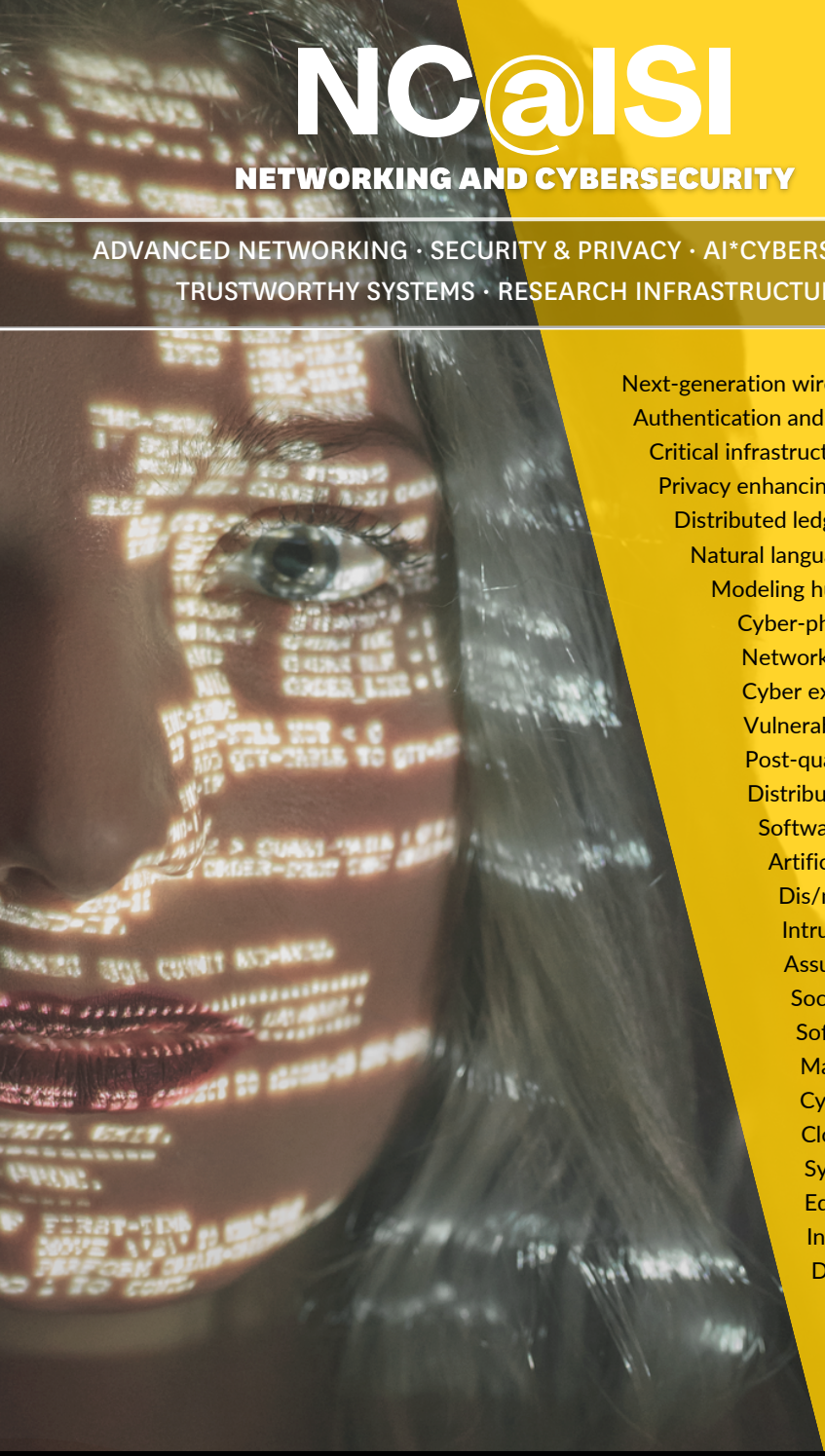
NC@ISI

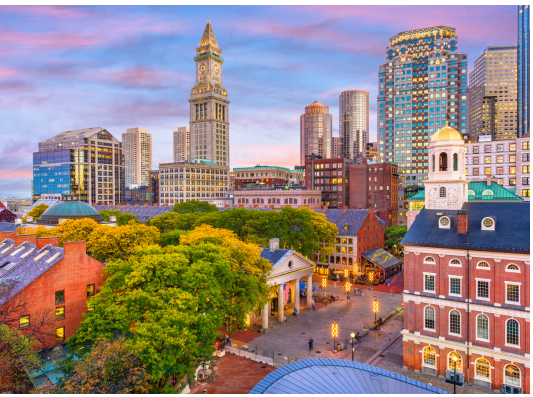
NETWORKING AND CYBERSECURITY

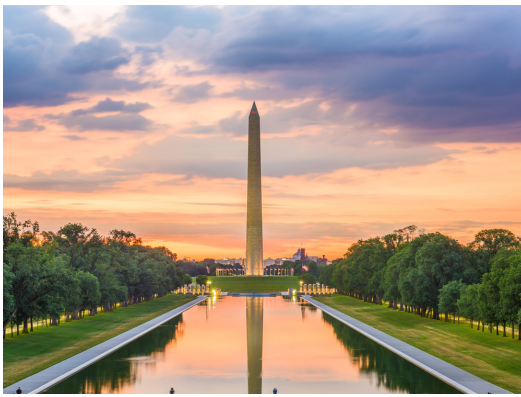
ADVANCED NETWORKING · SECURITY & PRIVACY · AI*CYBERSECURITY
TRUSTWORTHY SYSTEMS · RESEARCH INFRASTRUCTURE



Next-generation wireless networks
Authentication and access control
Critical infrastructure protection
Privacy enhancing technologies
Distributed ledger technology
Natural language processing
Modeling human behavior
Cyber-physical systems
Network measurement
Cyber experimentation
Vulnerability discovery
Post-quantum security
Distributed computing
Software engineering
Artificial intelligence
Dis/misinformation
Intrusion detection
Assured autonomy
Social engineering
Software security
Machine learning
Cyber operations
Cloud computing
Systems security
Edge computing
Internet security
Digital forensics
Binary analysis
5G technology
Cryptography
Data science

USC *Information Sciences Institute*





About ISI

The Information Sciences Institute (ISI), a unit of the University of Southern California (USC), is home to over 400 researchers, doctoral students and staff, including 90 in the networking and cybersecurity division.

ISI is also part of USC's Viterbi School of Engineering, currently ranked as one of the top ten engineering schools in the country—due in part to ISI's standing within the scientific research community. In addition to networking and cybersecurity, ISI employs internationally recognized experts in artificial intelligence, grid computing, electronic commerce, integrated circuit design and fabrication, quantum computing and space electronics.

ISI's main research campus is located in Los Angeles, CA, with satellite offices in Arlington, VA, and Boston, MA. Networking and cybersecurity research is performed at all three locations. Many ISI researchers also serve as faculty in some of Viterbi's departments—computer science, biomedical engineering, aerospace engineering and more, where they advise graduate students on research skills and directions.

About USC

The University of Southern California is one of the world's leading private research universities. An anchor institution in Los Angeles, a global center for arts, technology and international business, USC's diverse curricular offerings provide extensive opportunities for interdisciplinary study and collaboration with leading researchers in highly advanced learning environments.

