halperin, Eskin developed the HAP software tool that efficiently translates genotypes into haplotypes—the sequences of nucleotide bases in each copy of the chromosome. For this study, bioinformatics researchers had to process more than 190 million data points. "Using other programs, haplotyping would require at least a few months of CPU time," says Eskin. "Using HAP we were able to perform our final entire analysis in less than 12 hours."

Learning to See

In September 2004, 26 graduate students were selected from CSE, Cognitive Science, Psychology, and the Salk Institute to participate in an intensive two-week “boot camp” sponsored by the CSE department. This annual boot camp is designed to give students an interdisciplinary perspective on the areas of human learning, human vision, computer vision and machine learning. Faculty members taught crash courses from their different disciplines, and students developed week-long projects. The boot camp was funded through an NSF Integrative Graduate Education and Research Training (IGERT) grant to explore “Vision and Learning in Humans and Machines.” CSE professor **Gary Cottrell** led the project, along with co-PI **David Kriegman** of CSE and professors from Cognitive Science, Psychology and the Salk Institute. The \$3.2 million grant provides two-year fellowships to train a new generation of scientists and engineers who are as well-versed in the mathematical foundations of computer vision and learning as they are in the biological and psychological fields of natural vision and learning. Early signs suggest it may be paying off. Boot camp graduate, Matthew Tong, was recently awarded the Marr Prize in Cognitive Science for his neurocomputational analysis of the “fusiform face area.”



IGERT boot camp participants analyze data from a brain scan.



Center for Networked Systems faculty.

Networking Drives Industry Partnership

UCSD has a new multi-disciplinary research center founded on CSE's strength in networking and distributed systems. The Center for Networked Systems (CNS) joins leading UCSD researchers with five industry members – AT&T, Alcatel, Hewlett-Packard, QUALCOMM, and Sun Microsystems—which have committed over \$9 million to CNS over three years.

“Networks and systems have converged, becoming complex systems in their own right,” says CNS director **Andrew Chien**. “CNS is the first center of its kind devoted specifically to understanding the contribution of networks, pervasive computing and grids as networked systems. Research in the center is very broad, spanning networking, operating systems, middleware, and distributed systems in both wired and wireless networks.” The Center's academic members include faculty and researchers from Computer Science and Engineering, Electrical and Computer Engineering, the San Diego Supercomputer Center and Calit2. They are working together with member companies to address practical high-impact problems.

A unique aspect of CNS is its industrial internship program, which earmarks funding to support graduate student involvement with leading industrial researchers from member companies. In 2003 and 2004 CSE sent 16 students to AT&T Labs under this program. These internships were very successful, resulting in a patent filing, publications in SIGCOMM, SIGMETRICS, IMC, and a best paper award at WWW. Moreover, the work has significantly impacted AT&T's operational networking practices, including key changes that reduce routing-related network disruptions.



New CSE Building Opens

Students joining CSE in Fall 2005 are the first class to start their career in the new \$40 million Computer Science and Engineering Building. Spanning five floors and housing more than 86,000 assignable square feet, the new building accommodates the department's dynamic growth with research and education labs, and faculty and graduate student offices. Moreover, in the tradition of supporting strong industrial and academic partnerships, the building provides ample accommodations for visiting researchers and scientists.



We have designed our space to encourage collaboration at all levels, including informal interaction spaces scattered throughout the building, a fourth-floor terrace and reading room and a graduate student lounge with professional espresso service. In their offices, building residents enjoy designer wood furniture and floor-to-ceiling windows that provide ample light.

The building opens onto a spacious courtyard at the confluence of the Bioengineering and Calit2 buildings. This academic quad is designed to foster collaboration among



students and scientists across engineering fields. Combined with state-of-the-art auditoriums in each of the three buildings, the courtyard provides a wonderful venue for scientific conferences and large events.



Quick Facts

- 148,000 gross square feet
- 150 faculty and staff offices
- 46 graduate student offices
- 12,000 square feet of undergraduate labs
- 11 conference rooms



Shedding Light on Computer Vision

David Kriegman points to a collection of nine images on a computer monitor. Each is the same face, but lit differently. "This collection shows how lighting significantly affects a person's appearance," he notes. "It also explains why lighting can confound efforts to recognize faces or other objects."

Lighting is a common thread running through Kriegman's computer vision research. "We've been looking at how to model the effects of light on images in order to overcome it," says Professor Kriegman. "On the flip side, we want to know how lighting can become a source of information to perform complex tasks such as reconstructing the three-dimensional geometry of objects."



Kriegman and his colleagues have developed two novel techniques for reconstructing the 3-D shape of objects even when the surface is glossy (e.g., metallic) and conventional reconstruction techniques fail. Based on a 19th century German physicist's finding that specularities (glossiness) at a single spot on the surface are identical if the viewing and lighting directions are interchanged, Kriegman built a stereo vision system that actively interchanges the camera and light source. GE Research Labs is currently exploring this Helmholtz Reciprocity Stereopsis technique for inspection of metal turbine blades.

Kriegman developed a second technique that uses a robot arm to move a light around an object while a camera acquires images under varying lighting conditions. "We first reconstruct the 3-D structure of the object without any prior knowledge of the object's reflectance, and from that structure we figure out the reflectance properties," explains Kriegman. This type of image-based modeling can be applied in computer graphics for more realistic special effects, games, and simulations.

Kriegman believes his findings could also have broad applications, ranging from biomedical imaging to search engines. One of Kriegman's students interned at Honda, and developed variations of the lab's face recognition algorithms for the Japanese automaker's ASIMO two-legged humanoid robot. Kriegman is also investigating (with fellow CSE professor Serge Belongie) how refractive objects, such as water or glass, bend and attenuate light as it passes through them, and how motion can help reveal this structure. Understanding these properties can improve the recognition of objects through a wet windshield, for example, or an underwater camera.

"Ultimately," says Kriegman, "to improve how computers see three-dimensional objects and scenes, we must better understand lighting and its effects."



Serge Belongie

works in vision and learning. He co-invented Shape Contexts,

which recently achieved the world record in handwritten digit recognition. Belongie currently heads the Smart Viarium project, which aims to improve the health and welfare of lab animals via automated visual monitoring.



Henrik Wann Jensen

develops computer graphics algorithms. He is best

known for inventing the photon mapping algorithm for simulating global illumination, and the first practical technique for simulating translucent materials such as human skin. In 2004 he received a Sloan Fellowship and an Academy Award.



David Kriegman's

research in computer vision includes 3-D scene reconstruction, illumination and reflectance modeling, and object recognition with application to face recognition, microscopy, robotics, and computer graphics. Kriegman will be the next Editor-in-Chief of the IEEE Transactions on Pattern Analysis & Machine Intelligence.



Matthias Zwicker's

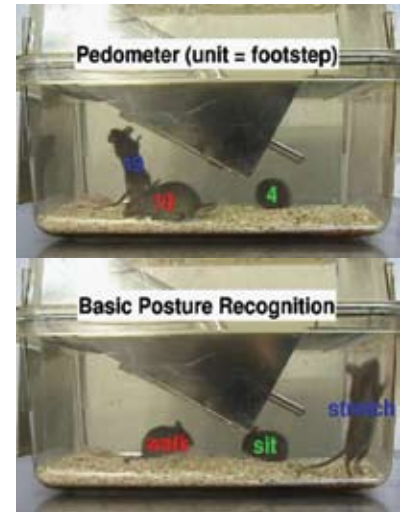
research focuses on computer graphics.

He is most interested in geometric problems in computer graphics applications, such as three-dimensional shape representation, editing, and modeling. He will join the UCSD CSE faculty in January 2006.

Adjunct Faculty:
Samuel Buss

Of Mice and Men

Serge Belongie was recently named one of 100 Top Young Innovators by MIT's *Technology Review* magazine, a ranking borne out by his recent NSF CAREER and Sloan awards. As an undergraduate student, Belongie developed new techniques for fingerprint analysis. Applying these techniques to the real world, he co-founded Digital Persona, Inc., the world leader in PC-based fingerprint authentication. Since joining UCSD in 2001, Belongie has continued to mix theoretical vision research with practical applications. His recent work on motion segmentation and spectral analysis includes applications to the automated analysis of tissue microarrays and, most recently, to the monitoring of mice and other animals in laboratory research. His "Smart Vivarium" project equips each cage with a camera and embedded processing, then uses pattern recognition to generate a continuous stream of measurements 24 hours a day — providing better data on how animals respond in drug trials, while also improving their health and welfare.



Smart Vivarium continuously and automatically monitors animal behavior.

Finding Meaning in High Dimension

One of **Sanjoy Dasgupta's** primary goals as an artificial intelligence researcher is to rigorously explore how computers can "learn" underlying structure in such seemingly disparate fields as biology, climate modeling, and large-scale networking. Historically, statistical procedures for exploratory data analysis have had few rigorously proven guarantees. This is especially true of clustering algorithms for generating tree-like, or hierarchical, models of data sets, leading Dasgupta to wonder about the quality of the output. "As far as the theory goes, there is no telling," says Dasgupta. "The output could be anything."

A supermarket chain might use the data gathered with personalized plastic cards to separate male and female customers and examine the buying habits of each group more closely. And clustering algorithms might partition grocery buyers who do or don't buy alcoholic beverages, meat and vegetables, or convenience foods into three or four categories.

