# ISRConnector

INSTITUTE FOR SOFTWARE RESEARCH / UNIVERSITY OF CALIFORNIA, IRVINE

#### HOT RESEARCH

# In Search of Better Tools

With all the advances they have made in designing new software systems for all kinds of different domains, purposes, and users, one would think that software engineers would pay as much attention to improving the software they use themselves. After all, why would they not want to work with the best possible development tools they could imagine?

To a degree, software engineers do exactly that: they reflect upon their experiences with their current tool set and, when they encounter problems or identify opportunities for further improvement, they will experiment with creating new or enhanced functionality.



It is not an accident that tools such as Jenkins, Heroku, and Cloud9 were all born out of developers who recognized ways in which they could make their own lives easier.

At the same time, it sometimes takes an outsider looking in to see things software engineers themselves might not or to think of out-of-the-box opportunities that would help them work in a more effective and efficient manner. This is the specialty of ISR Professor and Informatics Department Chair **André van der Hoek** and his research group. They love thinking about, designing, and experimenting with new software development tools.

For van der Hoek, it all started during his Ph.D. work at the University of Colorado Boulder. "I have always had an interest in connecting to 'the real world'," van der Hoek says, "not wanting my research

#### **RESEARCH BRIEFS**

- Prof. **Richard N. Taylor** and alumnus **Roy T. Fielding** received the 2017 ACM SIGSOFT Impact Paper Award at the International Conference on Software Engineering (ICSE) for their paper entitled "Principled Design of the Modern Web Architecture" which was presented at ICSE 2000. The SIGSOFT Impact Paper Award is presented annually to the author(s) of a highly impactful paper presented at a SIGSOFT-sponsored or co-sponsored conference held at least 10 years prior.
- Prof. **Cristina Videira Lopes** has been appointed as ISR Interim Director beginning July 1, 2017.
- Prof. **Gloria Mark** has been elected to the CHI Academy, an honorary group of influential individuals who have made substantial contributions to the field of humancomputer interaction and have been active participants in the SIGCHI community.
- Prof. **Sam Malek** gave a keynote entitled "Android Security from a Software Architectural Perspective" at the IEEE International Conference on Software Architecture (ICSA 2017) held in Gothenburg, Sweden in April.
- Prof. **Alfred Kobsa** gave an invited talk entitled "Privacy by Design in an IoT Environment" in the Privacy-by-Design Workshop: Can engineers and organizations do it? at Hewlett-Packard Enterprise in Yehud, Israel in April.
- Prof. **Walt Scacchi** was part of the research team that received the 2017 Robert Newcomb Interdisciplinary Team Science Award from the UCI Institute of Clinical & Translational Science in the School of Medicine for their project on Telerehabilitation in the Home Versus Therapy In-Clinic for Patients with Stroke, directed by Prof. Steve Cramer and funded by the National Institute for Neurological Disorders and Strokes.

#### More Research Briefs, including Book Publications, on pages 10.

to just solve some artificial problem, but tackle issues faced by Jane and Joe developer in their day-to-day work." At the time, van der Hoek dove into configuration management, developing distributed versioning systems that explored new ways of managing conflicts stemming from par-

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12-ISR Events allel software development. He also began work in software architecture, studying design environments for software product line architectures. In both cases, van der Hoek spent countless hours programming the new tools he envisioned and putting them to the test—sometimes by actually using the experimental tools across various real-world settings and other times by recreating industrial case studies in his tools to assess the relative strengths and weaknesses of his approaches.

Since joining UC Irvine, and ISR, in January 2000, van der Hoek has continued to focus on creating new collaboration and software design tools, but also expanded his research agenda in the process. "I like it when the students bring their own concerns and possible research ideas to the table. After all, they are software developers too, growing up working with the latest development tools and understanding the



a result and issuing a directive: more like this, somewhat like this, or less like this. CodeLikeThis, then, delivers results that are similar to the chosen result, somewhat different, or divergent. In evaluating both CodeExchange and CodeLikeThis, Martie found that each can hold their own against Google (the gold standard), but that the two solutions are complementary: one works better when developers have specific results in mind, the other when their search is more openended. As such, a next step is to attempt to put the unique features of each together in a single, still easy to

limitations they innately have." An example is the work of van der Hoek's graduate student **Lee Martie**, who has been designing new code search tools as part of his dissertation research. At the time Martie started his Ph.D. work, it had become abundantly clear that software developers programmed very differently than in the years before: they now routinely search for code examples on the internet, so much so that



they can spend 20% or more of their time searching instead of actually writing code. With such an important and growing role for search. then, an opportu-

nity existed to rethink the functionality of search tools.

Martie's observation was that code search tends to be an iterative process, but that current search engines—whether Google as the default or a specialized code search engine such as SearchCode or Krugle—do little to help the programmer in iterating. That is, when the first query does not lead to the results the programmer would like to see, the programmer is left to their own devices in identifying a new set of keywords to be issued as the next search. "While we are used to searching this way," van der Hoek says, "it need not be. Indeed, some search engines provide keyword recommendations that can be added to a query with a single click. But can we do more for the programmer?"