It is home to the Viterbi School of Engineering, College of Letters, Arts and Sciences and 22 exceptional academic schools and units.

USC's Health Sciences campus houses renowned specialized care and research in cancer, stem cell and regenerative medicine, orthopedics and sports medicine. The university is the largest private sector employer in the city of Los Angeles, responsible for $8 billion annually in economic activity in the region.

In its comprehensive 2022 ranking, The Wall Street Journal and Times Higher Education ranked USC 19th among more than 1,000 public and private universities. Among all California institutions — public and private — only USC, Caltech and Stanford University ranked within the top 20. Of the 150 universities surveyed in the western U.S., USC ranks No. 3 overall. Among the top 25 schools, USC ranked No. 4 in engagement, which measures student sentiment on how their education prepares them for the real world.

In 2022, USC received more than 71,000 applicants for its fall freshman class and had an acceptance rate of 12.5 percent.

USC's distinguished faculty of 4,000 innovative scholars, researchers, teachers and mentors includes five Nobel laureates, and dozens of recipients of prestigious national honors including the MacArthur "Genius" Award, Guggenheim Award, the National Medal of the Arts, the National Humanities Medal, the National Medal of Science, the National Medal of Technology and Innovation, and Pulitzer Prize.

Researcher Highlights

DAVID BALENSON

MS, U. OF MARYLAND, 1985 | BALENSON@ISI.EDU

Cybersecurity for critical infrastructure and cyber-physical systems including automotive and autonomous vehicles, cyber experimentation and test, technology transition, and multi-disciplinary research.

GENEVIEVE BARTLETT

PH.D, USC, 2010 | BARTLETT@ISI.EDU

Cybersecurity and social engineering with an emphasis on combing meta-data signals with language cues in defending networks and communications. Networking and traffic analysis with an emphasis on timing analysis and signal processing.

TERRY BENZEL

MA, BOSTON UNIVERSITY, 1982 | TBENZEL@ISI.EDU

Experimental cybersecurity, including design and development of advanced open infrastructure, methods, and widely available tools for cybersecurity experimentation and evaluation.

