

HOT RESEARCH

Towards an Accessible World: A Software Engineering Approach

The ability to use software with ease is important for everyone, especially for the approximately 15% of the world population with disabilities. Even the simplest operations, taken for granted by non-disabled users, can be daunting tasks for disabled users. A recent observational study found that to simply open a web browser, enter a search term, and navigate to the first result on a mobile device, it can take over 50 interactional turns for a blind person. Because of this, blind users often resort to rote memorization of navigation sequences, decline to update apps they have committed to memory, or stop using apps altogether.



Sam Malek

According to professor **Sam Malek**, “For decades, the software engineering research community has been developing techniques to evaluate and improve the quality attributes (e.g., reliability, security) of software. Among the various quality attributes, however, accessibility has received significantly less attention in the literature. This is while software organizations are in dire need of solutions that can help them develop and deliver accessible software.” Professor **Iftekhar Ahmed** adds, “Mandates from government regulations, such as the Rehabilitation Act and the Americans with Disabilities Act (ADA) are bringing further attention to accessibility



Iftekhar Ahmed

factors in software. In fact, the number of software accessibility-related lawsuits has been growing rapidly, by 180% in just the past year.”

Malek and Ahmed believe there is an

RESEARCH BRIEFS

Professor **Gloria Mark**, professor Suellen Hopfer of UCI Public Health, and professor Chen Li of UCI Computer Science have been awarded \$180,000 from the National Science Foundation for a RAPID grant for their research on “Leveraging Twitter Data for Real-time Public Health Responses to Coronavirus: Identifying Affective Desensitization, Loneliness and Depression, and Trust.”

Professor **Cristina Lopes** is co-chair of the newly established ACM Presidential Task Force on Virtual Conferences, which was established in March in response to a proposal to ACM by Lopes and fellow co-chairs Benjamin Pierce of University of Pennsylvania and Jeanna Matthews of Clarkson University. Collaborating with a group of technology experts, the task force produced a set of guidelines: “Virtual Conferences: A Guide to Best Practices.”

Professor **Cristina Lopes** is serving as the Virtualization Chair for ICSE 2020 which is being held virtually, for the first time, from June 27 to July 19.

Chancellor’s Professor **Paul Dourish’s** CHI 2020 paper titled “On Being Iterated: The Affective Demands of Design Participation” received a Best Paper award. The paper is co-authored by Christopher Lawrence and Tuck Wah Leong of University of Technology Sydney and Greg Wadley of University of Melbourne.

Professor **Joshua Garcia** gave a talk titled “Android Malware Detection: From Obfuscation Susceptibility to Obfuscation Resilience” at NortonLifeLock in Culver City, CA on March 24. NortonLifeLock is a major software security company.

Professor Emerita **Bonnie Nardi** was bestowed the ACM SIGCHI 2020 Social Impact Award which honors those who have past or current work in the HCI profession that demonstrates social benefit. Nardi was one of two recipients of the 2020 award.

More Research Briefs on page 9.

opportunity to improve the lives of millions of disabled users through innovative, interdisciplinary research at the intersection of software engineering and accessible computing. Their objective is to develop software engineering solutions for use by developers to eliminate accessibility issues prior to the release of software. Broadly, ISR research in this area can be categorized under three thrusts: (1) Understanding the disabled users’ concerns. Disabled users have unique concerns that are often poorly understood by software developers. (2) Means of identifying and presenting accessibility issues to developers in an effective way. For instance, identifying accessibility issues and ranking them based on their impact on the overall usability of the application, thereby allowing developers to prioritize their effort in resolving them. (3) Automatic solutions for fixing the accessibility issues. For example, by mining fixes

IN THIS ISSUE

- 2-Message from the Director
- 4-SoCal Software Engineering Symposium (SuCSES 2020)
- 5-Bolcer and Gallardo Valencia Inducted into ICS Alumni Hall of Fame, Alumni News
- 6-Taylor and Gallardo Valencia Graduate Student Awards
- 7-Recent Graduate Jabbarvand’s Software Energy Behavior Research
- 7-11-Student News
- 9-Research Briefs
- 10-Sponsorship, Graduations
- 11-Asst. Dir. Brodbeck Retires
- 12-ISR Events

MESSAGE FROM THE DIRECTOR

I hope all of you are safe and sound in light of the pandemic pandemonium. It has been a crazy few months since I communicated with you last. Like most organizations around the world impacted by COVID-19, ISR has had to make drastic changes to its activities. Notably, we had to cancel the ISR Distinguished Speaker series for the remainder of the year. We are planning to reschedule the visit of our two remaining distinguished speakers, Tim Menzies and Myra Cohen, once the situation improves. We are also reevaluating our future events as the situation evolves.

In other news, at the end of June ISR's Assistant Director **Debra Brodbeck** is retiring with approximately 30 years of service at UCI. For most of us, Debi is synonymous with ISR and it is hard to imagine one without the other. She has run the day-to-day operations of the Institute since its inception. I have had the pleasure of working with Debi closely in the past two years as the Director of the Institute. She could not have made the job any easier for me. I am grateful for all of her service to ISR and wish her a wonderful retirement. We are planning to have an event to celebrate Debi's retirement once such gatherings are allowed again on campus. Please stay tuned for that.



Stay safe!

Software Engineering in the Age of Pandemic

While the pandemic has undoubtedly impacted software professionals all around the world, it is fair to say we are quite lucky. Compared to many other professions, software engineering is relatively pandemic-proof. Software engineers and software companies have long mastered the notion of remote work. Software engineers habitually use numerous software development tools (e.g., version control systems, issue trackers) that among other benefits facilitate remote collaborative work. Similarly, software engineering research is not

impacted as drastically as some of the other disciplines, say Biology or Chemistry, where without access to laboratory equipment, it is impossible to conduct certain types of experiments. The exception perhaps is those working on human aspects of software engineering, which naturally involves extensive in-person interaction.

Arguably, the most drastic impact in our field has been on the conferences. So far, numerous software engineering conferences have had to either cancel or move to a later date. This has really challenged the research community, since conferences are the primary publication venues for software engineering research. For the first time in its history, ICSE, the premier conference in the field, has decided to go fully virtual. In fact, ISR is playing a critical role in this, continuing ISR's long history of service to the research community. ISR professor **Crista Lopes** has been tapped as the Virtualization Chair of the conference. She is assisted by a team of ISR faculty and students. The main conference is expected to be streamed live from three locations in the world, at three different times in the day, in the second week of July. UCI will be the production headquarter for the Pacific Time zone, aimed to mainly serve North/Central/South America, Asia, and Australia.