Martie answered this challenge by designing and implementing two experimental code search engines: CodeExchange [codexchange.ics.uci.edu] and CodeLikeThis [codelikethis.ics.uci. edu]. In CodeExchange, the search tool is enriched with features through which it is possible to take aspects of the search results (e.g., the length of a code result, a method call inside a code result, a keyword common across multiple results) and add it to the query (e.g., shorter than this result, including this method call, including this common keyword) with one click. CodeLikeThis, however, takes a more radical approach: once a first set of keywords returns a first set of results, any subsequent query is issued simply by selecting

use code search engine.

Van der Hoek notes the critical role ISR alumni and corporate sponsors have played in the research. "We asked alumni and our friends in industry to take a look at our early prototypes, and were provided with a wealth of brutally honest feedback that we were able to parley into the current incarnation of the search engines," he says. "Being part of a community like ISR's is just fabulous for the research and a reason why I joined UCI in the first place."

Martie, for his part, will soon join other alumni from van der Hoek's research group—and indeed ISR—who have gone on to bring their expertise and ideas to the real world. Defending his dissertation in August, he has been recruited by Microsoft to join the Tools for Software Engineers group at Microsoft, loosely affiliated with Microsoft Research, thereby keeping with the tradition of engaging with research, but solving problems real developers experience every day.

For more information, visit van der Hoek's research group website:

http://sdcl.ics.uci.edu

Contact Prof. van der Hoek at: andre@uci. edu.

#### MESSAGE FROM THE DIRECTOR

On July 1 of this year Professor **Crista Lopes** became the Interim Director of the Institute for Software Research. Crista has served as Associate Director during this past year and will be leading ISR forward. I am very happy with this transition, as it will provide new energy to ISR as it expands in new directions. Crista is eminently qualified. She is a Distinguished Scientist of the ACM, the premier professional computer science association, and a Senior Member of the IEEE. She has been involved for several



years in leadership positions within ACM, including serving as Treasurer of the Special Interest Group in Programming Languages (SIGPLAN) and Chair of the Steering Committee of SPLASH/OOPSLA, one of the major programming conferences. She is also a member of two important ad-doc ACM committees: the Committee on Conference Reclassification, which created the new journal series Proceedings of the ACM, and a Committee on Sustainability, which is looking into how to reduce the amount of conference travel related to ACM conferences. Outside of the ACM, she is the founding Editor-in-Chief of the journal, *The Art, Science, and Engineering of Programming*.

One of the new directions ISR will be pursuing was introduced in my last Message: an increased focus on cybersecurity. I am happy to announce that the campus leadership has recognized both the importance of the topic and the appropriateness of ISR together with the Cybersecurity Policy & Research Institute (CPRI) to lead this emphasis, by awarding two faculty slots for new hires in this area. The slots are formally awarded to the School of Information and Computer Science. Stay tuned for news on faculty candidates during the coming academic year.

On page 1 of this *Connector* you can find a notice of an award that **Roy Fielding** and I recently received, the SIGSOFT Impact Paper Award. As ACM describes it, "The ACM SIGSOFT Impact Paper Award is presented annually to the author(s) of a paper presented at a SIGSOFT-sponsored or co-sponsored conference held at least 10 years prior to the award year... The papers are



judged by their influence since their publication." Our award is for the work that alumnus Roy Fielding led in creating the modern Web, in particular the REST architectural style. In addition to REST, Roy is also the first author on the HTTP/1.1 protocol spec, is an author on the URI specs, led the Apache web server project (httpd), and was the first president of the Apache Software Foundation.

My point in bringing up this old history is not to tout accomplishments or burnish medals. Rather it offers a chance to reflect on software engineering research: how it is funded, conducted, evaluated, published, and transitioned. The tale of REST, the Web, and the HTTP/1.1 protocol is certainly at odds with much current software engineering research practice. The work on these topics at ISR spanned a decade. In the early years of the work it was difficult to explain to funding agencies why the Web was a "big deal" and why they would later be glad to tout it as one of their signature

accomplishments. The University of California, Irvine had a hard time understanding why one of ISR's Ph.D. students was taking close to a decade to finish his degree. Wasn't that "slowness" indication of "inadequate progress towards the degree"? And how was this "open source" thing actually going to produce production-grade software? In hindsight it is easy to see that we made the right decisions. But at the time it was a bit of a struggle to tell the tale well. The point I want to emphasize, though, is that the accomplishments required a relentless determination to make advances that had depth, integrity, quality, and value. REST did not result from a summer research project that produced a one-off solution that no one will ever actually use. Developing REST and HTTP/1.1 required tenacity and a dedication to quality. It required building substantial software of lasting value. Kudos to Roy. I just wish all software engineering research held to the same standards and values.

Finally, given that this is my final Message, I would like to extend a most heartfelt thanks to all who have worked so hard over the past 18 years to make ISR such a success. This includes the faculty and graduate students, of course, but also our many industrial partners, some who have supported us over virtually the entire time I have served as Director. And a special thanks to the ISR staff who have ably served, running conferences, handling all the (virtual) paperwork that is endemic to large public institutions, and being the constant, professional, public face of the Institute. Most especially I would like to recognize Assistant Director, **Debra Brodbeck**, for her outstanding service. Thanks to all of you!

ISR Director Richard N. Taylor can be reached at taylor@uci.edu.

