

## HOT RESEARCH

### Bridging Cognitive Gaps of Software Development Dynamics

“Dynamism. The quality of being characterized by change and progress.” Software, in particular, is defined by this quality. From changing source code, contributed by teams of developers over the course of years, to billions of



instructions performing calculations in the blink of an eye, software is highly dynamic.

Although this quality can be awe-inspiring, it can also be intimidating and challenging for even the developers of the software to comprehend. Bridging these gaps between ever-changing complexity and the need for human comprehension of these aspects of software is the subject of Professor **Jim Jones's** research at UC Irvine. Jones explains, “We architect software, concept by concept, often with an incomplete vision of our intentions. Those intentions get fleshed out over the course of years, with influences coming from customers, other developers, and many other stakeholders. So, what starts as a coherent architecture and plan often morphs into a product whose structure and behavior are emergent and not easily fully comprehended by any single developer.”

An early success in Jones's career was an

## RESEARCH BRIEFS

Prof. **André van der Hoek** and postdoctoral researcher **Thomas LaToza** have been awarded \$1.4M by the National Science Foundation for their research on CrowdProgramming which seeks to bring the benefits of microtask crowdsourcing to programming. See story on page 8.

Prof. **James A. Jones**, has been awarded a National Science Foundation (NSF) CAREER grant of \$499,010 for his research on Aiding Comprehension of Complex Software Dynamics to Support High-Quality Software Development.

Prof. **Walt Scacchi** received a research grant of \$114,607 for 2014-15 from the Naval Postgraduate School, Acquisition Research Program to investigate the cost-sensitive acquisition of open architecture software systems. This marks the eighth consecutive competitive award for Scacchi and ISR research associate **Thomas Alspaugh** from the NPS ARP.

Prof. **Gloria Mark** has received a Best Paper Award from this year's ACM Conference of Human Factors in Computing Systems (CHI 2014) for her paper entitled “Narco' Emotions: Affect and Desensitization in Social Media during the Mexican Drug War.” The paper was co-authored by Andres Monroy-Hernandez and Munmun de Choudhury of Microsoft Research.

Prof. **Bonnie Nardi** has been awarded an Honorary Doctorate from the University of Umeå in Sweden for her research contributions to Informatics and Human-Computer Interaction (HCI), and for her outstanding and long lasting research collaboration with Umeå University.

*More Research Briefs on page 7.*

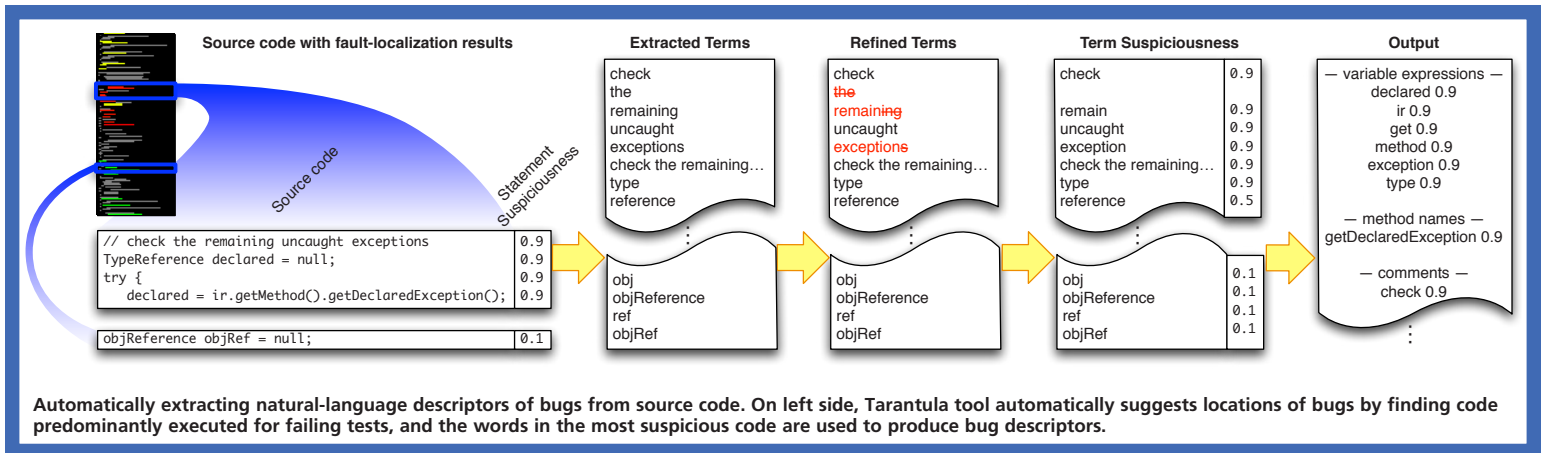
innovation that uses information from test suites to automatically identify the locations of bugs in large codebases. The technique observes the instructions that are executed by each test case, computes the correlation of each instruction's execution with failure and success, and visualizes a heat-map of the code to highlight areas that may be buggy. The technique and tool, called “Tarantula,” sparked off a currently popular field of research called spectra-based fault localization.