JIM BLYTHE

PH.D, CMU, 1997 | BLYTHE@ISI.EDU

Modeling human behavior with applications to cybersecurity and computational social science. Work involves cognitive agent models, planning and social networks.

YOUNG CHO

PH.D, UCLA, 2005 | YOUNGCHO@ISI.EDU

Embedding physical models within predictive deep learning algorithms for oil field applications. R&D of novel embedded systems including self-sustaining IoTs and ultra low power reconfigurable integrated circuit fabric.

Researcher Highlights

MICHAEL COLLINS

PH.D, CMU, 2008 | MCOLLINS@ISI.EDU

Bridging the gap between security research and operations. Security instrumentation, experimentation and design. Research and investigational experience on insider threat, moving target defense and multidisciplinary security.

MARJORIE FREEDMAN

MS, CORNELL, 2001 | MRF@ISI.EDU

Exploring how people interact with intelligent systems including language understanding tools. Using language processing to organize information. Understanding the alignment between classic symbolic representations and language in narrative sources.

LUIS GARCIA

PH.D, RUTGERS UNIVERSITY, 2018 | LGARCIA@ISI.EDU

Developing trustworthy and resilient autonomous systems that interact with humans in and on control loops. Enabling relationship for providing mutual assurances between deep-learning-enabled cyber-physical systems and humans in safety-critical contexts.

WES HARDAKER

MS, UCDAVIS, 1994 | HARDAKER@ISI.EDU

Malicious actor Tactics, Techniques, and Procedures (TTPs) identification. Encrypted traffic classification via statistical analysis. Network domain and routing standardization.

CHRISTOPHE HAUSER

PH.D, CENTRALESUPÉLEC/QUT, 2013 | HAUSER@ISI.EDU

Software and systems security with a focus on binary program analysis for vulnerability discovery, automated verification and reverse engineering, generalizing program understanding with AI and automatically retrofitting security in legacy code.

Researcher Highlights

JOHN HEIDEMANN

PH.D, UCLA, 1995 | JOHNH@ISI.EDU

Leading the ANT (Analysis of Network Traffic) Lab, developing privacy-aware methods to measure the Internet and improve network reliability, security, protocols, and critical services.

ALEFIYA HUSSAIN

PH.D, USC, 2005 | HUSSAIN@ISI.EDU

Modeling and analysis of large scale networked systems, monitoring network traffic to identify emerging threats, traffic engineering and mitigating risks. Research on security technologies, vulnerabilities, and attack vectors.

ERIK KLINE

PH.D, UCLA, 2012 | KLINE@ISI.EDU

Developing novel techniques allowing better understanding and management of wired and 5G networks such as privacy through FHE, traffic analysis, obfuscation, routing, and security.

BRIAN KOCOLOSKI

PH.D, U. OF PITTSBURGH, 2017 | BKOCOLOS@ISI.EDU

Developing novel mechanisms to build and operate high fidelity experimental research infrastructure, enabling research in computer systems, networking, cybersecurity, and distributed systems.

JELENA MIRKOVIC

PH.D, UCLA, 2003 | MIRKOVIC@ISI.EDU

Cybersecurity solutions, with a focus on network-based threats, binary analysis and authentication; human-centric cybersecurity; measuring privacy risks on online sites; cybersecurity experimentation and cybersecurity education.

Researcher Highlights

HEIDI MORGAN

PH.D, ERASMUS UNIVERSITY, ROTTERDAM, NETHERLANDS, 2006 | HLMORGAN@ISI.EDU

Co-Principal Investigator on NSF sponsored projects for leading-edge international network infrastructure for research and education between the U.S., Latin America, the Caribbean, and Africa.

SRIVATSAN RAVI

PH.D, TECHNICAL UNIVERSITY OF BERLIN, GERMANY, 2015 | SRAVI@ISI.EDU

Theory and practice of distributed computing. Algorithms and lower bounds for fault-tolerant distributed systems with a focus on building provably safe and secure concurrent/distributed systems and applications.

STEVE SCHWAB

MS, CMU, 1990 | SCHWAB@ISI.EDU

Developing and evaluating cybersecurity technologies for networks and systems; modeling cyber environments and scenarios for rigorous evaluation of novel capabilities in testbeds.

SATISH KUMAR THITTAMARANAHALLI

PH.D, STANFORD UNIVERSITY, 2005 | SKUMAR@ISI.EDU

Constraint Reasoning, Planning and Scheduling, Probabilistic Reasoning, Machine Learning and Data Informatics, Robotics, Combinatorial Optimization, Approximation and Randomization, Heuristic Search, Model-Based Reasoning.