It will be interesting to see what will be the impact of the pandemic on the future of software engineering conferences. Virtual conferences have a number of benefits. Among them are the reduction of carbon footprint due to reduced conference travel and increased participation, particularly from underrepresented countries. Lost in a virtual conference, however, are the side conversations and hallway chatter that are regarded by many to be more valuable than the formal technical talks, particularly for junior researchers. In the Fall/Winter 2018 *ISR Connector*, I wrote about the blurring line between software engineering conferences and journals. If virtual conferences become the norm, I expect that line to get even more blurry and possibly non-existent. We are at a critical time. It all depends on how successful the virtual conferences will be this year. If successful, in-person software engineering conferences may soon become a thing of the past, for better or worse.

Prof. **Sam Malek** can be reached at malek@uci.edu.

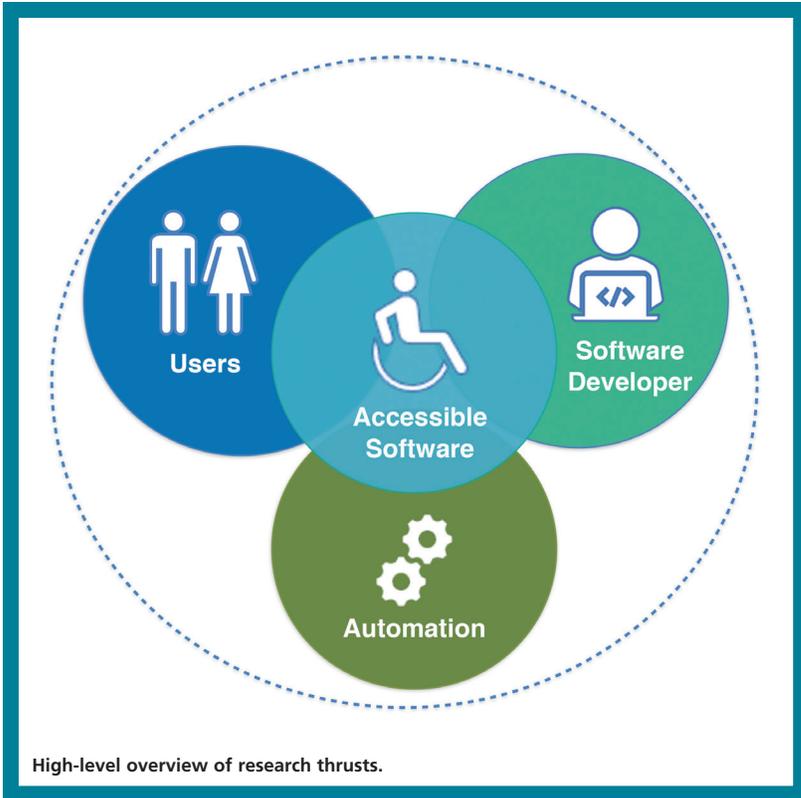
from the large repositories of open-source applications.

While elaborating more regarding the first thrust of research, Ahmed explains, the software engineering community by and large does not have a good understanding of the challenges faced by disabled users. For instance, all of the existing techniques for detection of accessibility issues in software focus only on individual UI elements, e.g., check the color contrast or font size of

a UI widget, or determine whether a button has a proper label for screen reader. However, recent research shows that even if all UI elements are individually free from known accessibility issues, the overall functionality composed of those elements may be prohibitively difficult to use. Thus, the first research thrust aims to better understand the challenges faced by disabled users through conducting observational studies. Malek and Ahmed believe such studies will be quite informa-

tive, providing them with detailed insights into the challenges faced by disabled users.

The second thrust of research has resulted in the largest empirical study to-date, aimed at understanding the prevalence of accessibility issues in Android apps. To evaluate the accessibility features of Android apps, **Abdulaziz Alshayban**, a software engineering Ph.D. student co-advised by Malek and Ahmed, developed an automated accessibility evaluation



es on automat- ed accessibility repair. Malek explains, “To the best of our knowledge, none of the existing soft- ware engineer- ing tools rec- ommend ways of fixing the accessibility issues. Only identifying the problems and not rec- ommending ways to fix them leads to developer apathy toward adopting the tools. We are creating a large data- set of mobile applications

more future work in this space. In fact, Malek, Ahmed, and Informatics profes- sor Stacy Branham recently received a School of ICS Exploration grant to work toward solutions for improving the acces- sibility of software. Malek explains, “In spite of the promising results we have obtained so far, our tools suffer from the well-known limitations of static program analysis and produce a large number of warnings (a.k.a., “wall of bugs”), making it difficult for developers to sift through them to identify the important accessibil- ity issues.” To mitigate these limitations and make the technology more useful for practitioners, Malek and Ahmed are now working on combining dynamic analysis with static analysis to reduce the number of generated warnings and to prioritize them. Additionally, they are developing tools to provide application designers and developers with suggestions and examples to fix accessibility issues.

For more information on these projects visit Malek’s Software Engineering and Analysis Lab (SEAL) website: <https://seal.ics.uci.edu/> and Ahmed’s Software Engineering & Testing Using Artificial Intelligence for Reliable Software (STAIRS) website: <http://stairs.ics.uci.edu/>.

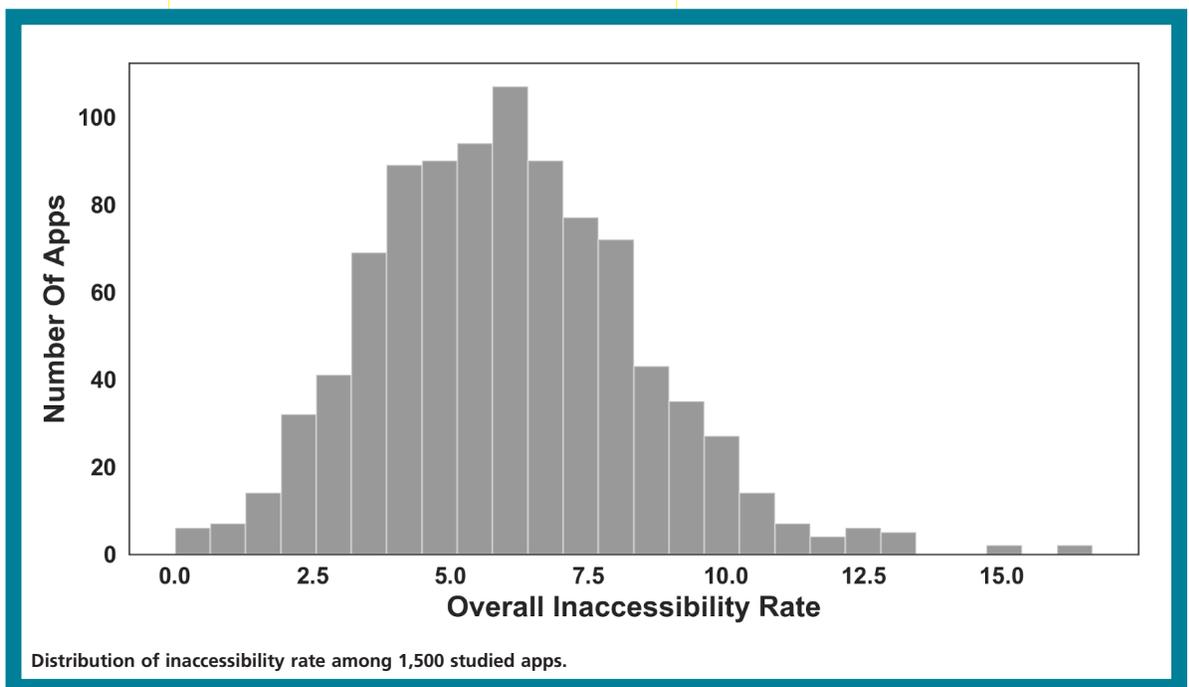
Contact professor Sam Malek at [malek@ uci.edu](mailto:malek@uci.edu) and professor Iftekhar Ahmed at [iftekha@ uci.edu](mailto:iftekha@uci.edu).