#### **ISR STUDENT NEWS**

Mahmoud Hammad (S. Malek, advisor) gave a presentation at the OC IEEE Cybersecurity chapter in March based on his Int'l Conf. on Software Architecture (ICSA) paper "Determination and Enforcement of



Least-Privilege Architecture in Android" which was presented at ICSA 2017 in Sweden in April. The paper was nominated for Best Paper and invited to appear in

the upcoming Journal of Systems and Software (JSS) special issue on Architecting Autonomous and Smart Systems. The paper is coauthored by his advisor Prof. Sam Malek and Prof. Hamid Bagheri (University of Nebraska, Lincoln).

#### Krithika Jagannath (G. Mark, advisor) is interning as a UX researcher



at Google, San Francisco this summer, working with ICS alum Dr. Julia Haines. Additionally, Jagannath received "Excellent Reviewer Recognition"

for CHI 2017 paper reviews.

Peizhao Ou (B. Demsky, advisor) presented his paper "Checking



Concurrent Data Structures Under the C/ C++11 Memory Model" at the 22nd ACM SIGPLAN Symp. on Principles and Practice of Parallel Programming

(PPoPP'17). The paper is co-authored by his advisor, Prof. Brian Demsky.



Alumni Dr. Arthur Hitomi and Dr. Jason Robbins

# Two Illustrious ISR Alumni Inducted into Second ICS Alumni Hall of Fame

Congratulations to ISR alumni Arthur Hitomi (Ph.D. 2010, advisor Richard N. Taylor) and Jason Robbins (Ph.D. 1999, advisor David Redmiles) for being inducted into the second UCI School of Information and Computer Sciences (ICS) Hall of Fame! Six ICS alumni were honored at the induction ceremony, held jointly with the School of Engineering, on February 24 at the Marconi Automotive Museum in Tustin.

Dr. Arthur Hitomi is President, Chief Executive Officer, and co-founder of Numecent. He is a recognized figure in the areas of application virtualization and streaming, has contributed to the development of Internet standards, and has authored 19 issued patents. He heads the company's overall goals and the technol-

ogy strategy, including its patent portfolio. He has led the acquisitions of other technologies and has invented and led the development of the company's products including Cloudpaging. In the past, he co-founded Endeavors Technologies and has held both industry and academic positions. Hitomi holds a B.S. with honors, M.S., and Ph.D. in Information & Computer Science from UC Irvine.

Dr. Jason Robbins has been a professional software developer since 1988, and founded the ArgoUML open source project in 1999. He played a central role in the early development of CollabNet's project hosting toolset, and was a founding member of the team behind Google Project Hosting on code.google.com. His current focus is on building collaboration tools for Google's Chrome development team. Robbins earned his Ph.D. in 1999 & M.S. in 1995 in ICS at UC Irvine.

"Since I was at ICS," Robbins reflected, "it has really shined as a top tier research and academic institution. It's humbling to think that my work played a small part in that. And I am thankful to have been part of a such a supportive community."

More info on the ICS Alumni Hall of Fame is available at:

http://tech.uci.edu/halloffame2017/

For more alumni news, see page 11.



Prof. Alfred Kobsa, Prof. Gloria Mark, Alumnus Dr. Mark Bergman, Dr. Arthur Hitomi, Dr. Jason Robbins, Prof. David Redmiles, Prof. André van der Hoek, Programmer Analyst Kari Nies, and Assistant Director Debra Brodbeck at ICS Alumni Hall of Fame Induction ceremony. Photo by Paul Kennedy.



Founding Director Richard N. Taylor receives Award of Appreciation from Interim Director Cristina V. Lopes.

# Founding Director Prof. Richard Taylor Steps Down

ISR Founding Director, Prof. Richard N. Taylor, who retired in 2013, has passed the directorship baton to Interim Director Cristina Lopes as of July 1. Taylor has served as Director since ISR's inception in 1999. Under his stewardship, the ISR faculty grew from seven members to 29, and nearly 100 ISR-affiliated students earned their Ph.D. He established the popular ISR Research Forum and Distinguished Speaker series. Under his aegis, ISR always emphasized building community and cultivating relationships with industry. Taylor also served as Director of ISR's predecessor, the Irvine Research Unit in Software (IRUS), from 1993 to 1999 and led the effort to establish ISR as a UCI Organized Research Unit-the only ORU focused on software research. We thank Prof. Taylor for his years of dedicated service

"On June 9, on behalf of the ISR community, I had the pleasure to give Prof. Taylor a plaque celebrating his leadership of the Institute over the past 2 decades. ISR is not just about software research; it's also about training and connecting people who do and benefit from software research. Prof. Taylor built an incredible community of faculty, staff, students, visitors, alumni, and industry colleagues. This community is a part of his legacy."

– ISR Interim Director Prof. Cristina Videira Lopes

"Dick was instrumental in building software engineering into a major powerhouse at UC Irvine. He had an outstanding vision for the kind of research we should be doing at UCI, how to make that research relevant and indeed have a major impact on the real world, and in the process build excellent and lasting university-industry partnerships. UCI would not be where it is today without Dick's leadership."

"I personally am indebted to Dick reaching out and recruiting me to UCI when I was still a graduate student at CU Boulder. I landed in a fantastic place with fantastic colleagues and support. Now as department chair, I would love to continue to honor and expand the legacy Dick has built."