Debugging has been a focus of Jones's research, then and since, because it “exemplifies the cognitive gap between intention and actuality that often plagues software developers.” Jones explains, “Our code is designed and implemented as static structures—large constructions of logic and intention. But only when we actually run the system, does it come to life—and the logic and those intentions are put to the test. Unfortunately, because these systems are so large and complicated, those intentions often are not fully realized and the symptoms of bugs are observed—resulting in the launch of a potentially time-consuming and frustratingly difficult debugging process.”

One direction that Jones and his research group, The Spider Lab, are taking is to model and analyze the entire change-history of a software system. The analysis is performed at a fine-grained level that allows for powerfully expressive querying and discovery of trends, culpability,

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and rationale. Current revision control systems are not well suited for answering queries such as “which developers ever changed any past version of these particular lines of code, and when were all those changes made?” Such a query could support investigations of culpability, recovery of design rationale, or discovery of neglected bug patches.

At a more microscopic (or “micro-chronologic”, as Jones puts it) scale,

Jones’s research is modeling and analyzing fine-grained internal behaviors of software in execution. Jones and his group are researching ways to observe and record internal software execution in ways that allow for discovery of key events that stray from the intention of its developers. Jones has been inspired by modern brain-mapping technologies, such as functional magnetic resonance imaging (or “fMRI”), that shows areas of the human brain that are active during different sorts of activity.

Similarly, Jones is mapping internal software behavior to visualizations of execution behaviors. Code is first “clustered” according to observed cooperation in computation, then the software is executed to observe how those clusters (Jones calls them “emergent features”) activate as a result of the input stimulus to form the externally observable behavior of the system. Through such observation, patterns and