tool that is capable of reporting 11 types of accessibility violations in Android. In extensive experiments on a dataset of 1,500 Android applications, the research- ers found that almost all apps (99.6%) are riddled with accessibility issues, hindering their use by disabled people. On aver- age, the apps had an inaccessibility rate of 6.4%, i.e., ratio of inaccessible user interface elements in apps to all user interface elements. They then investigated the developer sentiments through a survey of 66 developers aimed at under- standing the root causes of so many accessibility issues. They found that developers in large part are unaware of accessibility design prin- ciples and analysis tools, and the organizations in which they are employed do not place a premium on accessibility. The result of this work has been accepted for publication at ICSE 2020 – the International Conference on Software Engineering.

with “positive” and “negative” accessibil- ity experiences. In our next steps, we will examine ways of leveraging this data to recommend suggestions and examples to fix accessibility issues, and eventually automatically fix the issues whenever possi- ble.”

Malek and Ahmed believe there is a lot

The third thrust of ISR research in this space focus-





Keynote Speaker Dr. Evelyn Duesterwald.



Keynote Speaker Dr. Daniel M. Russell.

Southern California Software Engineering Symposium (SuCSES) Connects Industry with University Researchers

ISR held its second annual Southern California Software Engineering Symposium (SuCSES) on January 24. The goal of this event is to bring together researchers, leaders in industry, and technical practitioners to Southern California to discuss trends in the field of software engineering, showcase current research, formulate visions on strategic future research and technological directions, and build community.

SuCSES 2020 featured two exciting keynote speakers. The event opened with Dr. Evelyn Duesterwald, Principal Research Staff Member and Manager, AI Lifecycle

Acceleration at IBM T.J. Watson Research Center. In Duesterwald’s keynote presentation, titled “Engineering the End-to-End AI Lifecycle,” she discussed the end-to-end lifecycle for machine learning models and ways to operationalize it using reusable components. The afternoon keynote talk was given by Dr. Daniel M. Russell, Senior Research Scientist for Search Quality and User Happiness at Google. His talk, titled “The Joy of Search: Adventures in teaching online research skills (and why that’s important for software engineering),” included a discussion of his experience teaching a massive open online course (MOOC) which has had over 4 million students.

One goal of SuCSES is to building community among software engineering researchers. To this end, the program included talks by faculty from three universities in addition to those from UCI. The speakers were: professor Chao Wang from USC; professor Yu Sun from Cal Poly Pomona; professor Na Meng from Virginia Tech; and professors Joshua Garcia, James A. Jones, and David Redmiles from UCI ISR.

The speakers were: professor Chao Wang from USC; professor Yu Sun from Cal Poly Pomona; professor Na Meng from Virginia Tech; and professors Joshua Garcia, James A. Jones, and David Redmiles from UCI ISR.

A poster and demo session held over lunch featured 18 projects, presented by

students from UCI as well as USC. This always popular session, held over lunch, provided a great opportunity for attendees to meet graduate students, interact one-on-one with researchers, and learn about research projects firsthand.

A new opportunity was added this year: a career-oriented mixer at the end of the day enabled industry participants to meet students looking for jobs and internships—in particular, students from the professional Master of Software Engineering (MSWE) program, who are required to have a summer internship.

SuCSES 2020 attracted over 160 attendees from 20 companies, and 11 regional, national, and international universities—making it a true success! Attendees commented enthusiastically on the applicability of the keynote talks to their work, the germane research addressed in the faculty talks, and the prospects for meeting graduate students at the poster/demo session, the career-oriented mixer, and throughout the day.

“I have been attending SuCSES and the previous ISR Research Forum every year since I graduated,” said alumnus **Arthur Valadares** (Ph.D. 2016, advisor C. Lopes), Staff Software Engineer, Rockley Photonics. “I work at a start-up where I am responsible for most software engineering decisions, where little existing software infrastructure exists. The symposium presentations and posters provide an opportunity to follow research trends that help me navigate best practices for industry. At this year’s symposium, I also had the opportunity to recruit a promising student from the new professional Master of Software Engineering (MSWE) program for a summer internship. I certainly look forward to attending next year as well.”

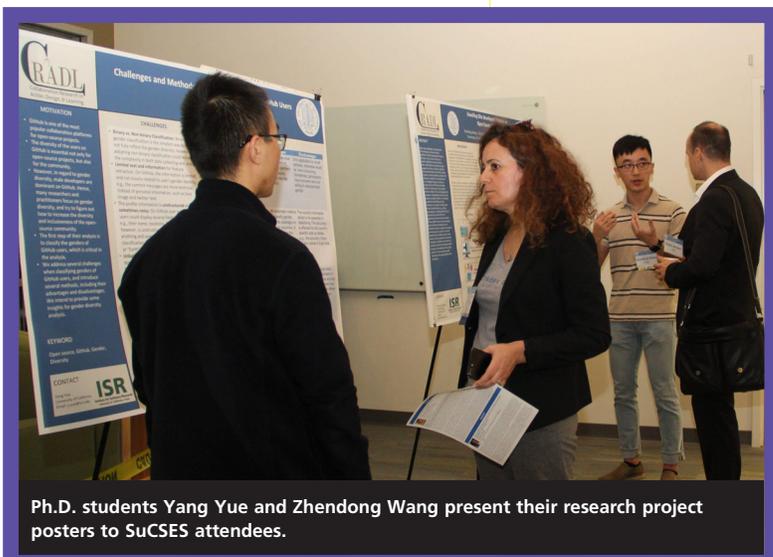
For additional information, visit the SuCSES 2020 website:

<http://isr.uci.edu/isr-events/symposium/2020/>

Videos of the talks are available on the SuCSES 2020 website and the ISRUCI YouTube channel.