But with more data available on each shopper, more sophisticated analyses become possible. Whether it be a grocery store or an econometric database, the number of variables, or dimensions, of each data point has exploded along with the size of databases that contain them.

Dasgupta wondered if it was even possible to do hierarchical clustering on high-dimensional data in a way that was meaningful across the many different levels of resolution at which one can look at the data. In a paper that recently appeared in the *Journal of Computer and System Sciences*, Dasgupta demonstrates a method for hierarchical clustering that is simultaneously meaningful at every level of granularity. "It is only recently that the tools for doing this kind of data analysis have been developed," he says. "This method builds on a lot of work in algorithms, work that may not be known to most statisticians."



Garrison W. Cottrell is more interested in necktaps than laptops, and works on neurocomputational models of cognitive processes. He directs both the Interdisciplinary Ph.D. Program in Cognitive Science and a campus-wide NSF IGERT initiative on vision and learning that funds 16 students in five departments.



Sanjoy Dasgupta develops algorithms for the statistical analysis of high-dimensional data. This is a broad, emerging research area whose foundations lie in artificial intelligence, information theory, probability/statistics, convex geometry, and theoretical computer science.



Charles Elkan's current research focus is on learning algorithms and data mining. His earlier work on the foundations of fuzzy logic is the central topic of the book *La trame de l'evidence* by Claude Rosental, Presses Universitaires de France, Paris, 2003.

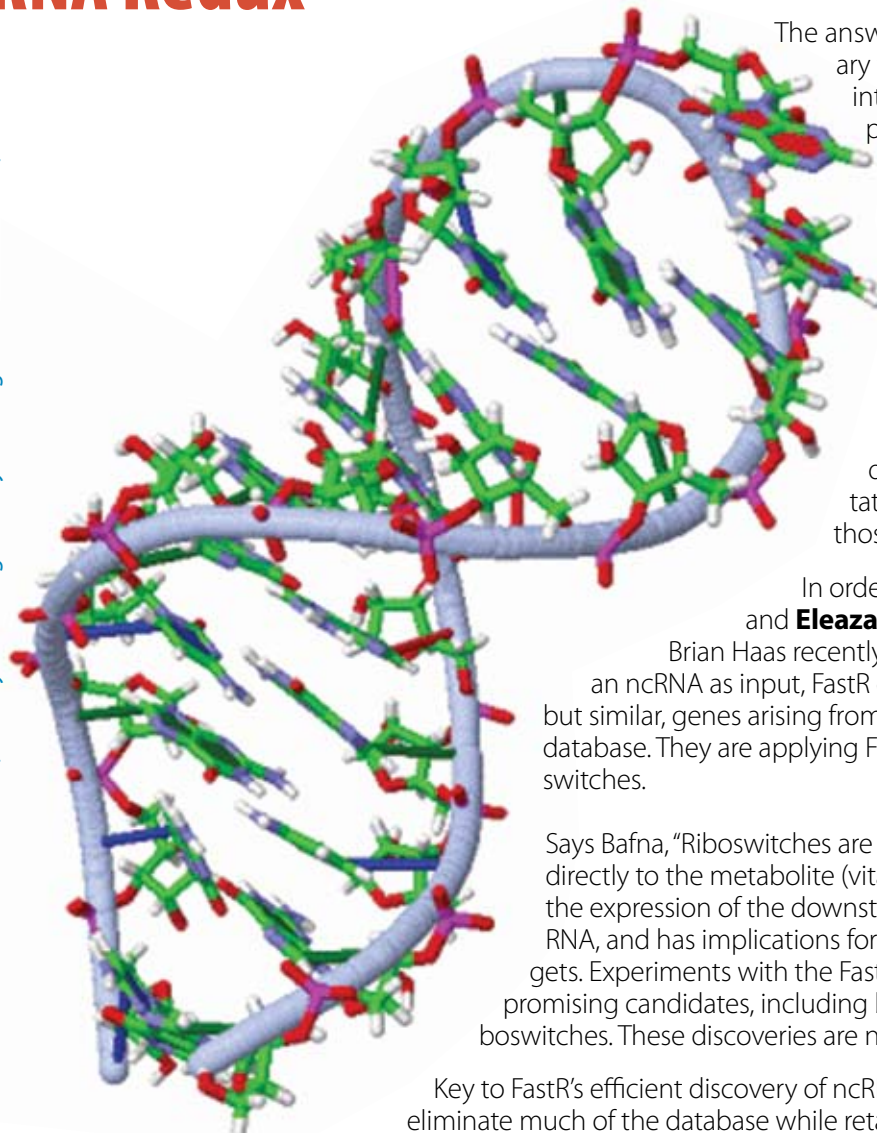


Yoav Freund works on machine learning, adaptive systems and bioinformatics. Currently, he's focusing on applications in systems biology, computer vision and resource management. Freund and Robert Schapire received the 2003 Godel award and the 2004 Kanellakis award for their work on Adaboost.

Adjunct Faculty:
Terrence Sejnowski

RNA Redux

22-Nucleotide RNA structure (courtesy Jena Image Library of Biological Macromolecules).



The Human Genome Project revealed that protein-encoding genes comprise only 2 percent of the genome. This result begs the important question: Are these 30,000-40,000 genes alone sufficient to carry out complex cellular functions? This question intrigues bioinformatics expert **Vineet Bafna**, who joined the UCSD faculty in 2003 after participating in the Human Genome and Proteome projects at Celera Genomics Group.

The answer might be in RNA, a key cellular intermediary that processes genetic information from DNA into proteins. Some RNA molecules do not encode proteins, but instead act directly to catalyze and regulate cellular processes. And this behavior has some scientists such as Bafna questioning whether there is in fact an abundance of undiscovered non-coding RNA (ncRNA) that are partly responsible for maintaining these complex cellular functions.

"The discovery of many novel families of ncRNA is one of the most exciting recent developments in biology. The reason these genes remained undiscovered for so long is that genomic and computational tools for finding ncRNA are not as advanced as those for protein coding genes," says Bafna.

In order to accelerate the discovery of novel ncRNA, Bafna and **Eleazar Eskin** and graduate students Shaojie Zhang and Brian Haas recently designed a tool called FastR. Given a query with an ncRNA as input, FastR can efficiently discover novel homologs – distinct, but similar, genes arising from a common evolutionary origin – from a sequence database. They are applying FastR to identify many novel ncRNA including riboswitches.

Says Bafna, "Riboswitches are RNA motifs upstream of messenger RNA that bind directly to the metabolite (vitamins/amino-acids/nucleic acids, etc.) and regulate the expression of the downstream gene." Such regulatory function is novel for RNA, and has implications for riboswitches becoming effective anti-microbial targets. Experiments with the FastR tool have resulted in the discovery of many such promising candidates, including bacterial species not previously known to contain riboswitches. These discoveries are now being validated in collaboration with biologists.

Key to FastR's efficient discovery of ncRNA is the development of structural filters that eliminate much of the database while retaining the true homologs. These filters are deduced from the common secondary structure that defines the specific ncRNA family. FastR then structurally aligns the filtered sequence to the query to discover true homologs. This approach makes FastR two orders of magnitude faster than similar tools. FastR and the associated research was presented in August at the 2004 IEEE Computer Society Computational Systems Bioinformatics conference.



Vineet Bafna works in computational biology, specifically on problems in comparative genomics, mass spectrometry, population genetics, and genome rearrangements. His recent work has focused on the efficient discovery of non-coding RNA. Prior to UCSD, he participated in the Human Genome Project at Celera.



Eleazar Eskin works at the intersection of genetics, bioinformatics and medicine. His research focuses on applying bioinformatics techniques to understand the genetic basis of human disease by developing tools to analyze human variation and correlate the variation to disease.



Pavel Pevzner's research interests lie in computational molecular biology and bioinformatics. His recent work involves analysis of genomic rearrangements and identification of evolutionary "faults" in human genome. Pevzner authored the graduate textbook *Computational Molecular Biology: An Algorithmic Approach* and, with Neil Jones, the undergraduate textbook *Introduction to Bioinformatics Algorithms*.

Adjunct Faculty:
Ben Rosen

Who are You?

Alin Deutsch worries about privacy. Today, thousands of databases track the detailed minutiae of our lives --- how much money we owe, what movies we like, even our medical records. As this data is shared, linked, and analyzed, each of us surrenders more of our anonymity.

"I want to prevent that from happening," says Deutsch, who recently received a \$500,000 Early Career award from NSF to study how organizations could publish useful data via the World Wide Web, yet do so in a controlled manner that preserves the privacy of personal information in the data. His research would prevent a database system from inadvertently violating an individual's privacy by constraining what data is exposed via outside queries, even in indirect ways, by a commercial, government, or academic institution. "We need a flexible definition of what it means to keep a secret," said Deutsch. "We need to quantify it, which may mean controlling the possible associations such that anybody's chance of guessing a patient's secret is no larger than a minimal threshold."



The CAREER Award allows Deutsch to focus on a concern of every institution that must restrict access to personal information, such as medical records and financial data. Institutions such as hospitals face an ever-increasing demand to publish propriety data via the Web so that other organizations, such as insurance companies, can use the data in their business. Deutsch's research will enable such "data publishers" to provide access to their data and verify that they do not inadvertently expose sensitive material. In particular, subtle privacy issues can arise when such institutions offer different views of their data. While each individual view may obscure any private information, others may still be able to infer this information via queries across multiple views. Deutsch aims to provide strong automated protections to prevent such accidental information leaks.