– ICS Dept. Chair Prof. André van der Hoek

"Dick has left an indelible mark, not only on ISR, but on all of software engineering at UCI. Looking from the outside, this is visible in the long-line of students, projects, publications, and awards that he produced. Those of us who have worked with him know that his greatest contribution has been establishing an amazing work environment where relationships have always come first. Dick has been an invaluable mentor and colleague, but he is also a role model I strive to emulate, and a friend."

- Prof. Nenad Medvidović, USC

Prof. Taylor influenced the course of my career far more than any other individual. He mentored me as both an undergrad and graduate student. During my first years in grad school, I met and worked on joint research with my future colleagues at the Aerospace Corporation, an outgrowth of personal and organizational relationships that Dick had cultivated and nurtured over many years. Universityindustry relationships like these are critical for innovation - they motivate and inform academic research topics, and they infuse the latest ideas into industrial practice. At ISR-organized and supported events (ISR Forums, GSAW, and so on), I met more Aerospace engineers, got to know the company, and ultimately chose to go there upon graduation. I now serve as the Aerospace liaison to UCI and ISR, and am proud to do so. As Dick's long and fruitful directorship comes to a close, it's clear that through IRUS and ISR he has built and sustained something much greater than himself.

– Alumnus Dr. **Eric Dashofy**, The Aerospace Corporation

# Prof. Richard Taylor Receives Distinguished Alumni Award

Director **Richard N. Taylor** has been bestowed the 2017 Distinguished Engineering Alumni Award from the University of Colorado Boulder College of Engineering & Applied Science for his contributions to computer science Education. Taylor obtained his M.S. in Computer Science in 1976 from CU Denver and his Ph.D. in 1980 from CU Boulder. The awards are granted annually to outstanding graduates and friends of



Prof. Richard N. Taylor (center) with wife Lily May Taylor and alum Prof. Ken Anderson, CU Boulder.

the College of Engineering and Applied Science who have distinguished themselves through outstanding personal qualities, knowledge, and significant contributions to their fields. CU Boulder cited Taylor as a top contributor in the field of information and computer sciences who led a research group that produced the HTTP/1.1 protocol and other key technologies underpinning the web. Taylor also previously served on the CU Boulder computer science advisory board. Alumnus Prof. Ken Anderson, CU Boulder, was on hand for the award presentation. For more information: http://www.colorado.edu/cs/2017/03/28/ software-engineering-researcherreceives-colleges-top-alumni-award

#### ISR STUDENT NEWS

**Byron Hawkins** (B. Demsky, advisor) presented his paper, "ZenIDS: Introspective Intrusion Detection



for PHP Applications," at the Int'l Conference on Software Engineering (ICSE 2017), Research Track, held in Buenos Aires, Argentina in May. The

paper was co-authored by his advisor Prof. **Brian Demsky**. Hawkins spent Winter and Spring quarters as an Intern at INRIA in Grenoble, France where he worked on extending a performance debugging tool with iterative/interactive capabilities.

#### Samantha McDonald (B. Nardi

and W. Tomlinson, advisors) is interning at the Congressional Management Foundation in



D.C. this summer working on Congress 3.0 research studying how Congress can better use digital communication. The outcome will be a toolkit

Washington

distributed to House and Senate offices. She also received a GAANN fellowship for two quarters last year.

**Kyle Canavera** (S. Malek, advisor) has been awarded an NSF Graduate Research Fellowship, given to grad



ing degrees in science, technology, engineering and mathematics (STEM) fields. Awardees were chosen from over 13,000 applicants this year.

students pursu-



# 2017 ISR Research Forum: Where Research meets the Real World

ISR held its thirteenth Research Forum on June 2. The goal of the ISR Forum is to foster interaction between industry and ISR researchers, and encourage research collaborations amongst all. The daylong event featured two keynote speakers from industry; seven faculty/staff talks; an Open House with posters and demonstrations of research projects, and a reception with posters to close the day. This year's Forum attracted 140 attendees from 28 companies and organizations, as well as seven regional and national universities.

"Irvine and Orange County, in general, are home to many technology companies which either sell software solutions or integrate software in their products," said Interim Director Prof. **Cristina Lopes**. "ISR's annual Research Forum is a wonderful event that brings together many software engineers and technologists with UCI faculty and students. Along with the talks, the poster session is a highlight, as it allows participants to talk directly with the graduate students about research, and how it relates to the products developed by local companies. Building relationships between UCI and local industry is one of



Keynote Speaker Dr. Owen O'Malley

the main missions of the Institute, and we are delighted that this annual event continues to bring so many software engineering aficionados together."

The morning keynote, "Lessons from the Jungle of Open Source Big Data Development," was given by alumnus Dr. **Owen O'Malley**, Co-Founder and Technical Fellow at Hortonworks. Dr. Peri Tarr, Principal Research Staff Member, IBM T.J. Watson Research Center, delivered the afternoon keynote, "Cognitive Software Engineering: Helping Developers Work Successfully in a Cognitive World."

The seven faculty and staff technical talks covered a broad range of topics: using large datasets in software engineering-Prof. Cristina Lopes; understanding software execution behavior-Prof. **Jim Jones**; understanding the workplace experience-Prof. Gloria Mark; privacy in an IoT setting-Prof. Alfred Kobsa; legal and policy challenges in attributing cyber attacks-Bryan Cunningham, Director, UCI Cybersecurity Policy & Research Institute (CPRI); communication exploits for Android applications-Associate Project Scientist Joshua Garcia; and enhancing industry software practices for compliance with privacy laws and regulations-Prof. Sameer Patil (Indiana University Bloomington).