You can read more about SuCSES 2020 in this article by ICS senior writer Shani Murray:

<https://bit.ly/2UP5AJh>.



Ph.D. students Yang Yue and Zhendong Wang present their research project posters to SuCSES attendees.



Alumni Gregory Alan Bolcer (left) and Rosalva Gallardo Valencia (right) with ICS Dean Marios Papaefthymiou upon induction into the ICS Alumni Hall of Fame.

Greg Bolcer and Rosalva Gallardo Valencia Inducted into the ICS Alumni Hall of Fame

Congratulations to **Gregory Alan Bolcer** (Ph.D. 1998; Richard N. Taylor, advisor), and **Rosalva Gallardo Valencia** (Ph.D. 2012; Susan Elliott Sim, advisor) for being inducted into the ICS Alumni Hall of Fame! The Engineering & ICS Alumni Hall of Fame Celebration was held on February 28 at the Discovery Cube Orange County in Santa Ana, CA. Donald Bren School of Information and Computer Sciences (ICS) Dean **Marios Papaefthymiou** bestowed the awards to the ICS inductees.

Greg Bolcer is the Chief Data Officer at Bitvore. He has held multiple Chief Technology (CTO) and founder positions at several of Orange County's most successful startup companies. He holds three degrees: a B.S. and Ph.D. from UCI ICS and an M.S. from USC.

Upon graduating with his B.S., Bolcer started his career working for Prof. **Richard Taylor** as a programmer on the Arcadia research project after being introduced to software engineering through an undergraduate project course taught by Prof. **Debra Richardson**. He earned his M.S. from USC while being both a full-time student at USC and a full time employee at UCI. After a couple of years of research, he joined the ICS Ph.D. program in 1995. He was the project lead for

the world's largest Java project outside of Sun Labs in 1995. While at ICS, he built the world's very first microservices architecture based on HTTP, WebDAV, and the REST architectural style called Magi (Micro-Apache Generic Interface) by developing a peer-to-peer version of the Apache HTTP open source project.

Bolcer founded three startup companies, worked for three others including his current company, and has been an advisor to at least a dozen others. Throughout the course of his career, he has authored close to two dozen software patents and broken a lot of new ground creating innovative, new software products. He also is an active participant in OC's startup community and regularly conducts due diligence for investors and reviews for early stage entrepreneurs. He's been a judge for ICS's student startup contests and a visiting lecturer both at UCI and USC from time to time.

"I only think that I'm where I am in my career because I am standing on the shoulders of others," said Bolcer. "ICS is truly a special place. There are amazing people doing amazing stuff that is well known all over the world. While other universities may have greater name recognition, UCI in general and Information and Computer Sciences specifically have been quietly doing the things that truly make a difference in people's lives. ICS has become students' top choice."

Rosalva Gallardo Valencia is a Senior Program Manager at Google in Silicon Valley, where she leads global pro-

Alumni News

Roy Fielding (Ph.D. 2000, advisor



Fielding

R. Taylor), a Senior Principal Scientist at Adobe, is serving as Chairman of the Apache Software Foundation. This is Fielding's third stint as an ASF

Board Member.

The paper titled "Be Water: Technologies in the Leaderless Anti-ELAB



Kow

Movement in Hong Kong," by professor **Yong Ming Kow** (Ph.D. 2011, advisor B. Nardi) of City Univ. of Hong Kong, professor emerita **Bonnie Nardi**, and Wai Kuen Cheng,

received an Honorable Mention (top 5% of submissions) at CHI 2020.

Sylvia Lindtner (Ph.D. 2012, advisor P. Dourish), has been awarded



Lindtner

tenure at the University of Michigan. Lindtner holds positions in both the School of Information and the Penny W. Stamps School of Art and Design.

Mengyao Zhao (Ph.D. 2018, advisor



Zhao

D. Redmiles), is now a User Experience Researcher at WhatsApp Inc., in San Francisco, California.

grams to advocate for both Strategic 3rd Party Software Developers and Google Developer Products. Before joining Google, she worked as an Engineering Manager at Intel Corporation in Silicon Valley leading global software quality programs. Gallardo Valencia started her career as a Software Engineer in the IT Department at the Pontifical Catholic University of Peru. Later, she worked at Novatronic as an Engineering Manager leading teams creating software for banks and telecoms.

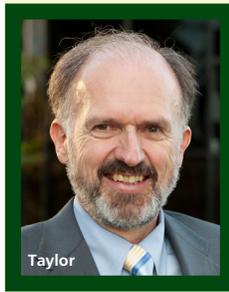
Gallardo Valencia is committed to empowering women and Latin@s to be leaders in the field of computing. She led the Google.org collaboration with Laboratoria which is transforming tech education for women in Latin America. She was selected to represent Google in the Technolochicas TV campaign to inspire Latinas to pursue careers in Technology. She is the co-founder of PeruSV.org a non-profit organization with the mission of closing the technology gap between Peru and Silicon Valley. She is also the co-founder of Techsuyo, the annual conference that brings together Peruvian Tech Professionals in the US and Peru. Techsuyo has been held successfully at Stanford, MIT, and UC Berkeley. In 2019, Techsuyo was held in Peru and brought together 300+ professionals and inspired 700+ students to pursue careers in Technology. Gallardo Valencia, in collaboration with the UCI Foundation, created the Rosalva Gallardo Valencia Graduate Award to celebrate her Latino heritage and support Ph.D. students at UCI.

Gallardo Valencia reflected on the induction: "I am honored and very grateful to have been inducted into the ICS Hall of Fame and to have been the ICS featured speaker during the Celebration! The HoF Celebration was very special because people who supported me the most during my UCI journey and people who now I support at UCI were with me, sharing this moment. My mother, sister, and niece came from Peru and my Ph.D. advisor **Susan Sim** came from Canada for the Celebration. Also, **Adriana Meza Soria**, the first recipient of the Gallardo Valencia Fellowship, was in the audience. It was an unforgettable event where I connected with familiar and new UCI alumni."

Photos from the induction ceremony are available on the ISR website.

Join us in our Mission to Support our Students by Contributing to these Software Engineering Graduate Awards

The UCI Donald Bren School of Information and Computer Sciences (ICS) has two graduate awards geared towards supporting software engineering students. Are you interested in supporting our students through these awards?