Alin Deutsch

develops tools that assist database owners in publishing propri-

etary data on the Web. A recent example is the MARS project that supports the publishing in XML form of data from Mixed And Redundant Storage. Deutsch received an NSF CAREER Award in 2004.



Yannis Papakonstantinou

works with database and Internet technologies. His work

on enterprise information integration spans academia and industry and led to the first generally available distributed XQuery processor. His interests include Internet-wide information integration and the intersection of database querying and keyword-based information retrieval.



Victor Vianu

works in database theory, logic and complexity, and

data management on the Web. He is best known for his work on the theory of query languages and, more recently, static analysis of XML queries and formal verification of Web services.

Adjunct Faculty:

Bertram Ludascher



Handling a Hot Potato

It is not often that a graduate student can have a tangible impact on the way a Fortune 500 company and an entire industry work. But for Brazilian-born **Renata Teixeira**, that is exactly what emerged from research she undertook during a summer internship with AT&T. "She was given access to all the routing data from AT&T's domestic backbone to analyze the network's behavior," says CSE professor Geoff Voelker, her faculty advisor. "Looking at the data, Renata developed unique insights that are already changing the way the telecom giant, router manufacturers and large Internet service providers handle the way they route data over the Net."

What Teixeira found was that there is a fundamental disconnect in today's routing protocols when they have to cope with so-called "hot potato" disruptions. She observed that an event happening inside one domain can trigger an enormous number of routing changes on traffic flowing between domains, which could lead to packet losses and longer delays. In addition, it can take up to a few minutes for the inter-domain protocol to converge. "The interaction of these two protocols and its impact on end-to-end performance was not very well understood," explains Teixeira. "It might only take tens of milliseconds to route around disruptions in AT&T's own network, but the response might take as much as a few minutes when it triggers inter-domain changes. You can imagine how serious a problem that is for anyone using voice over IP, or someone watching streaming video!"

Teixeira worked in AT&T's New Jersey lab in 2003 for five months, and did a similar internship there in 2004. She briefed AT&T and industry engineers on her findings, and created a model that network operators could use to predict these disruptions. That work formed the basis of a paper she delivered at SIGCOMM 2004 in outlining an analytical model of hot-potato routing that incorporates metrics to

evaluate network sensitivity to hot-potato disruptions. "There may be road construction somewhere and the fiber gets cut and the link has to go down," explains Teixeira. "With the model we built, they can predict exactly what the effects are going to be and try to use the model to minimize disruption to end users when something happens in the network."

AT&T has now asked vendor companies to reduce convergence times on future routers. As for Teixeira, she completed her Ph.D. in the summer of 2005 and is currently a postdoctoral fellow at Laboratoire d'informatique de Paris 6.



Walter Burkhard's algorithmic research

interests involve storage and hashing. Recent storage work includes data declustering as well as data layouts providing multiple failure tolerance; recent hashing studies provide performance improvements for double hashing.



Andrew Chien is well-known for his contributions in a wide range of areas including high-

performance computing and networking, grids, clusters, parallel architecture, interconnects, storage, and object-oriented languages. Director of the Center for Networked Systems (CNS) and a SAIC Chair Professor, Chien has also received a 1994 NSF Young Investigator award, as well as numerous other research recognitions.



Keith Marzullo

works on both theoretical and practical issues of fault-tolerant distributed computing in various domains, including grid computing, mobile computing, and clusters. He also studies the relations between reliability and security. In his spare time, he likes bicycling and playing Hawaiian music.



Joe Pasquale

does research in operating systems and networking, focusing on improving performance and quality-of-service of Internet-scale systems through algorithmic and architectural design. Pasquale's honors include NSF Presidential Young Investigator and UCSD Academic Senate Distinguished Teaching awards. He is also an avid tennis player.



Stefan Savage

works at the intersection of operating systems, networking and computer security. His best known recent work focuses on analyzing and defending against Internet-scale threats -- worms, viruses and denial-of-service attacks. Savage received a Sloan Fellowship in 2004 and plays fretless bass guitar.

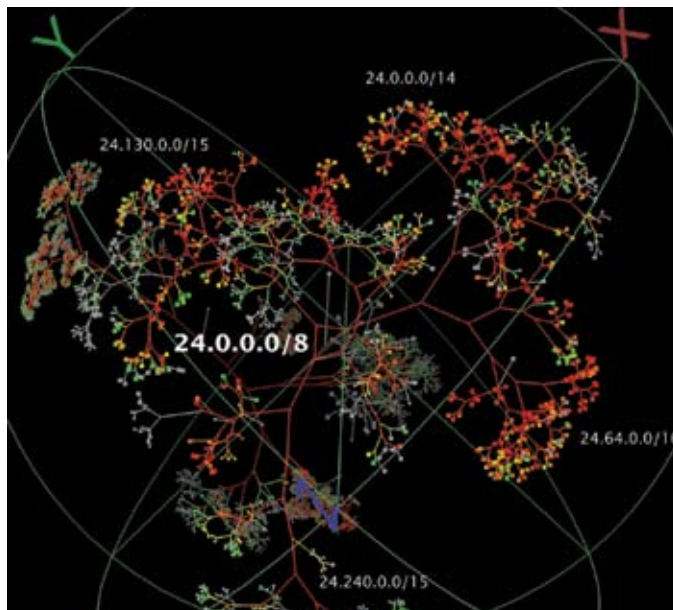
Modeling the Internet

Each year our society becomes more dependent on the Internet, its services

and the applications they support. In turn, these applications – including communications, entertainment, commerce and control – depend on Internet services to deliver consistent levels of reliability and performance. Unfortunately, the very characteristics that have made the Internet so successful – its decentralized control, operation, and evolution – also make it difficult to reason about the complex interactions between applications, network services and the network itself. Consequently, application designers are unable to rigorously test their designs in advance and must wait for wide-scale deployment to discover errors or bottlenecks.

To address this problem, **Amin Vahdat** and his students are developing ModelNet, a high performance network emulation environment that provides a framework for rigorously evaluating Internet applications and services. ModelNet comprises a cluster of commodity servers that act as arbitrary Internet hosts, in turn interconnected by a high-speed LAN that is configured to emulate a user-specified network topology with parameterized hop-by-hop bandwidth, latency, failure and congestion characteristics. Thus, ModelNet allows developers to create a realistic test environment, including unmodified applications, services, operating systems and hardware platforms, and subject it to the end-to-end network characteristics that are present in a global-scale setting.

Fighting Internet Diseases



CAIDA visualization of the CodeRed worm spreading in the 24/8 address block of the Internet. CodeRed infected more than 350,000 hosts in 14 hours.

Every day, thousands of computer systems are compromised, subverted and turned to malicious ends by epidemic attacks such as worms and viruses. The fastest of these pathogens have blanketed the Internet in a few minutes and the most prolific have infected millions of hosts. The rising prevalence of these attacks, coupled with increasing technical sophistication and associated criminal activity, led a recent Computer Research

Association study to declare epidemic attacks as one of four grand challenge problems in computer security.

To address these threats, **Stefan Savage, Geoff Voelker** and **George Varghese** – in collaboration with researchers at the International Computer Science Institute – have founded the Collaborative Center for Internet Epidemiology and Defenses (CCIED). Established in 2004, CCIED is one of only two National Science Foundation CyberTrust centers and will receive \$6.2M in federal funding, as well as industrial support from Microsoft, Intel, Hewlett-Packard and UCSD's Center for Networked Systems. CCIED's activities focus on analyzing large-scale Internet-based pathogens, developing early-warning and forensic capabilities and designing fully automated defense technologies.

The Center builds in part on the previous work of Varghese, Savage and their students, Sumeet Singh and Cristian Estan, who developed the first automated high-speed system for detecting and filtering out network worms. The key technique, called content sifting, was commercialized by CSE spinout NetSift, Inc., and has since been licensed by leading network equipment vendor Cisco Systems.



Alex Snoeren's research interests

include operating systems, distributed computing, and mobile and wide-area networking. Known for developing an end-to-end approach to Internet mobility, Snoeren received a 2004 NSF CAREER Award to support his recent work on authenticated, policy-compliant Internet routing.



Amin Vahdat's research encompasses

several topics in systems and networking. Currently, he focuses on infrastructure and abstractions to support highly available, scalable, and dynamically reconfigurable network services. Vahdat received an NSF CAREER Award in 2000 and a Sloan Fellowship in 2003.



George Varghese's research is in

network algorithmics, using algorithmic and systems techniques to speed up key networking tasks. His work on scheduling, timers, and IP lookups has been incorporated in commercial products. Varghese was selected to be an ACM Fellow in 2002.



Geoffrey M. Voelker works in distributed systems,

network security, wireless networking, and content delivery. Recently, he has focused on availability in distributed systems, defending the Internet against large-scale attacks, public-area wireless networks, and Web server farm performance. On Friday mornings he surfs in Del Mar.

Adjunct Faculty:

Kim Claffy
George Polyzos

Can you Keep a Secret?