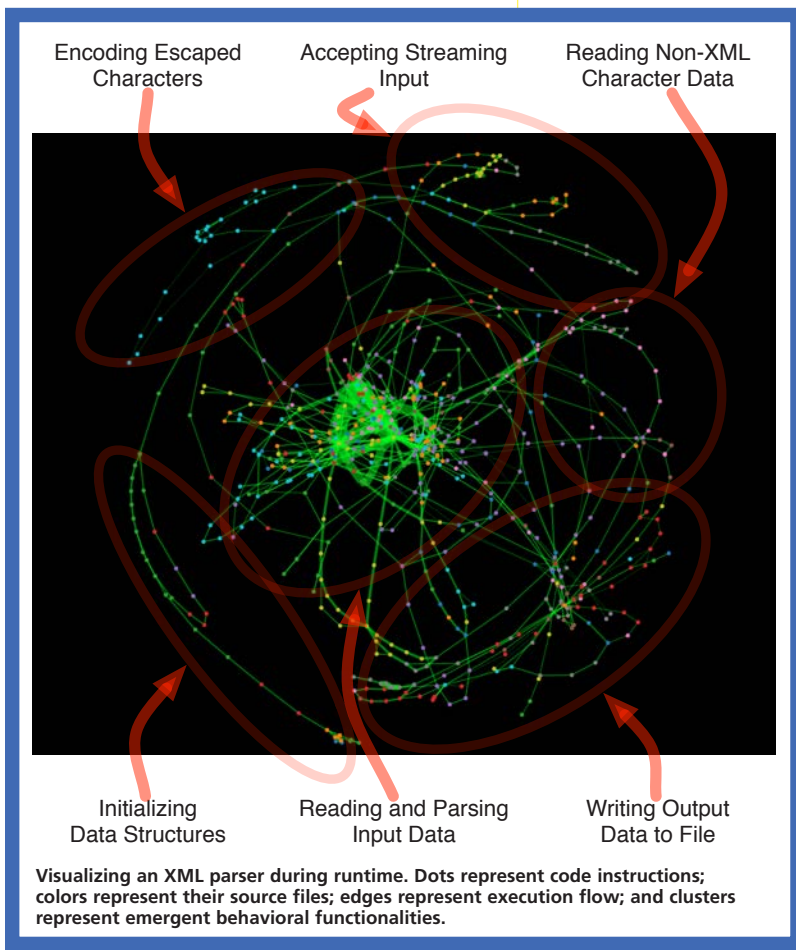
anti-patterns can be observed that lead to insights that can be otherwise difficult to diagnose and comprehend. Moreover, observation and analysis of these internal behaviors will allow developers to navigate, challenge hypotheses, and query distant effects of code execution through the development of futuristic debugging environments.

Further assisting human comprehension of large and complex software systems, Jones’s group has worked to provide automatic, natural-language characterizations of software behavior. By analyzing the software codebase for common concepts described by developers (in code “comments” and identifiers) and pairing these with observations of execution invocations, Jones’s work produces high-level natural-language descriptions of software behavior: both internal and external, and both intentional and unintentional. These automatic natural-language cues provide early and fast hints of the nature of complex behaviors.

Through such innovations and tools, Jones and his research group are working to facilitate deeper comprehension of complex software dynamics, such as its runtime behavior and the evolution of its codebase over time. Practicality and usability are ever-present goals for Jones, and he is working to turn his ideas and prototypes into systems usable by all software developers.

Jones’s research group—The Spider Lab—includes Ph.D. students **Francisco Servant**, **Nicholas DiGiuseppe**, and **Vijay Krishna Palepu**, and recent undergraduate students **Ethan Wessel** and **Lawrence Yu**.

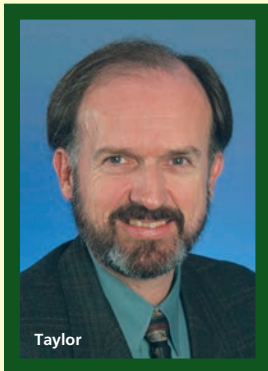
Jones is a recipient of the prestigious



## MESSAGE FROM THE DIRECTOR

"It's like déjà vu all over again."

Perhaps you saw the news headlines in late July that the Social Security Administration has spent close to \$300 million to procure a system known as the Disability Case Processing System (DCPS). According to a letter to the SSA from the House Committee on Oversight and Government Reform, "The DCPS project was intended to improve case processing quality, enhance customer service, and reduce administrative costs among SSA and state disability determination services." But unfortunately the letter goes on to say, "While the Committee supports modernizing antiquated technology, the DCPS project is costly and years behind schedule." Because of problems with the procurement, McKinsey & Company was hired to investigate. Their report notes "the project has permanently been in 'beta,' meaning a pre-release version." Indeed. According to the McKinsey report, now available in redacted form on the House Committee's website, "For [the] past 5 years, Release 1.0 [is] consistently projected to be 24-32 months away." The House letter and the redacted report never mention who the prime vendor on the procurement is, but it is easy to ascertain. Recalling my commentary in the previous issue of the ISR Connector noting some failures of a CMMI Level 5 organization at the heart of the healthcare.gov fiasco, you might think you know where this SSA story is going to end up. Well, not exactly. While the parent organization advertises in a slide deck from 2012 that it is "CMMI Level 5," a closer study reveals that the sub-group within that parent organization that has been doing the work was assessed at level 3 in 2013.