Arcadia Reunion: Dr. Roy Fielding, Craig Snider, Prof. André van der Hoek, Dr. Owen O'Malley, Prof. Hadar Ziv, Dr. Jason Robbins, Dr. Greg Bolcer, Kari Nies, Prof. Debra Richardson, Debra Brodbeck, and Dr. Peri Tarr.

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For more information about ISR Sponsorship, please contact:

Debra A. Brodbeck brodbeck@uci.edu (949) 824-2260

Twenty-five posters and demos were featured at the Open House, representing nine faculty members' research groups. Of note: two undergraduate students supervised by Prof. **Walt Scacchi** participated see the story about them on page 12.

A bonus this year was a reunion of sorts: almost a dozen members of the Arcadia Research Project were in attendance. The DARPA-funded Arcadia project ran for 10 years, ending in 1997. It focused on investigating tools and techniques to improve the software engineering process, and included researchers from UC Irvine, the University of Colorado Boulder, and the University of Massachusetts, Amherst, as well as industry partners.

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

http://isr.uci.edu/isr-events/forum/2017

And be sure to mark your calendars for the 2018 ISR Research Forum, to be held on Friday, June 8!



Ph.D. student Di Yang explains her work to Dr. Eric Dashofy, The Aerospace Corp. at Open House.

# Become Part of the ISR Family

Rubbing elbows with ISR faculty, staff and students gives you a valuable window into the technology landscape of the future. But a relationship with ISR can be much



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**Debra A. Brodbeck** Assistant Director brodbeck@uci.edu, (949) 824-2260

#### ISR STUDENT NEWS

**Yao Li** (A. Kobsa, advisor) presented her paper "Cross-Cultural Privacy



Prediction" at the 17th Privacy Enhancing Technologies Symposium (PETS 2017) in Minneapolis, MN in July. The paper is co-authored by her advisor

Prof. **Alfred Kobsa**, alumnus Prof. **Bart P. Knijnenburg** (Clemson University), and M-H. Carolyn Nguyen (Microsoft Corp.).

Ph.D. candidate **Lee Martie** (A. van der Hoek, advisor) will present his paper "Understanding the Impact of Support for Iteration on Code Search" at the 11th joint meeting of



the European Software Engineering Conf. and the ACM SIGSOFT Int'l Symp. on the Foundations of Software Engineering (ESEC/FSE 2017), to

be held in Sept. in Paderborn, Germany. The paper is co-authored by alumnus **Thomas Kwak** and their advisor Prof. **André van der Hoek**.

Hosub Lee (A. Kobsa, advisor) presented his paper "Privacy Preference Modeling and Prediction in a Simulated Campuswide IoT Environment" at the 15th IEEE



Conf. on Pervasive Computing and Communications held in Kona, HI in March. The paper is coauthored by his advisor Prof. Alfred Kobsa.

#### ISR STUDENT NEWS

**Mengyao Zhao** (D. Redmiles, advisor) had two papers accepted recently: "Using Collaborative



Drawing to Build Up Distributed Teams" was accepted to the IEEE Int'l Conf. on Global Software Engineering (ICGSE 2017); and

Online

"Using Playful Drawing to Support Affective Expressions and Sharing in Distributed Teams" was accepted to the 2017 IEEE/ACM 2nd Int'l Workshop on Emotion Awareness in Software Engineering (SEmotion). Both papers were coauthored by alumnus Prof. **Oliver Yi Wang** (Rochester Institute of Technology) and her advisor Prof. **David Redmiles.** 

**Daniel Gardner** (B. Nardi, advisor) presented the paper "Chat Speed



Coherence in Massive Twitch Chat" at CHI 2017 held in Denver, CO in May. The paper is co-authored by Colin Ford (first author), **Leah Horgan**, Calvin Liu, a.m.

**OP: Practices of** 

tsaasan, Gardner's advisor Prof. **Bonnie Nardi**, and Jordan Rickman. He also received a GAANN fellowship for Winter and Spring quarters.

Nicole Crenshaw (B. Nardi, advi-



sor) received "Excellent Reviewer Recognition" for CHI 2017 paper reviews. She defended her dissertation and graduated in June. Congrats!

### **ISR Hosts Visitors from NTT Software Innovation Center**

From July 1, 2016 through December 30, 2017, ISR is hosting visiting researcher Dr. **Shinobu Saito**, Senior Research Engineer at the NTT Software Innovation Center (NTT SIC), Software Engineering Project, in Tokyo, Japan. Dr. Saito's research interests are in software requirements engineering, design recovery, business modeling, and business process management. During his stay at ISR, Dr. Saito has been interacting with Prof. **André van der Hoek** and Prof. **Jim Jones**, among others. Dr. Saito's managers and colleagues from NTT SIC, Software Engineering Project have also made shorter visits to ISR, cultivating a deeper relationship between our organizations.

In February, ISR was delighted to host a visit by Saito's manager Mr. Keitaro Horikawa, Senior Research Engineer, Supervisor and Group Leader, and Mr.