Julius Caesar often wrote battlefield commands in nonsense words that his lieutenants decoded into Latin. Confident that neither his messengers nor enemies could crack the code, Caesar successfully expanded the Roman Empire across Europe. In the presence of modern, technologically savvy adversaries, governments, enterprises, and individuals alike now seek this same confidence in their Internet communications. However, truly securing messages against the actions of the most clever adversaries is a challenging task.

"Security cannot really be measured experimentally," observes **Daniele Micciancio**. "The only thing you can observe is the lack of security, for instance when all the money in your bank account has been taken." Because of this, he and his colleagues focus on ways to guarantee the security of a system *a priori*. "We obtain mathematical evidence, a proof, that no matter what the aggressor tries, he will not be able to break the system," Micciancio says. "In a sense, you want to study what cannot happen, and you need mathematical modeling to do that."

Micciancio's research primarily focuses on the inherent difficulty of mathematical problems, as well as techniques to "amplify" their hardness for cryptographic applications. He is the author of some of the strongest hardness results for computations on point lattices, a finding he presented at the recent IEEE Symposium on Foundations of Computer Science.

Additionally, Micciancio is also exploring techniques to automate the design and analysis of cryptographic protocols. Real

protocols are typically designed using a high-level programming language to manipulate secret keys, cipher texts, digital signatures, and other cryptographic objects. However, such techniques frequently fail to address vulnerabilities that emerge at lower levels of abstraction. By combining computational complexity techniques typical of modern cryptography with symbolic security analysis, Micciancio seeks to build a framework where complex cryptographic protocols can be designed using a high-level language, and yet can be proven secure against lower-level attacks as well.



Mihir Bellare's area is cryptography and computer security, with emphasis on the design

of practical, proven-secure schemes. He is a co-designer of HMAC, used in SSL, SSH and IPSEC. He is a recipient of a Packard Foundation Fellowship in Science and Engineering and the RSA conference award in mathematics.



Fan Chung Graham is a Professor of Mathematics and Professor of Computer Science and Engineering

at UCSD. She is the Akamai Professor in Internet Mathematics. Her research interests are graph theory, combinatorics, and algorithmic design. In 1990, she was awarded the Allendoerfer Award by the Mathematical Association of America.



Ron Graham's research covers many areas in mathematics and theoretical computer science.

These include combinatorics, graph theory, number theory, geometry, and the design and analysis of algorithms. In addition to various professional positions he is also a past President of the International Jugglers Association.



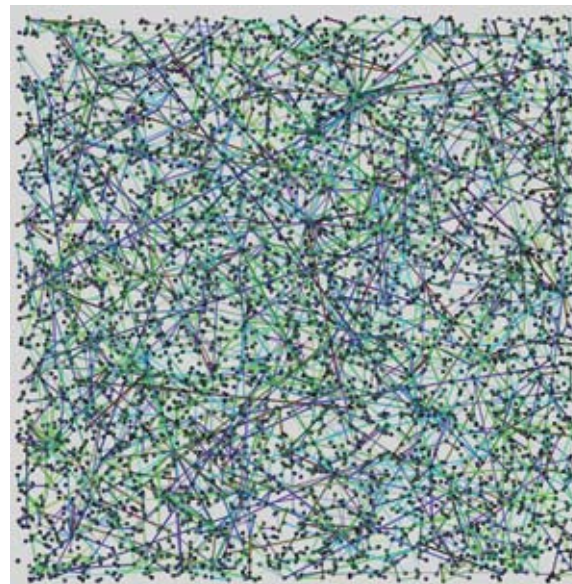
T.C. Hu is interested in combinatorial algorithms, optimization, integer programming, networks,

management science and computer-aided design. His best-known works include Gomory-Hu Tree, Hu-Tucker algorithm for alphabetic binary tree, and Hu-Shing Matrix-Chain Multiplication. He has also authored five widely-translated books.

Turning on the Power Law

Fan Chung Graham and her colleagues are among the first to use relatively succinct mathematical descriptions to rigorously analyze the graph properties of the Internet, which currently connects nearly 100 million hosts, and services that run over the Internet. For example, an interesting property of the World Wide Web is that most Web sites are small and link to few other pages, such as personal homepages, while a handful are large and link to many pages, such as popular news sites like CNN.

In fact, the interconnectivity of the Internet and its services follow “power laws,” which have also been used to describe social and biological networks, and power-law models are proving to be invaluable tools in the analysis of the Internet. “With these power-law descriptions, we are now able to do more quantitative analysis than we ever have before,” says Graham, UCSD’s Akamai Professor in Internet Mathematics. “It’s like nature finally gave us a break.” Funded by a \$1.3M NSF Information Technology Research grant, Graham and her co-PI, Andrew C. Yao of Princeton University, are using this insight to model a variety of complex systems, with applications ranging from finance to bioinformatics.



Visualization of a power law graph of 5000 vertices randomly distributed on a unit square.

Random Limits

In 2002, Manindra Agrawal of IIT Kampur and his two undergraduates, Neeraj Kayal and Nitin Saxena, made an international splash when they announced a polynomial point algorithm for determining if a number is prime or not. At that time the only efficient algorithms for the problem, critical for modern cryptography, were based on random selection and could not guarantee a correct answer in any fixed time period. This raises the question: can all such algorithms be efficiently derandomized? Work by UCSD’s **Russell Impagliazzo** and his colleagues suggest that this is in fact so. They have shown that progress on the seemingly unrelated problem of circuit complexity lower bounds is also sufficient to prove that all randomized algorithms can be reduced to deterministic polynomial time equivalents, i.e., that randomness provides no inherent increase in capability. Further linking these two mysteries, Impagliazzo and his colleagues have shown that derandomizing some problems, such as the Schwartz-Zippel algorithm, can only be achieved with such a lower bound. However, Mathematics guards her secrets closely and, while a lower bound on circuit complexity is widely believed to exist, it has resisted proof for over sixty years.



Russell Impagliazzo

works in complexity theory, cryptography, and algorithms. In particular,

he studies the power of randomness and pseudo-random generators in computation and in cryptography. Among his other interests are proof complexity, logics for cryptography, optimization heuristics, and the exact complexity of NP-complete problems.



Daniele Micciancio

works at the intersection of computational complexity, cryptography and computer

security. His most recent work includes the strongest hardness results known to date for many computational problems on lattices, and the study of cryptographically-sound methods for the symbolic analysis of security protocols.



Mohan Paturi

joined UCSD in 1986 after a post-doctoral fellowship at Harvard

University. He obtained his Ph.D. from Pennsylvania State University in 1985. Paturi is a recipient of the Jacobs School’s Teacher of the Year Award. He founded Parity Computing, a digital library and data mining technology company.

Adjunct Faculty:

Samuel Buss
Alon Orlitsky
Alexander Vardy



Designing for Moore

Over the last three decades the semiconductor industry has focused its energies on meeting the exponential growth predictions of Moore's Law. UCSD's **Andrew Kahng** has been at the center of this mad scramble. Since 1996, he has helped author the International Technology Roadmap for Semiconductors (ITRS), which defines technology requirements out to a 15-year horizon. Over the last five years, Kahng chaired the design technology component of the ITRS and came to the conclusion that the "cost of design is the greatest threat to the future of the semiconductor roadmap." In particular, he noted the "yield" of useful chips that could be produced with the latest semiconductor technology was increasingly being limited by their design rather than by traditional problems like contaminants. "Defect-centric yield loss is the past," says Kahng. "Mature process and design techniques allow most of today's chips to be fully functional when fabricated. However, only some of them will perform up to their specification. The challenge is that, with the tiny feature sizes in today's chips, manufacturing variability is inevitable. We simply can't control variance down in the sub-10nm range. It's like trying to write a letter with a pencil the size of an umbrella." Thus, a natural tension emerges between cost and variability.

The solution, says Kahng, lies in the cross-disciplinary mindset and technologies that comprise "Design for Manufacturing" (DFM) – a field that Kahng has pioneered over the last 10 years. The premise behind DFM is that physical chip design can be adjusted to manage, model and compensate for variability in the fabrication process and therefore maximize the probability that resulting chips will perform up to spec. "The traditional regime was to focus on pattern fidelity – how accurately a designed shape is reproduced on the wafer," says Kahng. "But what we really care about is functional fidelity – how well the chip will perform to its specification." Thus, for a physical circuit design

some transistors may need to be larger than others, some wires spaced further apart, and so on. However, determining which of these changes will best ensure that a chip runs at full speed has become one of the hottest areas of research in both academia and industry. DFM is now part of the ITRS and is the fastest expanding market segment in Electronic Design Automation, growing from effectively 0 to \$200M in a few short years. Today Kahng is in demand throughout the industry, serving on a range of technical advisory boards and recently founding his own company, Blaze DFM, to take some of his ideas to market. And a large market it may be. In his keynote speech at the 2004 Design Automation Conference, Mentor Graphics CEO Wally Rhines maintained that DFM was the single biggest cost-saving tool for semiconductor manufacturers and predicted that DFM-aware tools would be a \$1B industry within five years.



C.K. Cheng's work is concerned with circuit analysis and physical planning of VLSI designs.

For circuit analysis, his group revamps a transient circuit simulator. For physical planning, his team constructs performance-driven layout systems to automate the interconnect planning, clock synthesis, data path generations, and packaging.