The Social Security Administration has decided to "reset" the program, and the McKinsey report addresses the possibility of transitioning to a new vendor and possibly moving some development in-house. Management failures are, of course, at the heart of this (and many other software engineering failures). Indeed, one of the prime recommendations for DCPS is that someone be put in charge. "Appoint a single accountable executive for DCPS, and centralize program management." Imagine that. At a minimum we can conclude the development has been a[nother] software engineering failure; lots of focus on process, but apparently insufficient on the product.



"Alice," Down the Rabbit Hole.

In other news, the ISR Research Forum, held at the end of May, had a major focus in the afternoon session on software-focused intellectual property. The session started with the keynote address by Pamela Samuelson, from UC Berkeley's Law School and iSchool. Her address focused on the issue of patentable subject matter and whether "software" fits into the eligible category. Her talk led up to a discussion of *Alice Corp. Pty. Ltd. v. CLS Bank Int'l*, which at the time of the Forum had not been ruled upon by the U.S. Supreme Court. As you may have read, the Supreme Court did rule on the issue, and did so unanimously, ruling that Alice's method, computer-readable medium, and system claims were invalid, being directed to a patent-ineligible abstract idea. Professor Samuelson's talk was followed by a panel directed to advising entrepreneurs on what to do about intellectual property. The panel session was exceptionally lively with lots of audience participation. Unsurprisingly there were lots of conflicting opinions about what to do. What is incumbent upon us, as researchers, is development of (intellectual) property worth protecting in the first place!

ISR Director **Richard N. Taylor** can be reached at [taylor@uci.edu](mailto:taylor@uci.edu).

National Science Foundation CAREER Award (2014), which recognizes early-career faculty whose activities form a firm foundation for a lifetime of leadership in integrating education and research. Jones is also a recipient of a National Science Foundation Computing and

Communication Foundations Award (2011) and a Google Faculty Research Award (2011). His research has also been funded by grants from Boeing and Tata Consultancy Services.

For more information on Jones's research, visit his website:

<http://www.isr.uci.edu/~jajones>

and his research group's website:

<http://spideruci.org>

Contact Prof. Jones at: [jajones@uci.edu](mailto:jajones@uci.edu).



## ISR STUDENT NEWS

**Nicholas Lopez** (A. van der Hoek, advisor) has been awarded the



Lopez

Miguel Velez Scholarship, which is for graduate students who demonstrate outstanding past academic achievement as well as future promise, and who are citizens

of a Latin American country.

**Yubo Kou** (B. Nardi, advisor) presented his paper entitled "Governance

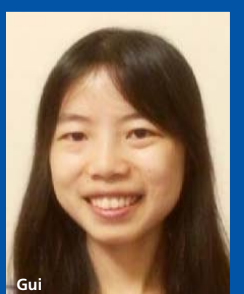


Kou

in League of Legends: A Hybrid System" at the conference on Foundations of Digital Games held at sea (Fort Lauderdale, FL to Cozumel, Mexico) in

April. The paper was co-authored by his advisor, Prof. **Bonnie Nardi**.

**Xinning Gui** (B. Nardi, advisor) is interning at the Center for Sustainable Communications, KTH Royal Institute of Technology in Stockholm, Sweden conducting a field study in the Swedish ecovillage Änggärdet



Gui

on understanding how to combine sustainability knowledge with information and communication technology in creating sustainable communities.