Eiichi Oka, Senior Research Engineer and Supervisor. Prof. van der Hoek met with Saito, Horikawa, and Oka, exchanging ideas on a collaborative environment for agile and lean software development, IoT issues, humanmachine interfaces, and various machine

learning topics. Prof. van der Hoek provided them with a number of technical suggestions, and gave pointers to related research.

ISR was pleased to host a second group of NTT SIC Software Engineering Project visitors in April. The group was comprised of Mr. Takashi Hoshino, Project Manager, and three of his software testing team Researchers: Mr. Haruto Tanno; Mr. Toshiyuki



Kurabayashi; and Mr. Hiroyuki Kirinuki. Prof. Jones met with Dr. Saito and the group, and presented an overview of his research in software debugging and maintenance. The three NTT SIC researchers gave presentations on their research in software regression test, software fault localization, and automated program repair. Jones provided practical advice on their topics, pointed them to several studies, and recommended perti-

nent papers. He encouraged them to submit papers to international conferences such as ICST and ICSME. Jones motivated them, saying "If the paper is rejected, never give up!" The group also visited with Prof. van der Hoek and discussed key research challenges faced by NTT, the work by Dr. Saito during his stay here, and also the writing of research papers and submission of them to key conferences, such as ICSE and its SEIP track.

"The visits from NTT colleagues have been very productive for both partners," says Prof. van der Hoek. "By exchanging knowledge and ideas, research products for both NTT and UC Irvine benefit. It has been constructive getting to know the practical challenges being faced at NTT, and beneficial for my students to learn about—and have their work influenced by—these challenges. Simply being in an ivory tower as an academic is just not what we do here at ISR!"



REINFORCE workshop attendees. Prof. Sam Malek (far left), Prof. Nenad Medvidović (center, with glasses), and Associate Project Scientist Dr. Joshua Garcia (second from right).

# A Community-Wide Infrastructure for Empirical Research in Architecture-Based Software Maintenance

Over the past two decades, software architecture research has yielded many different tools and techniques for understanding the architectures of large software systems. However, the work in the area is still characterized by one-off approaches and evaluations on limited and/or proprietary datasets. More extensive empirical research and technology transfer are impeded by myriad disjoint research and development environments, lack of a shared research infrastructure, high initial costs associated with developing robust tools, and a lack of datasets needed to conduct empirical research in this domain. The resulting specialized solutions inhibit further advances in software architecture research, preventing systematic synthesis and empirical validation of novel or previously existing techniques. As a result, researchers conducting empirical studies and practitioners in need of cutting-edge tools must typically re-invent or re-implement research infrastructure (e.g., a seemingly promising technique for reverse engineering existing software systems' architectures) from scratch. In doing so, they tend to repeat each other's efforts, which wastes time and resources-especially if the previous solutions prove to be ineffective in the desired context-and repeats old mistakes instead of moving the field forward. As a result, the opportunities for potential breakthroughs in this domain are regularly missed and the field is replete with solutions that do not work as advertised beyond very limited scenarios and/or are not interoperable.

To address these challenges impeding empirical research in the domain of architecture-based software maintenance, a Software Architecture INfrastructure (SAIN) is needed that (1) provides existing tools and techniques often used in that area and domain of study to prevent researchers from wasting time trying to "reinvent the wheel" and makes those tools accessible and reusable; (2) contains a repository of architectural baselines, benchmarks, and datasets; and (3) serves as a means of integrating these tools in a manner that eases replication and reproduction of experiments, or construction of new ones based on existing tools, techniques, baselines, benchmarks, and datasets.

To meet the need for SAIN and understand the requirements of the targeted research community, four researchers have taken on the task of eliciting requirements from the software-engineering research community and running workshops based on the theme of designing and constructing SAIN. These researchers include: ISR Prof. Nenad Medvidović, a Professor in the Computer Science Department at the University of Southern California; ISR Prof. Sam Malek, an Associate Professor in the Informatics Department at the University of California, Irvine; Dr. Joshua Garcia, an Associate Project Scientist at ISR; and Prof. Mehdi Mirakhorli, an Assistant Professor at Rochester Institute of Technology, Department of Software Engineering.

Two workshops have been organized so far in support of designing and constructing SAIN. The first workshop on infRastructurEs and InstrumeNts For sOftware aRchiteCturE (REINFORCE), was held on January 11-12, 2017 at the University of Southern California, in Los Angeles. REINFORCE was structured as a mix of presentations by distinguished researchers and software architects from major companies, as well as "working sessions" intended to solicit the participants' feed-

#### ISR STUDENT NEWS

**Reyhaneh Jabbarvand's** (S. Malek, advisor) paper "μDroid: An



Energy-Aware Mutation Testing Framework for Android" has been accepted to ESEC/FSE'17 to be held in Paderborn, Germany in Sept. The paper is co-

authored by her advisor, Prof. **Sam Malek**. In May, she presented her thesis, "Advancing Energy Testing of Mobile Applications," at the ICSE'17 Doctoral Symposium in Buenos Aires, Argentina. Jabbarvand also served as an artifact evaluation committee member for both ISSTA'17 and FSE'17.

**Di Yang** (C. Lopes, advisor) presented her paper "Stack Overflow in Github: Any Snippets There?" at the 14th Int'l Conf. on Mining Software



Repositories (MSR'17), held in May in Buenos Aires, Argentina, co-located with ICSE'17. The paper is co-authored by Assistant Project Scientist **Pedro Martins,** 

Ph.D. student Vaibhav Saini, and their advisor Prof. Crista Lopes.