Andrew Kahng's research focuses on the VLSI design-manufacturing interface. He pioneered methods

that link designer intent with the manufacturing process to reduce both mask and wafer costs. From 2000-2004, he chaired the international working group for design for the International Technology Roadmap for Semiconductors.



Alex Orailoglu has been with the CSE department

since 1987. His research interests include electronic design automation, VLSI test, and synthesis of fault-tolerant ICs, about which he has some 80 publications. He also leads the Reliable System Synthesis Group.

Adjunct Faculty:
Walter Ku

Spatial Programming

Rajesh Gupta is revolutionizing the programming semantics for cell phones, sensors and other wireless and embedded systems with reasoning capabilities for space and energy. "Currently software development for mobile applications is similar to the software written for desktops or mainframe computers," says Gupta, who holds the Qualcomm Endowed Chair in Embedded Microsystems. "But as computing migrates to wireless devices, location information is becoming critical."

This conceptual paradigm called "spatial programming" is in its infancy. It goes beyond awareness of location in system software functions to the use of location information in building new applications. "Changing what you do based on location means you have to treat location as a first-class concept in programming and system software. We do that based on the notion of observables among program components" explains Gupta. His goal is to make it easy for embedded application developers to specify and reason about actions associated with places. Semantic support for location can allow for automatic verification, so that, for instance, illegal combinations of actions and spaces do not occur. "It will allow memory management, or file system management, or data organization to take advantage of location in saving energy, processing and communication resources," says Gupta.

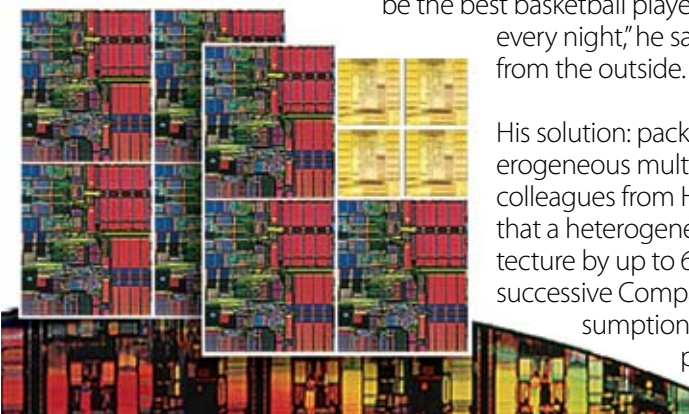


One Chip, Many Cores

Today's microchips aren't so "micro" anymore. The Pentium 4 is roughly twice the area of the Pentium 3. As these bigger chips consume more energy, communication from one part of the processor to another becomes more cumbersome. "We are reaching the point where it makes better sense to put two, four, or even eight processors on a chip rather than design one oversized processor," argues **Dean Tullsen**.

Multi-core processors already exist, but like IBM's Power5 server chip they typically pack two identical processors on a single die. Tullsen thinks this approach is fundamentally flawed. "Shaquille O'Neal may be the best basketball player in the world, but if you fielded a team with five Shaqs, they'd get clobbered every night," he says. "They wouldn't be able to get the ball up the court and couldn't shoot from the outside. What you want is diversity to cover all the different functions."

His solution: packing different levels of processors on the same chip—what he calls heterogeneous multi-core processing. In June 2004, Tullsen, Ph.D. student Rakesh Kumar, and colleagues from HP Labs reported to the International Symposium on Computer Architecture that a heterogeneous architecture outperformed the comparable-area homogeneous architecture by up to 63 percent. Earlier, Tullsen reported that a chip made of processors from four successive Compaq Alpha generations permitted a nearly 40 percent drop in energy consumption and sacrificed only three percent in performance. "The most demanding applications run on the most powerful chip," explains Tullsen, "but other applications can run on older cores, yielding a fraction of the power consumption."



Brad Calder's

current research focuses on phase-based analysis,

network processors, simulation methodology, and hardware/software solutions to aid program correctness. His research provides the SimPoint framework that determines where to take a few samples of execution to guide accurate program analysis and architecture simulation.



Rajesh Gupta's

interests span embedded systems, mobile computing

and VLSI design, with a recent focus on energy-efficient and location-aware embedded software. His best known achievements include the SystemC modeling package and the SPARK high-level synthesis framework each incorporated into research and industrial practices.



Tajana Simunic Rosing

works at the intersection of software and hardware design. Her current research interests are in the area of low-power design of embedded wireless systems, and the network on a chip design with power, performance and reliability as metrics.



Michael Taylor

designs and builds novel hardware and

software systems. The most recent such system is a scalable, parallel microprocessor. Related topics include computer architecture, parallel computing, microprocessor design, VLSI design, embodiment of computation in physics, on-chip interconnection networks, compilers, and software systems.



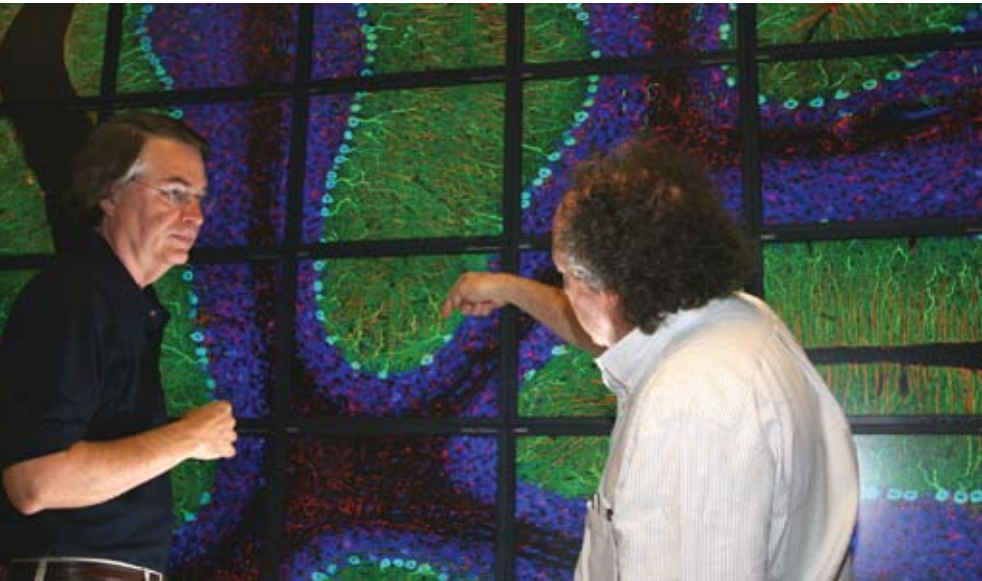
Dean Tullsen

does computer architecture and is best known for

simultaneous multithreading (SMT), now appearing in Pentium and Power processors. He also works on symbiotic scheduling for SMT, dynamic critical path prediction, and heterogeneous chip multiprocessing. Dean has received NSF CAREER and IBM Faculty Awards.

Looking Forward

In the early 1980's, **Larry Smarr** helped create the first national supercomputer centers and the NSFnet network that connected them. Two decades later, the founding director of the UCSD/UCI California Institute for Telecommunications and Information Technology (Calit2) is pushing the envelope again.



CSE professor Larry Smarr (left), and National Center for Microscopy and Imaging Research director Mark Ellisman in front of the 20-tile BioWall that is hooked up to other OptIPuter resources at UCSD and beyond.

Smarr argues that we are rapidly moving from an era in which focus was on centralized computing to one in which an international distributed fabric of computing and storage is emerging. Driving this transition is the race between the exponential growth in communications bandwidth and Moore's Law. "Optical bandwidth and storage capacity are growing much faster than processing power, turning the old computing paradigm on its head," he says. "We are going from a processor-centric world to one centered on optical bandwidth, where the networks will be faster than the computational resources they connect."

To demonstrate this vision, Smarr's OptIPuter project is building a virtual "metacomputer" in which individual "processors" are widely distributed clusters, the "memory" is a collection of large distributed data repositories, "peripherals" are large scientific instruments, visualization displays and/or sensor arrays, and the "bus" delivers packets over dedicated 10Gbps

optical wavelength lightpaths or "lambdas". Funded by \$13.5 million from the National Science Foundation, OptIPuter connects Calit2 with more than a dozen partnering institutions worldwide. Each lambda in turn can be connected to others, using a hybrid circuit/packet switch that forms a programmable optical "patch panel". Thus, computation and storage can be mustered on demand, stitched together and delivered to users anywhere within the "LambdaGrid".

Building on this foundation is the Laboratory for the Ocean Observatory Knowledge Integration Grid (LOOKING). Smarr is a co-PI on the \$3.9 million NSF project to prototype the cyberinfrastructure needed for remote-controlled ocean observatories. The project, a joint effort with the University of Washington and UCSD's Scripps Institution of Oceanography, anticipates the linking of on-land research institutions with networked sensors and undersea robots off the coasts of the United States, Canada and Mexico. However, storing, controlling, analyzing and visualizing the vast amounts of data steaming to and from these offshore instruments will tax the capabilities of any single research group. To this end, "the distributed OptIPuter will provide on-demand high performance compute and storage capacity," says Smarr, "and dedicated lightpaths will also permit interactive control of ocean-bottom instruments along with real-time access to the data they produce." The ultimate goal is to transform how scientists do science, allowing remote fieldwork, interactive analysis and data gathering at unprecedented scale and fidelity.