She is collaborating with her advisor Prof. **Bonnie Nardi**, Prof. Daniel Pargman at KTH Royal Institute of Technology, and Prof. Teresa Cerratto Pargman at Stockholm University.



Brainstorming session with participants collecting the most interesting themes, past, present, and future, related to the ongoing work under the umbrella of the SCALE grant.

## UCI hosts Workshop on Social Coordination Across Large Environments

The Department of Informatics hosted a workshop for the participants in the NSF "SCALE" grant. ISR Prof. **André van der Hoek** and ISR Prof. **David Redmiles** are co-PIs for the University of California, Irvine portion of the grant which involves three universities in total: UC Irvine, the University of Nebraska–Lincoln (ISR faculty associate and alumna Prof. **Anita Sarma**, PI), and Carnegie Mellon University (Profs. James Herbsleb, Laura Dabbish, & Linda Argote, PIs/co-PIs). The workshop brought together about 20 faculty, graduate students, post docs, and visiting researchers working together on themes of the grant. The acronym SCALE

stands for "Social Coordination Across Large Environments." This title seeks to capture a set of research themes around software tool support for distributed work environments. As many of the readers of this newsletter will know, most work today takes place using email, issue tracking systems, IM, code hosting sites (e.g. GitHub), and other tools for supporting distributed work. It is an on-going topic of research, how to best support this distributed work and how organizations are effected by and can affect distributed work. In the past, at UCI, Redmiles and van der Hoek have studied how collaborators can best maintain awareness of and coordinate one another's work, while working apart in a geographic sense. Currently under this grant, Redmiles and his team have expanded the research on awareness to seek how trust can be encouraged or engendered



SCALE workshop attendees at close of successful event.

among collaborators who may never meet. Van der Hoek and his team have expanded notions of coordination to include crowdsourcing. The teams at Nebraska, including Prof. Anita Sarma, and Carnegie

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Affiliate—Visiting	\$40,000	Visitor at UCI.
Affiliate—Grad Student	\$60,000	Graduate student research.
Partner	\$100,000 or more	Large-scale research project.

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**Debra A. Brodbeck**  
brodbeck@uci.edu  
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Mellon, including ISR alumnus **Erik Trainer**, a post-doctoral researcher, have studied how code-hosting sites such as GitHub have affected the way employers and collaborators assess one another as well as coordinate work. The researchers at Carnegie Mellon University have also studied how knowledge spreads in distributed settings with different kinds of teams. More information can be found in the publications on the web page for the SCALE group at <http://coaste.org/scalere-searchgroup/publications/>.

Two participants gave keynote addresses to kick off the workshop. Dr. Brian Skyrms (Distinguished Professor in Logic and Philosophy of Science, UCI & Stanford) gave a keynote on using game theory to model problems of cooperation. Dr. James Herbsleb (one of the grant's PIs and a Professor at Carnegie Mellon University) gave a keynote more generally on socio-technical coordination, previewing his keynote talk for the 2014 International Conference on Software Engineering (ICSE). Attendees from all three universities presented posters, and participated in multiple overall group discussions, special interest group discussions, and brainstorming sessions. The workshop took place May 13-15, enabling participants to attend the ISR Research Forum held on May 16 (see story, page 6).

Prof. van der Hoek can be reached at: [andre@ics.uci.edu](mailto:andre@ics.uci.edu).

Prof. Redmiles can be reached at: [redmiles@ics.uci.edu](mailto:redmiles@ics.uci.edu).

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Brodbeck

## ISR STUDENT NEWS

**Eugenia Gabrielova** (C. Lopes, advisor) is the recipient of the 2014 Palantir Scholarship for Women in

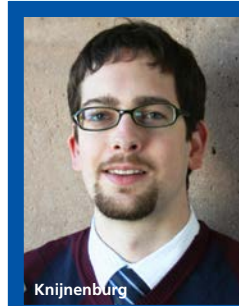


Gabrielova

Technology. The scholarship seeks to aid women in their academic careers and provide them with opportunities to learn from other women making a difference

through technological innovation. Gabrielova is interning at Rackspace this summer, working on automated monitoring for the Rackspace cloud infrastructure. Her mentor at Rackspace is Justin Gallardo.