Taylor

The **Richard N. Taylor Graduate Award in Software Engineering** was established in Fall 2018. This was the first award in ICS specifically dedicated to software engineering. It honors the legacy of ISR Founding Director and Chancellor's Professor Emeritus **Richard N. Taylor**. You can read more about it online at: <https://bit.ly/3e9h3uQ>.

Your tax-deductible donation can be made online at: <https://bit.ly/2VsX6se>.



Gallardo Valencia

The **Rosalva Gallardo Valencia Graduate Award in ICS** was established by alumna **Rosalva Gallardo Valencia** (Ph.D. 2012) to honor her Latino heritage and support graduate students in need. The establishment of this award fulfilled her dream of giving back and supporting graduate students as they pursue their degrees. You can read more about it at: <https://bit.ly/2Xm7jHC>.

Your tax-deductible donation can be made online at: <https://bit.ly/2DLZk3J>.

Does your company match donations? If so, please apply for the match to make your donation go farther!



Questions? Or do you prefer to send a check? Contact:

- Informatics Department Chair Professor **André van der Hoek**, andre@ics.uci.edu
- ICS Interim Executive Director of Development **Carolyn Canning-White**, ccanning@uci.edu
- ICS Associate Director of External Relations **Kristin Huerth**, khuerth@ics.uci.edu

Your gifts to these awards make an important and truly meaningful difference in the lives of our graduate students. We sincerely thank you!



ISR, IRUS, and Arcadia project alumni and faculty at ICS Alumni Hall of Fame ceremony. Left to right: Jie Ren, Debra Brodbeck, Roy Fielding, André van der Hoek, Richard Taylor, Greg Bolcer, Clay Cover, Justin Erenkrantz, Rosalva Gallardo Valencia, Eric Dashofy, Jim Berney, Hadar Ziv, Susan Sim, Kari Nies and Craig Snider.



Reyhaneh Jabbarvand

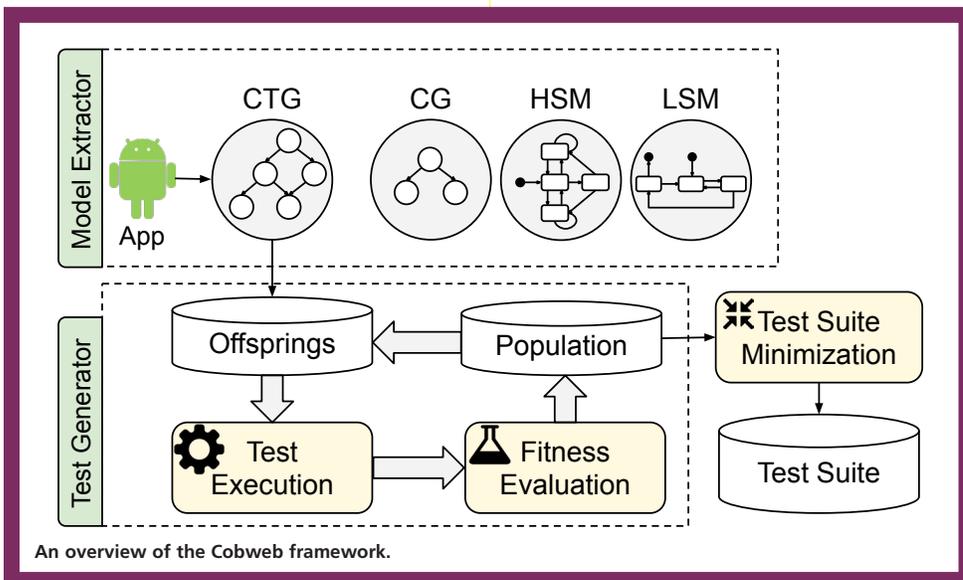
A New Perspective Towards a Greener Future

Cell phones and batteries are a part of our everyday life. While energy is a major concern for users, many mobile apps still abound with energy defects and developers find it difficult to properly evaluate the energy behavior of their programs. The root cause of this issue is that there is a lack of tools and techniques aimed at addressing energy concerns. In the mobile setting, reasoning about energy properties of software is further complicated by the fact that such defects manifest themselves under peculiar conditions that depend not only on the source code of the app, but also on the framework, context of usage, and properties of the underlying hardware elements. The best way to assess the impact of these contextual factors on an app's energy behavior is through dynamic

program analysis i.e., testing.

Recent Ph.D. graduate **Reyhaneh Jabbarvand's** research in the past five years has leveraged program analysis, AI, mathematical optimization, and data science, in order to advance the state of energy testing for mobile applications. In the preliminary steps of this research, through a novel utilization of mutation testing, Jabbarvand discovered that many energy defects depend on the execution context and manifest themselves under peculiar conditions. That said, the main objective of existing Android test generation approaches is maximizing conventional code coverage metrics and they do not consider the contextual factor into account. Thereby, there is a need to devise an energy testing technique.

One of Jabbarvand's recent projects, called Cobweb, employs a search-based evolutionary algorithm to generate event sequences that can identify energy defects. Cobweb uses a novel set of two genetic operators and four model types for generating the event sequences: (1) a model of the possible transitions between components in the app; (2) call graphs representing the internal behavior of each component; (3) state machines representing the possible lifecycle states of each component; and (4) a state machine representing the possible states of the hardware components. The evolutionary algorithm favors test suites based on event sequences that cover energy-greedy APIs and that help exercise different contextual factors. Extensive evaluation of the technique using real-world Android apps with con-



ISR STUDENT NEWS

Abdulaziz Alshayban (S. Malek and I. Ahmed, advisors) will present his paper titled "Accessibility Issues in Android Apps: State of Affairs, Sentiments, and Ways Forward" as part of the Technical Papers Track at the International



Alshayban

Conference on Software Engineering (ICSE), to be held virtually in July. The paper is co-authored by Alshayban's advisors professor **Iftekhar Ahmed** and ISR Director **Sam Malek**.

Farima Farmahinifarahani (C. Lopes, advisor) is a research intern this summer for Microsoft in Redmond, WA. Her project focuses on devising and evaluating a predictive test selection strategy based on the changes since the last execution of the system. Her manager is Sina Jafari.



Farmahinifarahani

Rahmadi Trimananda (B. Demsky, advisor) presented his paper titled "Packet-Level Signatures for Smart Home Devices" at the Network and Distributed System Security Symposium (NDSS) held in San Diego, CA, in February. The paper is co-authored by Ph.D. student Janus Varmarken, professor Athina Markopoulou, and Trimananda's advisor professor **Brian Demsky**.