Scott Baden's

research is in large-scale

computation, with a focus on software techniques to improve programmer productivity without sacrificing performance. The work is interdisciplinary, and has resulted in new computational tools used in applied fields such as neuroscience, computational fluid dynamics, and computational chemistry.



Fran Berman

is a pioneer in grid computing and has worked extensively in parallel computing, scheduling, and adaptive environments. Dr. Berman serves as Director of the San Diego Supercomputer Center, a national facility, where she leads a staff of 400+ scientists and technologists.



Jeanne Ferrante

works in high performance computing, with current focus on scheduling in large-scale distributed systems. She is best known for her co-development of intermediate compiler representations, most notably Static Single Assignment form (SSA). Ferrante is an ACM Fellow and likes to paint in oil.



Sid Karin

was the founding Director of the San Diego

Supercomputer Center. In addition to high performance computing and networking, he is currently interested in computer security research. Several pounds ago he was an active rock climber and is trying to return to that state.



Larry Smarr

is the PI of a \$15M NSF grant to build an "OptIPuter" – a

large-scale computational grid built on dedicated lightpaths – for processing medical and earth science images. Smarr also directs the California Institute for Telecommunications and Information Technology and enjoys growing orchids.

Adjunct Faculty:

Larry Carter
Allan Snively



William G. Griswold works in ubiquitous computing, software engineering, and educational technology. His ActiveCampus project is studying ubiquitous computing for educational communities. The WIISARD project is investigating wireless technologies for disaster response. In 2003 he won an Outstanding Teaching Award from Warren College's senior class at UCSD.

Bringing Computer Science to the Disaster Scene

It is not often that a computer scientist is at the center of a disaster drill. But that is where **Bill Griswold** found himself in May. The full-scale drill was a San Diego County effort that allowed researchers and first responders to test new technologies for coping with emergencies. Developed as part of a \$4 million project funded by the National Institutes of Health, the Wireless Internet Information System for Medical Response in Disasters (WIISARD) brings together members of Griswold's group with researchers from UCSD's School of Medicine and Calit2.

For the May drill, Griswold's team deployed locating technology on mobile 802.11 wireless access points linked to Verizon's digital cellular network backbone. "Situational awareness is critical because, in disaster situations, responders need to keep track of the locations of patients, equipment, and each other," explains Griswold. "A disaster scene is very dynamic and chaotic." Victims were equipped with wireless-enabled PDAs that served simultaneously as triage tags, location devices, and medical equipment to monitor the pulse and blood-oxygen levels of each patient.

Griswold is now working with county paramedic services to upgrade existing PDA-based applications to record patient data and then transmit it wirelessly on arrival at a hospital. "We are going to give paramedics an upgraded wireless device that can access real-time data from the disaster scene," says Griswold. "All of the first responders are giving us vital feedback about the software systems we are developing, so we can be better prepared if a real disaster strikes."



Joseph Goguen's research covers: information integration; cognitive linguistics for future media (e.g. video games); social and ethical aspects of IT; nonlinear systems theory for consciousness and music; and user interface design. Prior work includes fuzzy logic, software modules, inspiring aspects of ML, C++, and Ada, and formal methods for specification and verification.



Ranjit Jhala is interested in programming languages and software engineering, more specifically in techniques for building reliable computer systems. For his dissertation, he built BLAST, a tool that analyzes programs to find errors or guarantee their absence.



Bill Howden is one of the founders of software testing research. He co-authored a best-selling tutorial on testing and wrote the first book on theory of testing. Research areas include statistical testing, symbolic evaluation, functional testing software model checking, and currently, automated systems testing.



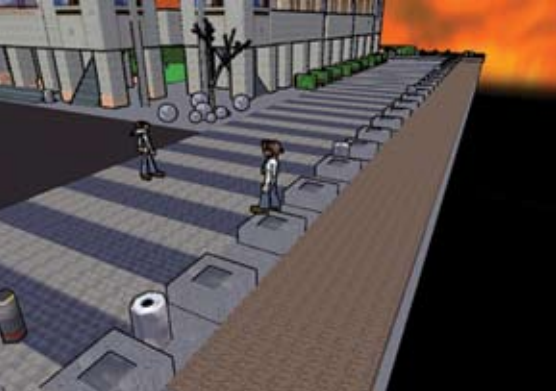
Ingolf Krueger and his team are developing methods and tools for service-oriented software and systems engineering. His research includes formal foundations, service-oriented software architectures, development processes, expressive description techniques, and applications in both next-generation automotive software and large-scale business systems. He is closely affiliated with Calit2.



Sorin Lerner is interested in programming language and program analysis techniques for making software systems easier to write, maintain and understand. Recently, he has worked on trustworthy compilation frameworks, dynamic optimization techniques for x86 code, and designs of scalable analyses for large C/C++ applications.

Undergraduate Education

The UCSD CSE department prepares its undergraduate students both for top placement in a competitive high-tech job market, as well as for advanced studies in graduate school. It offers a broad and deep curriculum for its majors as a combination of core requirements and electives in leading-edge areas and senior project courses. In addition to academic excellence, the department has a strong tradition in fostering student community through numerous organizations and activities.



Gaming the system

In one senior project course, Geoff Voelker's popular Software System Design and Implementation, students work in large teams to design and roll out a large, complex software system with real-time constraints. The class is very demanding, but students are motivated to excel because the system is a distributed, real-time, 3-D, multiplayer video game. During the quarter, the teams propose the features of their game, specify its requirements, create a design and implementation schedule, and then implement it from scratch. The final game demonstrations are open to the public and packed by CSE students and faculty. In 2004, one of the audience favorites was Kampus Kombat, a game where the characters are CSE faculty who battle their way around the UCSD campus with textbooks and keyboards.

Class projects that yield real rewards

In another senior project course, students learn the essential algorithms used for rendering computer graphics in Henrik Wann Jensen's Rendering Algorithms class. As a final project, students implement custom algorithms and render a realistic object or scene of their own choosing. These final projects are then judged in a contest where the best images are awarded prizes by an outside panel of experts. In 2004, Wojciech Jarosz won the grand prize with his rendering of a cluttered desk (front cover), and Sunny Chow won honorable mention with his rendering of the Salk Institute.



Annual programming contests

When not working on class projects, students frequently compete in both local and global programming contests. In annual UCSD competitions, over 100 students program game agents to compete with each other in head-to-head tournaments for prizes. UCSD students also compete as teams in regional and international ACM Collegiate Programming Contests. Over the past five years, UCSD teams have consistently won or placed in the top three in ACM regional contests, qualifying to compete in four ACM ICPC World Finals.

Lecturers



Gary Gillespie emphasizes building problem solving skills via insights into data

structures, memory management, and object-oriented design. He brings industrial experience into the classroom from his concurrent position as a Senior Software Engineer at SAIC. Additionally, he runs the CSE undergraduate tutor training program.



Paul R. Kube is a full-time lecturer who teaches courses in information technology fluency, introductory Java, and advanced data structures. He serves as Chair of the Undergraduate Committee, is a member of the UCSD Teaching Assistant Development Advisory Committee and initiated the idea of the campus-wide center for IT education (CITE).



Susan Marx is a full-time lecturer teaching introductory courses in computers

and programming centering on Java and C. Susan has also played a role in the design and development of these introductory courses, as well as assuming similar roles in the Java, C and Unix courses offered through UCSD Extension.



Richard C. Ord is a full-time lecturer teaching courses in information technology

fluency, Java, C, C++, assembly, Unix, and compiler construction. Recent teaching awards include CSE Teacher of the Year (2003 and 2004) and Warren College Outstanding Teacher (2004).



"The CSE faculty at UCSD truly care about their students and the subject matter, and actively encourage students to learn beyond the classroom. Professor Calder sponsored me for several research projects, which ultimately led to a hands-on understanding of research, three publications, and a compelling graduate school application."

Stefan Schoenmackers was a finalist for the Computing Research Association (CRA) Outstanding Undergraduate Award in 2004, and is now a Ph.D. student at the University of Washington.

"The CSE department has tremendous opportunities for the willing student. While the breadth and depth of the core curriculum is admirable, what's more important is the availability of resources -- courses, professors, other students -- which afford undergraduates the chance to pursue their specific interests within computer science. Whatever you're looking for in a CS department, you can find it in UCSD by fully taking advantage of all the resources available. The department actively helped me specialize in machine learning, the subfield of my choice, while ensuring that I also had a broad academic base."



Alex Simma is now a Ph.D. student at UC Berkeley.

"The best part about UCSD's Computer Science program is its friendly, caring, and knowledgeable faculty. Not only did I get a top-notch, hands-on education that landed me a great job, but every professor made me feel comfortable coming into their office and talking about anything. Whether it was class work, extra curricular activities, research, or just to say 'hi,' I always knew my professors would be welcoming. Many of the faculty I know I will keep in touch with for life."



Lindsey DeSalvo received the 2005 Jacobs School of Engineering Student Leadership Award, and is now a Software Developer at Amazon.com.



"I had such a great time as an undergraduate student in the CSE department at UCSD. The curriculum prepared me well for the next stage of my career in graduate school, and the department was very supportive in helping me achieve my academic goals. The years that I spent at UCSD made me who I am today, and I will forever be grateful for that."