**Bart Knijnenburg** (A. Kobsa, advisor) presented his position paper, "Information



Knijnenburg

Disclosure Profiles for Segmentation and Recommendation," at the Symposium On Usable Privacy and Security (SOUPS2014) Workshop on

Privacy Personas and Segmentation (PPS) in Menlo Park, CA in July.

**Alegria Baquero** (R. Taylor, advisor) is a summer intern at Bloomberg, working under the supervision of



Baquero

alumnus **Justin Erenkrantz**, Head of Cloud Architecture. She is working on understanding role-based permissions to Bloomberg's internal and external services through

a COAST- and formal policy-based access control approach. Baquero's internship is part of Bloomberg's sponsorship of ISR.



## ISR STUDENT NEWS

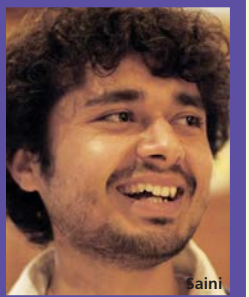
**Hitesh Sajnani** (C. Lopes, advisor) presented his paper entitled “Active Files as a Measure of Software Maintainability” in the Software Engineering in Practice Track at the International Conference on Software Engineering (ICSE 2014) in Hyderabad, India in June.



The paper was co-authored

by Lukas Schulte, Northwestern University, and Jacek Czerwonska, Microsoft Research. Sajnani also served as a student volunteer at ICSE.

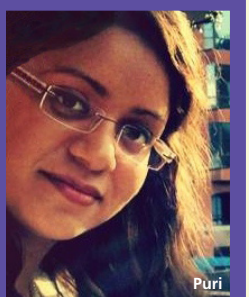
**Vaibhav Saini's** (C. Lopes, advisor) paper, “A Dataset for Maven



Artifacts and Bug Patterns Found in Them,” was accepted to the 11th Working Conference on Mining Software Repositories (MSR 2014), co-located

with ICSE 2014. The paper was co-authored by fellow Ph.D. student **Hitesh Sajnani**, alumnus **Joel Ossher**, Palantir Technologies, and Saini's advisor Prof. **Cristina Lopes**.

**Namrata Puri** (A. van der Hoek, advisor) is a program manager intern



this summer at Microsoft, in the Operating Systems Group's Enterprise and Security Division's Licensing team. Her supervisor for the internship is

Siddharth Mantri.



Ph.D. student Bart Knijnenburg presents poster on personalization and privacy at Forum Open House.

## ISR Forum: Where Research meets the Real World

ISR held its eleventh Research Forum on May 16th. The goal of the event is to foster interaction between industry and ISR researchers, and encourage research collaborations amongst all. ISR's banner event, the 2014 Forum attracted over a hundred attendees from sixteen companies, two law firms, and nine universities.

The morning portion of the program featured seven faculty presentations on topics

including: architectural styles and open software ecosystems; using games to support formal verification; diagnosing software problems through automated cause-and-effect sequence analysis; coordination in distributed software development; personalized privacy defaults; attention focus and mood in workplace online activity; and game-based learning in the classroom. ISR faculty presenters were drawn from UC Irvine, UC Santa Cruz, and the University of Nebraska-Lincoln.