Chris Wolf (P. Dourish, advisor) gave a presentation in April at Northwestern University's graduate



student conference InfoSocial 2017 entitled "Data Close and Far: Exploring Human-Data Interaction Through the Case of Mobile Work." back on the aforementioned objectives of SAIN. Dr. Garcia gave a presentation introducing the original vision of SAIN and the challenges it hopes to address.

Each participant was asked to give a 10-minute lightning talk about architecture-based software engineering and the requirements the participant would like SAIN to satisfy. ISR Prof. **Crista Lopes** gave a lightning talk about her experience as one of the main architects of OpenSimulator, an open-source server platform for hosting virtual environments.

As a follow-up to REINFORCE, the First International Workshop on Establishing the Community-Wide Infrastructure for Architecture-Based Software Engineering (ECASE) was held at the 39th International Conference on Software Engineering (ICSE) in Buenos Aires, Argentina on May 22, 2017. In addition to the continued focus on requirements elicitation, planning, and design of SAIN, ECASE featured refereed paper presentations on novel tools and techniques, or useful benchmarks or datasets, that support empirical research on architecturebased maintenance.

Two keynotes were given at ECASE. Jane Cleland-Huang, a Professor in the Department of Computer Science and Engineering at the University of Notre Dame, gave a keynote presentation on lessons learned by the traceability community in their efforts to build a community-wide research infrastructure. Rick Kazman, Professor in the Information Technology Management Department at the University of Hawaii, gave a presentation on reproducibility problems in the field of software engineering and ideas about how to improve that discipline.

In the next phase of SAIN design and construction, Medvidović, Malek, Garcia and Mirakhorli will work to build: a means of gathering and organizing requirements online, including online surveys; a website showing the requirements the community have converged on so far; and an initial SAIN prototype. This prototype will serve as a pilot study for SAIN. The project will conclude with another workshop to assess the state of the infrastructure and how to move forward with it as a community.

The ECASE 2017 Proceedings is available on the IEEE Xplore and ACM Digital

#### **RESEARCH BRIEFS**

Chancellor's Professor of Informatics and ISR faculty member **Paul Dourish** has published a new book about the digital representations that help shape our computerized existence entitled *The Stuff of Bits: An Essay on the Materialities of Information.* The book presents an argument that the material arrangements of information—how it is represented and interpreted—matter significantly for our experience of information and information systems. Published by The MIT Press in May.



Prof. **Bonnie Nardi**, with Hamid R. Ekbia of Indiana University

Bloomington, has co-authored the book *Heteromation, and Other Stories of Computing and Capitalism* wherein they explore the social and technological processes through which economic value is extracted from digitally mediated work, the nature of the value created, and what prompts people to participate in the process. Published by The MIT Press in May.

Interim Director **Cristina Lopes** has been included on the list "Women of VR - 35 Ladies Who Are Killing It In Virtual Reality" published by VIAR360.

Assoc. Proj. Scientist Joshua Garcia presented the paper

"A Taxonomy and Qualitative Comparison of Program Analysis Techniques for Security Assessment of Android Software" at the Int'l Conference on Software Engineering (ICSE), Research Track, held in Buenos Aires, Argentina in June. The paper is co-authored by graduate student **Alireza Sadhegi** (first author), Prof. **Hamid Bagheri** (Univ. of Nebraska-Lincoln), and Prof. **Sam Malek**, and appeared in the June 2017 issue of *IEEE Transactions on Software Engineering*.

Libraries. Additional information is available at the ECASE website: http://design.se.rit.edu/ECASE/ Dr. Joshua Garcia can be reached at: joshug4@uci.edu.

# **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:

"An Augmented Reality Interface for Game Based Stroke TeleRehabilitation" Arzang Kasiri and Walt Scacchi UCI-ISR-17-3, June 2017

"Just-In-Time AR-Based Learning in the Advanced Manufacturing Context" Bryce Tham and Walt Scacchi UCI-ISR-17-2, June 2017

**"An Energy-Aware Mutation Testing Framework for Android"** Reyhaneh Jabbarvand and Sam Malek UCI-ISR-17-1, January 2017

All ISR technical reports are available at: isr.uci.edu/publications/



# **Congratulations Graduates!**

Join us in wishing our recent graduates well as they move on to new jobs around the country. Three cheers to one and all!

- **Nicole Crenshaw** (Ph.D., advisor B. Nardi) is now a UX Researcher Intern working with the Battle.net User Experience team at Blizzard Entertainment in Irvine, CA.
- **Yong Hun Eom** (Ph.D., advisor B. Demsky) is now a Software Engineer at Twitter in Seatle, WA.
- **Michael Gorlick** (Ph.D., advisor R. Taylor) has resumed his role as a senior member of the technical staff at The Aerospace Corporation.

Thomas Kwak (M.S., advisor A. van der Hoek) is on the job market.

- **Vijay Pelapu** (Ph.D., advisor J. Jones) has accepted a position as a Software Engineer at Microsoft in Redmond, WA.
- Ankita Raturi (Ph.D., advisors B. Tomlinson and D. Richardson) is on the job market.
- Arthur Valadares (Ph.D., advisor C. Lopes) is now a Database Software Engineer at Rockley Photonics in Pasadena, CA.