Angelina I-Ting Lee is now a Ph.D. student at MIT.

"The technical and organizational skills I acquired in the large-scale courses like Compilers, Computer Architecture, and Software System Design ("The Video Game Class") are essential for industry and invaluable assets to have as a new hire."



Santos Cordon, Jr., is currently a Software Developer with Microsoft.



Beth Simon works in computer science education research specializing in educational

technology, first-year programming experiences, and multi-institutional studies. Additional computer science interests include performance prediction of scientific codes, compilers, and computer architecture. Beth spends weekends road and mountain biking.

ADMISSIONS

CSE welcomes applications to its bachelor programs in computer science, computer engineering, and bioinformatics from both incoming freshmen as well as transfer students.

For information, visit www.cs.ucsd.edu/ugrad and email questions to ugradinfo@cs.ucsd.edu.



The UCSD CSE department is consistently ranked in the top 20 nationwide. Its outstanding graduate programs span computer science and computer engineering, as well as a strong interdisciplinary program in bioinformatics. CSE also plays a leading role in key research centers that provide graduate students and faculty with excellent research opportunities. The San Diego Supercomputer Center (SDSC), directed by CSE Professor Fran Berman, is an international leader in high performance computing. The California Institute of Telecommunications and Information Technology (Calit2), directed by CSE Professor Larry Smarr, is a premier research center for the technologies that will shape the information and communication systems of tomorrow.



Cristian Estan (Ph.D. '03) developed new methods for performing Internet traffic measurement and analysis in his dissertation. His research enables networks to analyze traffic, detect network events, and quickly respond to them, such as during Internet attacks. He is now an Assistant Professor in the Department of Computer Sciences at the University of Wisconsin - Madison.

"The number one reason to come to UCSD is the wonderful faculty. I knew about the research of George Varghese as an undergraduate, and once I had the opportunity to meet him in person, I knew UCSD was the right place for me. While George has been my advisor, I've written papers with several other faculty and researchers - collaboration is the norm here."



Alexandra Boldyreva (Ph.D. '04) performed her thesis work in cryptography and information security. She developed robust methods for ensuring the privacy of data and communications among groups of individuals. Even if some group members prove untrustworthy, her research enables communicated information to remain secure. Alexandra is now an Assistant Professor in the College of Computing at the Georgia Institute of Technology.

"The years I spent at UCSD were the best and the most important ones of my life. I almost did not want to leave. I am very happy I found a fascinating research area, cryptography, a great advisor, Mihir Bellare, and many good friends. The department has a great reputation and a nice environment. The surrounding nature and weather are great bonuses."

Peter Petrov (Ph.D. '04), in his thesis, focused on improving customizable application-specific embedded processors and systems. Embedded systems are pervasive in the everyday world, such as consumer electronics devices like cell phones. His work uses knowledge of application behavior to improve the performance and power consumption of such devices. He continues to innovate in embedded systems as an Assistant Professor in the Department of Electrical and Computer Engineering at the University of Maryland at College Park.

"The years that I have spent at UCSD were some of the most enjoyable in my life. The environment in the CSE department is very friendly and professional. Recently, the department has grown to be one of the top computer science and engineering departments. This makes UCSD one of the best places to attend and conduct research work."



Ranjita Bhagwan

(Ph.D. '04) is now a research staff member at the IBM Thomas J. Watson Research Center, where she is designing and implementing scalable systems for supporting streaming database services. In her doctoral work, Ranjita developed techniques for automatically managing the availability of data stored in large-scale, wide-area distributed storage systems.

"What I like best about the CSE department is its faculty. They are approachable, easy to talk to and willing to take on cross-disciplinary collaborations. This gave me the opportunity to work with a number of the professors and develop a diverse background that ultimately helped me during my job search. A healthy interaction between students and faculty is extremely important for having an enjoyable and productive time at grad school, and that's something you definitely get at UCSD CSE."



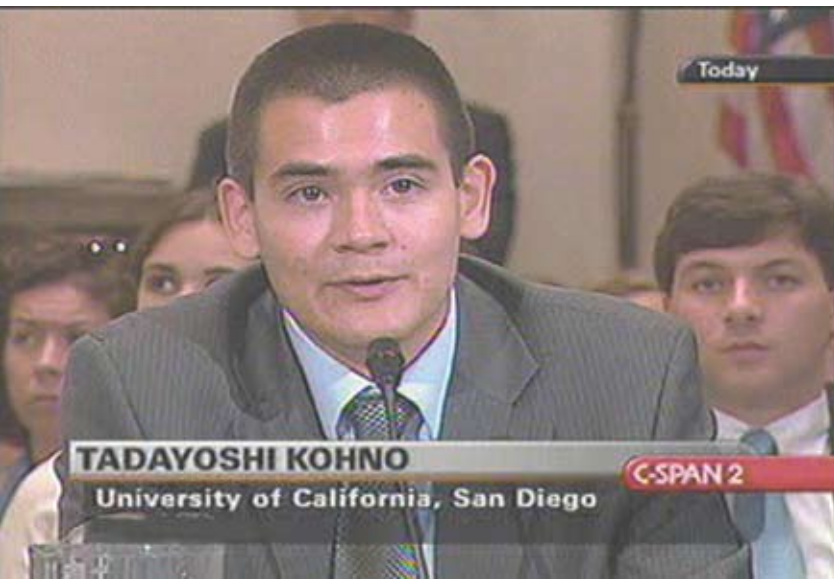
Dangling Chads in the Digital World

Before coming to UCSD four years ago, graduate student **Tadayoshi Kohno** worked as a computer security consultant to American Express, VISA, and other companies. “I am most interested in an area of cryptography called ‘practice-oriented provable security,’” says Kohno. “UCSD professor Mihir Bellare pioneered this area, and I came here specifically to study with him.” However, along the way, Kohno has also applied his expertise to understanding the vulnerabilities of systems that lack such strong security guarantees. On July 7th, 2004, Kohno appeared before the U.S. House of Representative’s Committee on House Administration and testified that a popular touch-screen voting machine is “vulnerable to simple and easy-to-mount integrity and privacy-compromising attacks.”

Kohno’s testimony centered around his work with colleagues Aviel D. Rubin, a professor of computer science at Johns Hopkins University, Adam Stubblefield, a graduate student at Johns Hopkins, and Dan S. Wallach, an assistant professor at Rice University. Together, the four authored a paper in the IEEE Symposium on Security and Privacy that described the analysis

of 49,609 lines of C++ computer code for the Diebold AccuVote-TS machines. The researchers reported that unscrupulous outsiders could vote repeatedly on the machines without being detected, and malicious insiders could not only modify legitimate votes cast on the machines, but “also violate voter privacy by matching votes with those who cast them.”

Washington state voting activist Bev Harris downloaded the AccuVote-TS source code in 2002 after stumbling upon it by chance. Consequently, the Diebold source code is the only system that has undergone analysis by an independent group. Kohno testified that “spot-treating” security problems, as advocated by Diebold, may raise the bar for a successful attack, but provides no guarantee that other security flaws will be detected and fixed. “Unless all components of the revised system, including the software and revised procedures, are open



to the public for scrutiny and review, the public will have no reason to believe that the spot-treatment actually succeeded in addressing the security problems,” Kohno testified.

Kohno also told the Committee that certification tests performed by independent testing authorities are poor substitutes for open review. The AccuVote-TS and other electronic voting systems have been certified by those tests. “There is no reason to assume that other vendors’ certified electronic voting machines are any more secure,” Kohno testified. “Our discoveries show that the current ‘logic and accuracy’ testing and certification processes for electronic voting machines cannot be trusted to uncover even the most elementary security problems.”

A study by Election Data Services, Inc., of voting equipment used by election jurisdictions across the United States shows that just over 50 million registered voters cast ballots on electronic equipment. Kohno told House committee members that the consensus of computer security experts is that the current generation of paperless electronic voting machines should not be used in elections. In response, voting machine manufacturers have vowed to fix security problems identified in the analysis by Kohno and his research collaborators.

ADMISSIONS

CSE annually seeks applications to Ph.D. and M.S. graduate programs in computer science and computer engineering. For information visit www.cs.ucsd.edu/grad and email questions to gradinfo@cs.ucsd.edu.



UCSD Pascal Reunion

Among all computing endeavors launched at UCSD, few have ever matched the impact of UCSD's Pascal project. To appreciate how revolutionary this work was, one must rewind to a time

before Gigahertz microprocessors and Gigabyte hard disks. In the mid-1970's mainframes ruled the day, computer software was written on punch cards, and data was stored on reel-to-reel tape. "Virtually no one worked on his own computer," recalls UCSD Pascal project alumnus **Richard Kauffman**. "It was as if you threw a sack of paper over the wall and then waited overnight and the results were thrown back at you the next day." Moreover, software was not portable and each new computer required students to write a new compiler or interpreter to make their programs run.

Professor **Kenneth Bowles**, then head of UCSD's computer center, was dissatisfied with this situation. He was aware of Pascal—a relatively new language designed by Swiss computer scientist Niklaus Wirth—and wondered if it could be altered to run on the new microcomputer systems being introduced. The opportunity for students to work on a program, run and edit it, and then try again with minimal lag time excited him.