The always popular open house was held over lunch and featured posters, demon-

## ISR Technical Reports Available Online

ISR technical reports present information resulting from student and faculty research carried out under the auspices of the Institute. They showcase early results not available in print elsewhere. ISR technical reports are available in PDF on the ISR website. Recent reports include:

“Green Calico - Reengineering Requirements for Sustainability for a Collaborative Drawing Tool”

Christopher Arciniega, Birgit Penzenstadler  
UCI-ISR-14-2, June 2014

“Systematic Mapping Study on Software Engineering for Sustainability (SE4S) — Protocol and Results”

Birgit Penzenstadler, Ankita Raturi, Debra Richardson, Coral Calero, Henning Femmer, Xavier Franch  
UCI-ISR-14-1, January 2014

“RCAT: A Scalable Architecture for Massively Multiuser Online Environments”

Thomas Debeauvais, Arthur Valadares, Cristina V. Lopes  
UCI-ISR-13-2, November 2013

All ISR technical reports are available at:

<http://isr.uci.edu/publications/>

strations, and visits to research labs. The open house provides an ideal opportunity for attendees to interact with researchers one-on-one and learn about projects first-hand.

The afternoon opened with a very engaging keynote by Prof. Pamela Samuelson, UC Berkeley, on "The Patentability of Software Revisited." (See Message from the Director, page 3.) A spirited panel on "Protecting Software as Intellectual Property: The Many Faces of Software Patents" followed, which turned out to be the resounding hit of the day. The panel featured four panelists: keynote Pamela Samuelson; UCI Law Professor Dan Burk; Allan Z. Litovsky, a litigator, IP attorney, and partner at Stradling Yocca Carlson & Rauth; and ISR Prof. **Nenad Medvidović**, USC. ISR Director **Richard N. Taylor** served as panel moderator. Medvidović observed that "one noticeable aspect of the panel discussion that emerged quickly was the difference in the



Forum panelists Allan Z. Litovsky, J.D., Stradling and Prof. Nenad Medvidović, USC.

perspectives brought forth by the three 'constituencies' represented in the room: (1) legal professionals with extensive expertise in patent law who are also familiar with software development; (2) academics with primary expertise in software engineering who have also been exposed to patent litigation; and (3) software engineering researchers and practitioners who are trying to understand how and to what extent patent law may pertain to them and their work." Feedback on the panel, and the 2014 Forum overall, was exceptionally enthusiastic!

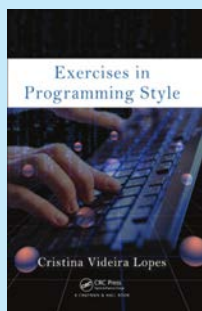
For more information on the Forum, including videos of the talks and presenters' slides, visit:

<http://isr.uci.edu/isr-events/forum/2014/>

## RESEARCH BRIEFS

Prof. **Alfred Kobsa** has been awarded a \$70,000 grant from Intel Labs to support his research on users' privacy decision-making in the context of mobile and ubiquitous computing.

Prof. **Bonnie Nardi** was a co-organizer of the "What have we learned?" SIGCHI HCI & Sustainability community workshop held at the ACM Conference on Human Factors in Computing Systems (CHI 2014) in Toronto, Canada in April. Informatics Ph.D. student Six Silberman served as lead organizer.



Prof. **Crista Lopes's** book, *Exercises in Programming Style*, has been released. Read more about Lopes and her focus on programming styles in the Fall/Winter 2013 issue of the **ISR Connector**.

Postdoctoral researcher **Thomas LaToza** co-organized the 1st International Workshop on Crowdsourcing in Software Engineering (CSI-SE), held at the 2014 International Conference on Software Engineering (ICSE), in Hyderabad, India in June.

Postdoctoral researcher **Birgit Penzenstadler** will be joining the Computer Engineering and Computer Science (CECS) Department of California State University Long Beach as a tenure-track

Assistant Professor in January 2015.

## ISR STUDENT NEWS

**Oliver Yi Wang's** (D. Redmiles advisor) paper, "New Opportunities for Extracting Insights from Cloud Based IDEs," was awarded the NIER



Innovation and Potential Impact award at ICSE 2014 in May. The paper was based on work Wang did on a summer internship at IBM T.J. Watson Research

Center, where he worked for Patrick Wagstrom. The paper was co-authored by Wagstrom, Evelyn Duesterwald of IBM T.J. Watson Research Center, and Wang's advisor Prof. **David Redmiles**.