Trimananda

ISR STUDENT NEWS

Adriana Meza Soria (A. van der Hoek, advisor) will present her research titled “KNOCAP: Capturing and Delivering Important Design Bits in Whiteboard Design Meetings” in the 42nd International Conference on



Meza Soria

Software Engineering (ICSE 2020) Doctoral Symposium to be held virtually in July.

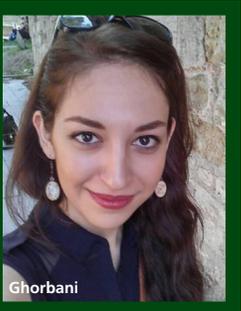
Kaj Dreef (J. Jones, advisor) is interning this summer for Sony in Aliso Viejo, CA. He is assisting the Hardware & Systems Engineering team in development of PlayStation Now server technology and Content Delivery



Dreef

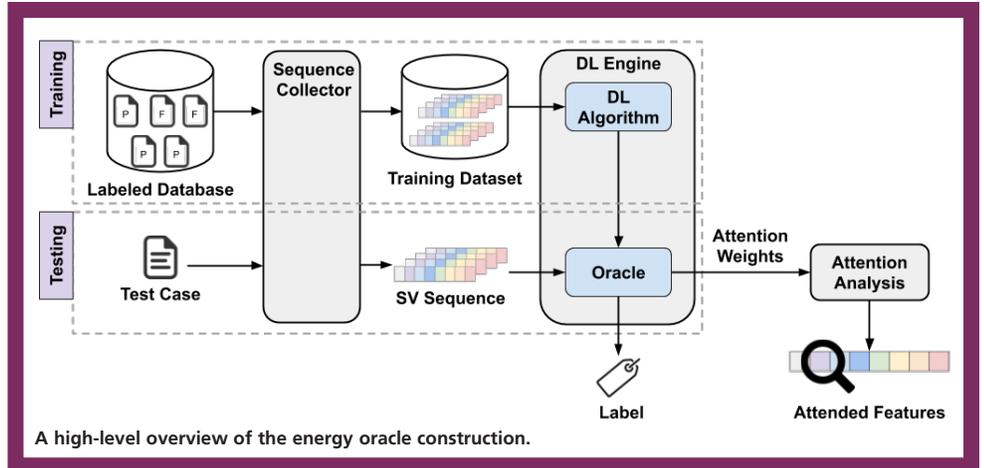
Network technology. His manager is Kim Low. This is the second summer that Dreef is interning for Sony in Aliso Viejo.

Negar Ghorbani (J. Garcia and S. Malek, advisors) is interning this summer at Fujitsu Laboratories of America, Inc. in Sunnyvale, CA. She will be working on mining developer forums (such as StackOverflow) to synthesize



Ghorbani

and suggest repairs for program crashes. Her manager is Mukul Prasad, Director of the Research department.



firmed energy defects demonstrated not only its ability to effectively and efficiently test energy behavior of apps, but also its superiority over state-of-the-art and state-of-the-practice Android testing techniques by finding a wider and more diverse set of energy defects.

Energy testing is not complete without an automated test oracle. Test oracle automation is one of the most challenging facets of testing and, in fact, is a much harder problem to solve for energy testing. Specifically, in contrast to functional defects where their impact is almost explicit as a test terminates, e.g. a crash, it may take several hours, days, or even weeks until developers or users realize that an app drains the phone’s battery. Hence, an energy oracle should be able to determine the outcome of tests by monitoring for certain patterns in the state of software and hardware elements during test execution. The challenge here lies in the fact that determining such patterns is exceptionally cumbersome and requires deep knowledge of energy defects. Furthermore, new types of energy defects may emerge, as mobile platforms evolve, making it impractical to manually derive such patterns.

Jabbarvand’s solution for this problem employs Deep Learning to learn the (mis) behaviors corresponding to the different types of energy defects. Her technique represents the state of software and hardware elements in the form of a feature vector and the learning component uses Long Short-Term Memory (LSTM) Neural Networks to construct an oracle for energy testing. Furthermore, the technique leverages Attention mechanism to interpret the model. Specifically, this technique per-

forms additional analysis on the Attention layer’s product, i.e., Attention weights, to identify a set of features that the model has focused on to predict a label for a given test. If such features for a failing test belong to the state of a hardware that is misused by an energy defect, the validity of the model can be verified. An extensive empirical evaluation demonstrated that the technique is (1) highly effective—achieves an overall precision and recall of 99%, (2) capable of detecting unseen energy defects, (3) interpretable and valid, (4) reusable across a variety of apps and devices, and (5) efficient—detects the existence of energy defects in only 37 milliseconds on average.

Jabbarvand’s plans for the future are to go beyond energy testing to ensure energy efficiency of software. Specifically, she aims to first enable energy debugging, to help developers understand where energy defects happen in the code, and then automatically fix energy inefficiencies in the code through automated program repair.

Jabbarvand will join the University of Illinois at Urbana-Champaign as an Assistant Professor in the Department of Computer Science in January 2021. She received her Ph.D. in May 2020 under the supervision of Professor **Sam Malek**. She was a recipient of the Google Ph.D. Fellowship in Program Technology and Software Engineering in 2018, and has been recognized as a Rising Star in EECS.

To find out more about Jabbarvand, visit her website: <https://www.ics.uci.edu/~jabbarvr/>.

Jabbarvand can be reached at: jabbarvr@uci.edu.

RESEARCH BRIEFS

Alumnus and ISR faculty member **Norman Su** has been awarded tenure and promoted to Associate Professor in the School of Informatics, Computing, and Engineering at Indiana University Bloomington. Congratulations, Norman!

UCI's work on "NoJITsu: Locking Down JavaScript Engines" by Taemin Park, Karel Dhondt (KU Leuven), David Gens, Yeoul Na, Stijn Volckaert (KU Leuven), and professor **Michael Franz** has been invited for presentation at Black Hat USA 2020 in August. Presenting at Black Hat is a rare honor which demonstrates UCI's relevance in this space.

Professor **Iftekhhar Ahmed** is leading the ICSE 2020 US(Pacific) Regional Live! team. The Live! team will set up the infrastructure for live streaming the ICSE 2020 sessions in July, provide technical support, and coordinate among the virtual conference participants during the sessions to ensure the program runs smoothly. ISR Director professor **Sam Malek**, professor **James A. Jones**, and a group of ISR graduate students are serving as team members.

Alumnus **Hosub Lee** (Ph.D. 2019) of Samsung Research America and his advisor professor emeritus **Alfred Kobsa** have published the paper titled "Confident Privacy Decision-Making in IoT Environments" in *ACM Transactions on Computer-Human Interaction*, 27(1), Article 6, December 2019.