Bowles' key idea was to create an intermediate "p-code" execution system that was spare enough to run on microcomputers, but powerful enough to serve as a universal translator. From here he recruited grad student **Mark Overgaard** and a handful of undergrads including Kaufmann, **Roger Sumner** and **John Van Zandt** to build a Pascal compiler for this system. As word began to leak out about UCSD Pascal, Bowles added more students to his crew. The project, which began with just a computer language, expanded until "UCSD Pascal" referred both to a language and to an operating system. In the end more than 70 students participated in the project in some way. Other universities called, asking for copies of the program for their own computers.

Soon UCSD Pascal and Pascal were synonymous. Apple computer licensed it for their new Apple II computer, IBM provided a compiler for the PC, the original Macintosh OS was written in UCSD Pascal, and a generation of students learned the language – the standard for the College Board's AP and GRE exams until 1995. Indeed, in his 1985 Turing Award lecture Wirth said that "Pascal gained truly widespread recognition only after Ken Bowles in San Diego recognized that the p-system could well be implemented on the novel microcomputers. His efforts to develop a suitable environment with integrated compiler, filer, editor, and debugger caused a breakthrough."

While the Pascal project eventually ended, its legacy can be felt to this day. It influenced the design of today's programming languages, operating systems, and most recently the intermediate code form used by Sun's Java and Microsoft's .NET. Moreover, the alumni of the Pascal project became a legacy in their own right, including members like **Bud Tribble** (original member of the Macintosh team, now Apple VP) and **Bart Miller** (Professor of Computer Science at the University of Wisconsin).

Bowles is now 75, and well recalls the height of UCSD Pascal's success. He was in high demand then, speaking with Bill Gates and Steve Jobs. But to him, the most satisfaction came from knowing the contributions UCSD Pascal made to undergraduate teaching. At one point he presented his students' work at a large conference in San Jose. "People just gasped in amazement at what could be done," he recalls. On October 22nd of 2004 we celebrated the 30th anniversary of this amazement at the UCSD Pascal Reunion.

More information can be found at: www.jacobsschool.ucsd.edu/Pascal/

Portions of this article were excerpted from "UCSD Pascal and the PC Revolution" in the September 2004 @UCSD alumni magazine.



Kenneth Bowles



Eric Anderson

When Henrik Wann Jensen accepted an Academy Award in 2004, he was not the first UCSD CSE member on a Hollywood award stage. In fact, that honor goes to Eric Anderson who accepted an Emmy in 2001 for the work of himself and his colleagues on the FireWire protocol.

While in UCSD's graduate program, Anderson worked under the direction of Professor Joe Pasquale, exploring architectural changes in Unix to improve network I/O performance; this background would prove a strong asset in his subsequent development of Apple's FireWire. When not working on high-speed networking, Anderson spent his time at CSE helping out with "Chez Bob" (the departmental junk-food co-op), and organizing department BBQs and laser tag trips to Los Angeles.

After graduating with a Ph.D. in 1995, Anderson accepted a position at Apple Computer where he became the lead engineer developing their new 400Mbps video transfer protocol: FireWire. He now manages a team of engineers for all FireWire software, firmware, and hardware in projects such as Mac OS X, the iPod, and the iSight camera. Anderson also helped drive official standardization of FireWire through the IEEE 1394a, 1394b and 1394 Open HCI committees and currently serves as chairman of the board of directors for the 1394 Trade Association.

In his 10 years thus far with Apple, Anderson's most unexpected assignment came in 2001 at the Goldenson Theatre in Hollywood. There he accepted Apple's first-ever Emmy from the Academy of Television Arts and Sciences, awarded in recognition of FireWire's role in the widespread deployment of affordable digital video camcorders and video editing software.



Doug Terry

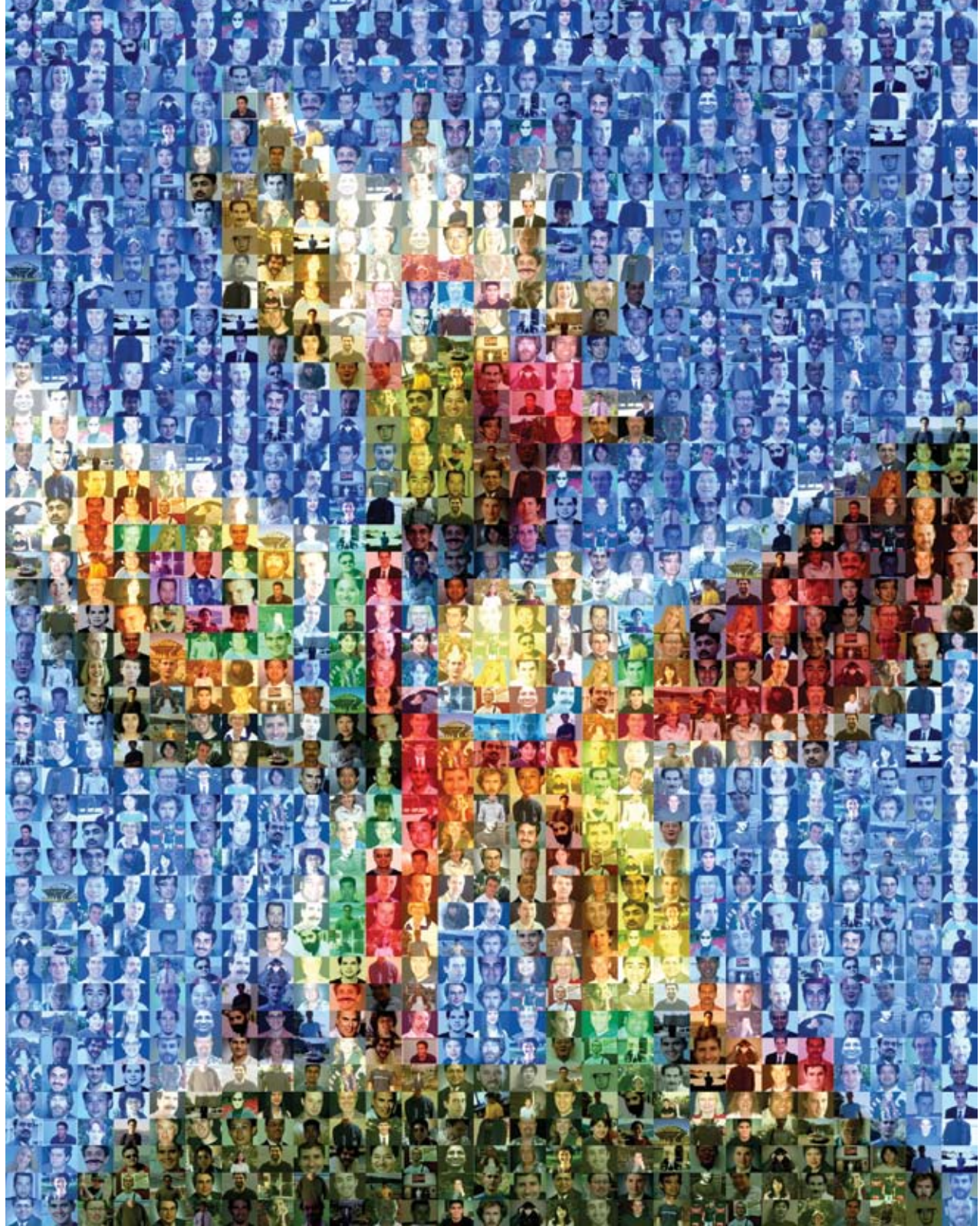
When Doug Terry was a Computer Science student at UCSD, the department did not exist and computing courses were taught by the Applied Physics and Information Sciences department. Terry did not even see a computer until his sophomore year, but he soon embarked on a long career in computing that has had substantial impact. Joining the UCSD Pascal effort, he gained access to the keyboard of a Terak (an early personal computer) paying his dues by writing a parser generator (similar to Lex and Yacc) for the project. "My education and experiences at UCSD established my broad interests in computing and instilled my passion for research," explains Terry. In 1979, he graduated with a BA in Computer Science and minor in Mathematics.

Terry went on to earn a Ph.D. at UC Berkeley where he helped develop the RIP routing protocol, TCP/IP, and DNS for the Berkeley Unix system. He then joined the Xerox Palo Alto Research Center (PARC) where he eventually served as the Computer Science Laboratory's Chief Scientist. At PARC, Terry helped define the notion of ubiquitous computing and became well known for his work on collaborative filtering, multimedia network services in

the Etherphone system, continuous queries, and epidemic algorithms.

In 2000 he left PARC to start a company, Cogenia, which developed an innovative mobile computing platform but did not survive the dot-com bust. Currently, he is a Senior Researcher at Microsoft's Silicon Valley campus helping to design the company's WinFS file system. His research interests continue to focus on the design and implementation of novel distributed systems, including issues of information management, fault-tolerance, and mobility.

More information for CSE alumni can
be found at www.cs.ucsd.edu/alumni



A photomosaic of Niki de Saint Phalle's iconic Sun God sculpture at UCSD, created from the faces of our department.

Founded in 1960, UCSD has become one of the nation's premier educational and research institutions, set apart by its entrepreneurial atmosphere, stellar faculty, and world-class research facilities. The Computer Science and Engineering department embodies UCSD's tradition of excellence as a world-class leader in computer science and engineering education and research.

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