Yiran Wang (Ph.D., advisor G. Mark) is on the job market.











# Alumni Event at Electronic Arts (EA) in Bay Area



Julia Haines, Informatics alumna, with ISR alums: Nilmax Moura (MS 2011; A. van der Hoek, advisor); Tiago Proenca (MS 2011; A. van der Hoek, advisor); Prof. André van der Hoek; Leyna Cotran (Ph.D. 2013; R. Taylor, advisor); and Rohit Khare (Ph.D. 2003; R. Taylor, advisor).

The Schools of ICS and Physical Science held an alumni event at Electronic Arts (EA) in the northern California Bay Area on March 28. The event provided a great opportunity for ISR alumni and faculty to reconnect, network, and establish new relationships. ISR alums in attendance included: **Leyna Cotran**, Process Manager, ARMUS Corp. and Lecturer, Santa Clara University; **Rohit Khare**, Product Manager, Google; **Nilmax Moura**, Senior Full Stack Software Engineer, VMware; and **Tiago Proenca**, Software Engineer, VMware. Prof. **André van der Hoek** joined them for the exciting event.

# **Richardson's Alums Reunite at ISR Forum**



Michelle Rousseau (Ph.D. 2007), Owen O'Malley (Ph.D. 1996), Prof. Debra Richardson; Hadar Ziv (Ph.D. 1997), Kristina Winbladh Nasr (Ph.D. 2010), and Jose Romero-Mariona (PhD. 2010).

The ISR Research Forum on June 2 enabled a reunion for Prof. Debra Richardson and a number of her alumni, including: Prof. **Michelle Rousseau**, Chair, Dept. of Computer Science, Saddleback College; Dr. **Owen O'Malley**, Co-Founder and Technical Fellow, Hadoop/HortonWorks—and Forum Keynote speaker; **Hadar Ziv**, Lecturer, Dept. of Informatics, UCI School of ICS; Dr. **Kristina Winbladh Nasr**, Technical Program Manager, Google; and Dr. **Jose Romero-Mariona**, Lead Research Scientist, Space and Naval Warfare Systems Command, Pacific (SPAWAR).



Arzang Kasiri and Bryce Tham, ICS Class of 2017.

# Undergrad Students Demonstrate Augmented Reality Software Development Capabilities

Starting in Spring 2016, two ICS undergraduate students, **Arzang Kasiri** and **Bryce Tham**, sought to get involved in a research project at ISR. Prof. **Walt Scacchi** agreed to serve as their faculty mentor. This relationship was then formalized through a full-year of ICS-Honors coursework in directed research under Scacchi's direction. As both Kasiri and Tham were



interested in computer game development, and also in software development, the next step was to identify possible projects they could participate in, and make substantive condent directed

tributions through independent directed research, all leading to a showcase project demonstration and final technical report.

Scacchi has been engaged in collaborative team science projects in the Neural Repair Laboratory, directed by Prof. Steve Cramer, at the Stem Cell Research Center, UCI School of Medicine, and in the national Clean Energy Smart Manufacturing Innovation Institute (CESMII) project at Calit2 directed by Prof. G.P. Li. Both of these efforts are pursuing research and development of

#### **ISR EVENT SCHEDULE**

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February 26 - March 1, 2018 Ground System Architectures Workshop (GSAW 2018) Held in cooperation with ISR.

gsaw.org

Friday, June 8, 2018 ISR Research Forum: Where Research Meets the Real World

The 2017-2018 ISR Distinguished Speaker Series will be announced in Fall.

We look forward to seeing you!

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new systems for training using computer games and Augmented Reality (AR) user interface displays and user experiences. These two projects provided the basis for the directed research studies by Kasiri and Tham, with Kasiri taking on AR-based computer game development supporting stroke telerehabilitation clinical research at the Neural Repair Laboratory, and Tham focusing on just-in-time training research for advanced manufacturing production lines.

During Spring and Summer 2016, Arzang and Bryce were tasked to become knowledgeable with prior research and practice in computer games and AR in their respective project areas. This was followed in the Fall with them taking on the challenge of preparing and submitting a research proposal for funding to the UCI Undergraduate Research Opportunities Program (UROP) to cover expenses associated with the project work. Their proposals were selected and funded by UROP during Winter 2017, leading up to the completion and demonstration of their project results at the UROP Symposium on May 20, in both formal presentation and poster format. Kasiri's and Tham's posters were both chosen to be included in the exclusive group of Best Posters. Two weeks later they had a second opportu-

#### SPECIAL THANKS

The UCI Institute for Software Research is generously supported by:

NTT Software Innovation Center The Aerospace Corporation nity to present their projects at the ISR Research Forum in June. Noteworthy here is that their project demonstrations and poster presentations at the Forum's Open House session positioned their work along side that of graduate/doctoral student projects associated with other ISR faculty, and both received highly favorable reviews from Forum participants.

Both of these efforts were memorialized as ISR technical reports and are available in the online ISR Publications. Finally, both Kasiri and Tham graduated with undergraduate degrees in Computer Science from UCI in June 2017.

Prof. Scacchi can be reached at wscacchi@ ics.uci.edu.

# ISR

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