Professor **Iftekhhar Ahmed** will present the paper titled "Planning for Untangling: Predicting the Difficulty of Merge Conflicts" in the Technical Papers track at the International Conference on Software Engineering (ICSE 2020), to be held virtually in July. The paper is authored by Ph.D. student Caius Brindescu of Oregon State University (first author), Ahmed, Ph.D. student Rafael Leano of Oregon State University, and professor **Anita Sarma** of Oregon State University.

Professor **Joshua Garcia** will present his paper titled "A Comprehensive Study of Autonomous Vehicle Bugs" in the Technical Papers track at the International Conference on Software Engineering (ICSE 2020), to be held virtually in July. The paper is co-authored by alumnus professor **Yang Feng** of Nanjing University, undergraduate student Junjie Shen, Ph.D. students **Sumaya Almanee** and Yuan Xia, and professor **Qi Alfred Chen**.

The paper titled "On the Relationship Between Design Discussions and Design Quality: A Case Study of Apache Projects" has been accepted to the Research track at ESEC/FSE 2020 to be held in November. The paper is authored by Ph.D. student Umme Ayda Mannan of Oregon State University, professor **Iftekhhar Ahmed**, and professors Carlos Jensen and **Anita Sarma** of Oregon State University.

ISR Director professor **Sam Malek**, professor **Iftekhhar Ahmed**, and professor Stacy Branham, Informatics, have been awarded a \$75,000 School of ICS Exploration grant for their project titled "Toward Stemming Accessibility Issues in Software."

Professors **Iftekhhar Ahmed** and **André van der Hoek** have been awarded a \$75,000 School of ICS Exploration grant to study "The Dark Side of Software Engineering: Stimulant Use among Software Professionals." Professor Eduardo Almeida of Federal University of Bahia, Brazil will collaborate with Ahmed and van der Hoek.

Professor **André van der Hoek**, his Ph.D. student **Adriana Meza Soria**, and long-time collaborator and UCI Visiting Distinguished Professor **Marian Petre** are studying distributed software design meetings at NextGen Healthcare. Supported by alumnus **Gerald Bortis** (Ph.D. 2016; A. van der Hoek, advisor), VP of Software Development at NextGen, they are studying what factors make distributed teams effective, and how being distributed affects the design process and outcomes.

ISR Director professor **Sam Malek** gave a virtual presentation titled "The Threat in Your Pocket: Trends, Challenges, and Solutions in Mobile Application Security" to the OC ACM Chapter in their meeting on May 20.

ISR STUDENT NEWS

Maruf Zaber (C. Lopes, advisor)



is interning this summer for Google in London, United Kingdom. He is working with the Android Core team on a machine learning model to better optimize the battery life

of Android devices. His host is Silvia Vineyes, Ph.D.

Anupriya Prasad (C. Lopes, advisor)



is interning this summer at NEC Labs in San Jose, CA in the machine learning department. She will be a stack developer for a machine learning based video streaming

console.

David Tamas Kutas (A. van der Hoek, advisor) will present his paper titled "Linecept: An Early Prototype of a Timeline-Based Design Coordination Tool" at the 13th International Workshop on

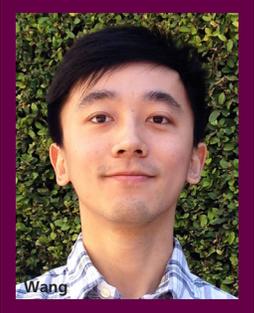


Cooperative and Human Aspects of Software Engineering (CHASE 2020) to be held virtually with ICSE in July. The paper is co-authored by M.S. SE

students **Aditya Nair** and **Prerna Singh**, Social Ecology Ph.D. student Emily Kan, visiting professor **Janet Burge** of Colorado College, and Kutas' advisor professor **André van der Hoek**.

ISR STUDENT NEWS

Zhendong Wang (D. Redmiles, advisor) is first author on the paper titled “Unveiling Elite Developers’ Activities in Open Source Projects” published in the journal *ACM Transactions on Software Engineering and Methodology*



(*TOSEM*), 29(3), June 2020. The paper is co-authored by alumnus professor **Yang Feng** (Ph.D. 2019, advisor J. Jones) of Nanjing University, China, alumnus and ISR professor **Yi Wang** (Ph.D. 2015, advisor D. Redmiles) of Beijing University of Posts and Telecommunications, China, professor **James Jones**, and Wang’s advisor professor **David Redmiles**. Z. Wang and Y. Feng both contributed equally to this research.

Want to get involved? Become an ISR Sponsor!

Sponsoring ISR has many benefits. It enables your company to form closer ties with our faculty and students, puts you on the fast track to our leading-edge research, and gives you first crack at our experimental software tools. A relationship with ISR can also be much more: Think of us as an extension of your company—a think tank, an R&D department, a research library, a consulting firm, a training department, and an employment agency, all rolled into one. More importantly, when you sponsor ISR you become part of a friendly group of folks who speak the same language and are eager to work with you to solve your current technical problems in the most cost-effective way possible.

Be part of the ISR Family—a Friend, Affiliate, or Partner.

Support Level	Annual Contribution	Contribution goes to:
Friend	\$10,000	ISR’s general research fund.
Affiliate—Collaborative	\$20,000	Collaborative efforts.
Affiliate—Research	\$30,000	Designated ISR research area.
Affiliate—Visiting	\$40,000	Visitor at UCI.
Affiliate—Grad Student	\$60,000	Graduate student research.
Partner	\$100,000 or more	Large-scale research project.

More information is available at: <http://isr.uci.edu/partnerships/sponsorship/>

If you are interested in becoming a sponsor, please contact:

ISR Director Professor **Sam Malek**
malek@uci.edu
(949) 824-0639

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!



Rohan Achar (Ph.D., advisor C. Lopes) has accepted a position as a Software Development Engineer 2 at Amazon in Irvine, CA.

Armin Balalaie (M.S., advisor J. Jones) is now a Software Engineer at Mixpanel in San Francisco, CA.

Reyhaneh Jabbarvand (Ph.D., advisor S. Malek) has accepted a position as an Assistant Professor of Computer Science at the University of Illinois at Urbana-Champaign.

Aditya Nair (M.S., advisor A. van der Hoek) has accepted a position as a Software Development Engineer at Amazon in Seattle, WA.