**Maryam Khademi** (C. Lopes, advisor) presented two papers at the ACM Conf. on Human Factors in



Computing Systems in April: "Comparing Direct and Indirect Interaction in Stroke Rehabilitation" and "Free-hand Interaction with Leap Motion for

Stroke Rehabilitation." Both are co-authored by H. M. Hondori (UCI), A. McKenzie (Chapman), L. Dodakian (UCI), S. C. Cramer (UCI), and her advisor Prof. **Cristina Lopes** (UCI).

**Christian Adriano** (A. van der Hoek, advisor) has been awarded the Miguel Velez Scholarship, which is



for graduate students who demonstrate outstanding past academic achievement as well as future promise, and are citizens of a Latin American country.



## ISR EVENT SCHEDULE

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of successes that microtasking is having in revolutionizing other domains can be brought to software development. As compared to microtasking in other domains, however, software is particularly challenging to microtask: it is inherently non-uniform, steeped with dependencies, difficult to describe in terms of the functionality desired, and can be implemented in any number of ways. The fundamental question they seek to address is how the nature of software impacts what may and may not be possible in terms of microtasking. To investigate this, they are developing (1) theoretical understandings of crowd programming in terms of whether it can be achieved, in which form(s), under what conditions, and with which benefits and drawbacks, and (2) a microtasking platform, CrowdCode, that offers a tool set specifically designed to address the intricacies of crowd programming.

In their current work, LaToza and van der Hoek have focused on two aspects of software development: programming and software design. In a paper to appear at the ACM Symposium on User Interface Systems and Technology, LaToza and van der Hoek, together with Ben Towne, Carnegie Mellon University and Ph.D. student **Christian Adriano**, investigated the initial feasibility of programming with microtasks. They designed an initial environment for programming, enabling developers to write code, write tests, respond to changes, and debug through only local self-contained microtasks, and devised a technique for the system to automatically generate these microtasks. In a small lab study, they found that 12 “work-

ers” were able to successfully write 480 lines of code and 61 unit tests through 265 individual microtasks. In another study, LaToza and van der Hoek, together with visiting masters students **Micky Chen** and **Luxi Jiang**, investigated the use of software design competitions, and found that enabling designers to “steal” ideas from others, thereby creating a recombination process, enables higher quality designs to be produced.

For more information on LaToza and van der Hoek’s crowdsourcing research, visit the Software Design and Collaboration Laboratory website:

<http://sdcl.ics.uci.edu>

and see the article “Microtasking Software Development” in the Fall/Winter 2013 issue of the **ISR Connector**.

Dr. LaToza can be reached at: [tlatoza@ics.uci.edu](mailto:tlatoza@ics.uci.edu).

Prof. van der Hoek can be reached at: [andre@ics.uci.edu](mailto:andre@ics.uci.edu).

# ISR

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LaToza

## Researchers Awarded \$1.4M to Study Crowd Programming

**Thomas LaToza**, a postdoctoral research associate, and **André van der Hoek**, an ISR Professor, have been awarded \$1.4M by the National Science Foundation to investigate “Crowd Programming,” applying ideas from microtask crowdsourcing to software development.

Microtask crowdsourcing (“microtasking”) has had extraordinary success in



van der Hoek

solving a diverse set of problems, ranging from digitization of libraries and translation of the Internet, to scientific challenges such as classifying elements in the galaxy or determining the 3D shape of an enzyme. By leveraging the power of the masses, microtasking systems have demonstrated that it is feasible to complete tasks in mere days and sometimes even hours, and to take on tasks that were previously impossible because of their sheer scale.

LaToza and van der Hoek seek to address the question of whether the same kinds