Assistant Director Debra A. Brodbeck

Debra Brodbeck, Assistant Director of ISR, Retires after 32 Years at UCI

By Chancellor's Professor and Director Emeritus Richard N. Taylor

Debra Brodbeck, for many the personal and enduring face of ISR, is retiring at the end of June. While she is ready for the next phase of her life, her departure from ISR will leave an enormous hole. Debi joined the staff of UCI in 1988 and has served in a variety of roles, starting as a research programmer and progressing ultimately to the role of ISR's Assistant Director. I had the privilege—and joy—of supervising her for most of those years. Debi was instrumental in the formation of ISR, its predecessor organization IRUS (Irvine Research Unit in Software), and in fostering ISR's development and impact over the past twenty years.

Debi came to Southern California from Pittsburgh when she was 19, already knowing how to program in COBOL, RPG, FORTRAN, and Assembly. After starting college at Saddleback, she transferred as an undergraduate student to UCI's Department of Information and Computer Science. Earning bachelor's degrees in both Mathematics and ICS in 1988, Debi was hired as a programmer/analyst to support activities within the Arcadia research project, a multi-university, multi-disciplinary effort that lasted well into the 2000's. That stint as a programmer only lasted a year, as Debi decided to return to Pittsburgh to obtain

her master's degree in computer science from the University of Pittsburgh. After graduating from Pitt, UCI proved a strong magnet, as Debi returned, not only again as a research programmer but also as a key staff member in the newly formed IRUS, which emphasized building relationships with industry.

This new role marked a major change in Debi's career, and provided a major benefit to UCI. The Arcadia project had shown to DARPA, the software engineering community at large, and certainly to the individual investigators participating in the project, the benefits of large, multi-organization research efforts. But critically, everyone involved realized that working across organizational boundaries, especially across the university/industry divide, was difficult and required concerted effort to develop and sustain such research partnerships. It was in support of this mission—building technical and organizational relationships—that Debi found her niche and thrived as a professional.

Building relationships in the academic/industrial world takes many skills and involves many types of activities and events. It requires understanding the various motivations and the sometimes-conflicting goals of the participants, technical knowledge, a strong management ability, and it certainly requires the human touch and the (un)common graces of friendliness, consideration, compassion, and humility. Debi excelled in all of these.

In the 1990's, Debi exercised her considerable skills in the service of IRUS, and especially in the particular role of organizing the Southern California SPIN (Software Process Improvement Network) meetings, which IRUS sponsored, and later the Bay Area Roundtables (BART), capitalizing on the heady days of the late 1990's. Orchestrating meetings, organizing events, identifying and hosting speakers, managing publicity—all were within Debi's purview. As IRUS expanded and

ISR STUDENT NEWS

Ted Grover (G. Mark, advisor) is first author on the paper titled "Design and Evaluation of Intelligent Agent Prototypes for Assistance with Focus and Productivity at Work," which was accepted to the 25th Int'l Conference on Intelligent



Grover

User Interfaces (IUI). The paper is co-authored by Kael Rowan, Jina Suh, Daniel J. McDuff, and Mary Czerwinski, all of Microsoft Research. This paper is a result of Grover's internship at Microsoft Research in summer 2019, where he worked under the supervision of Czerwinski and McDuff.

Reyhan Jabbarvand's (S. Malek, advisor) paper titled "Automated



Jabbarvand

Construction of an Energy Test Oracle for Android" has been accepted to ESEC/FSE 2020, to be held in November. The paper is co-authored by Ph.D. student **Forough**

Mehralian and Jabbarvand's advisor professor **Sam Malek**.

Sumaya Almanee (J. Garcia, advisor), **Farima Farmahinifarahani** (C. Lopes, advisor), **Fnu Jirigesi** (I. Ahmed, advisor), **Forough Mehralian** (S. Malek, advisor), **Navid Salehnamadi** (S. Malek, advisor), and **Maruf Zaber** (C. Lopes, advisor) are serving on the ICSE 2020 US(Pacific) Regional Live! team. This team will set up the infrastructure for live streaming ICSE 2020 sessions in July, provide technical support, and coordinate among the virtual conference participants during the sessions.

matured, Debi was instrumental in helping the effort to “graduate” IRUS into becoming ISR, a full-fledged Organized Research Unit (ORU), which took place in 1999. For the next twenty years Debi was the organizational master within ISR, overseeing its daily operations as well as assisting in its organizational development and perennial campus review.

For ISR, Debi managed numerous events including the annual ISR Distinguished Speaker Series, which over the past two decades has seen leading researchers and practitioners of software engineering from around the world speak at UCI. In organizing these events, Debi was always mindful of achieving the most goals for the most people, never allowing one perspective to overly dominate. Debi always kept focus on building relationships, not empires, and did so through diplomatic handling of the competing issues—and individuals.

Debi’s organizational skills were perhaps most obviously demonstrated in her role of managing the 2011 International Conference on Software Engineering, a 1,100-person event which was held, over nine days, in Waikiki. Four years of effort by Debi (and others) led to a very successful event, a critical achievement given the financial problems incurred by some of the immediately preceding ICSEs. (Of course, not everything about organizing ICSE in Hawaii was “hard work.” After all, we had to decide which of several competing companies on Oahu would be

ISR EVENT SCHEDULE

Information on the **ISR Distinguished Speaker Series, Southern California Software Engineering Symposium (SuCSES)**, and other ISR events will be announced as soon as conditions permit.

We look forward to seeing you in the future!

For the most current information, visit:

isr.uci.edu/isr-events

selected to perform at the conference luau. And that was on top of the site/hotel selection “work.”)

Debi has been a special friend to me, my wife Lily May, and my children over these years. My daughter, Lyrica, grew up in the years of IRUS and ISR and always looked up to Debi as “a big girl.” Lyrica especially respected Debi in her years of ice skating and gratefully bought a pair of special skates from her—same size boot! Debi, along with ISR programmer/analyst **Kari Nies** and Lily May, also organized my retirement party in 2013. Truly more of an alumni event than just a retirement party, through that event, Debi helped continue her ongoing mission of building relationships, for the betterment of the software engineering and UCI communities. It has always been a joy to work with Debi, the best of the best!

After retirement Debi says she’s going to relax a bit. Knowing her, somehow I find that a bit hard to believe. But I know she’s spending a lot of time looking after her elderly mother, and I know she is eager to spend more time in her garden and engaging with many of the arts and crafts that she has enjoyed over the years. Bookbinding anyone?



Former Director Professor Emeritus Richard N. Taylor and Assistant Director Debra Brodbeck at Taylor's retirement dinner in 2013.

Whatever her future activities, Debi will be long remembered and sorely missed at UCI. Thank you, Debi, for wonderful years of productive service!



Richard N. Taylor, Lily May Taylor, and Debra Brodbeck in Hawaii in 2011.

ISR

Follow **ISRUCI** on:



For more information:

isr@uci.edu
(949) 824-0639
isr.uci.edu

UCI University of California, Irvine