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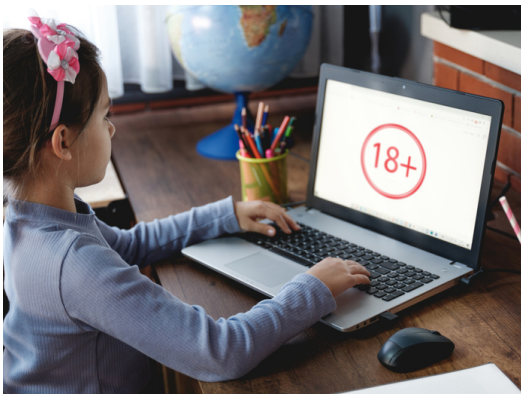
COMPUTER SCIENTIST · RESEARCH ENGINEER
RESEARCH FACULTY · VISITING RESEARCHER
POSTDOC · PH.D STUDENT · SUMMER INTERN



Featured Projects

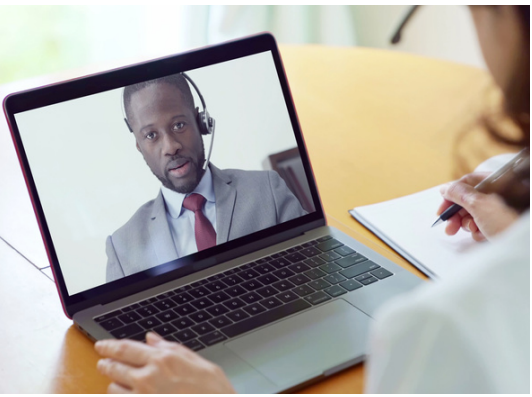
SHARING EXPERTISE AND ARTIFACTS

SEARCCH - Sharing Expertise and Artifacts for Reuse through a Cybersecurity Community Hub - is a web-based community portal that aims to improve the findability and reusability of cybersecurity artifacts. It maintains a catalog of information about research artifacts and helps researchers find relevant artifacts by enabling searching over domain-specific keywords and other metadata. Users can extend the content with new artifacts and share their experiences with artifacts that they have used (or tried to use) through online comments. Automated submission-assistant tools help extract and process metadata from webpages.

PROTECTING KIDS FROM HARMFUL YOUTUBE CONTENT

YouTube videos are a popular way of disseminating content, and they appeal to a diverse audience. Along with adults and older children, children as young as toddlers are avid consumers of YouTube videos. But young children often cannot evaluate if content is appropriate for their age, and they can become exposed to inappropriate content. ISI researchers and collaborators investigated how to build an automated classifier for YouTube videos that can flag videos inappropriate for young children. They collected a large, balanced dataset of 70,000 appropriate and inappropriate videos.

Featured Projects



REPRODUCIBLE VIDEO TELECONFERENCE TRAFFIC GENERATION

Large-scale video teleconference (VTC) environments are commonplace today as more people work from home and participate in meetings and conferences virtually. However, tools to model human-like VTC traffic for systematic and disciplined simulation and emulation are lacking. Researchers in the Networking and Cybersecurity Division built a VTC traffic generation tool that enables experimenters to create representative traffic on-the-wire with human-like bot interaction, including “talking” and “listening” periods.

AUDITING ALGORITHMIC FAIRNESS IN JOB ADS

Ad platforms such as Facebook, Google, and LinkedIn promise value for advertisers through their targeted advertising. These platforms often select ads skewed by gender or race. Social media platforms select ads using relevance algorithms that are proprietary to the platform. A Networking and Cybersecurity Division researcher, working with a student and Princeton professor, demonstrated that external auditors can evaluate job ad skew, even while accounting for legitimate differences in applicant qualifications.
They evaluated Facebook and LinkedIn for potential bias in ad delivery.

GUIDANCE TO DNS OPERATORS BUILDS ON RESEARCH

ISI operates one of the 13 systems providing service for the very top of the Internet’s naming system, the Domain Name System (DNS). The DNS translates human-understandable names like isi.edu into computer-usable information like Internet addresses, so it is part of every web page, email message, and almost all Internet uses. Researchers in the Networking and Cybersecurity Division pair the operation of this worldwide, critical infrastructure with research conducted by computer scientists and graduate students. The results of these studies are shared through peer-reviewed publications.

Featured Projects

FINDING RISKY CODE SUBMISSIONS IN OPEN SOURCE SOFTWARE

In large open source software projects open to contributions from any developer, such as the Linux kernel, code quality is maintained by trusted developers and reviewers. These projects are vulnerable to inadvertent errors or sociotechnical attacks.
Researchers in the Networking and Cybersecurity Division developed the SACHET dashboard, which combines a set of detectors for potentially risky code or social activity to assist an analyst in protecting open source code. These detectors are developed using machine learning to recognize situations associated with risky code submissions

EXPLORING THE INFORMATION ECOSYSTEM

Mobile networks employ a “one-size-fits-all” paradigm for deploying network resources to support different applications. This model is not sufficient for addressing the challenges of a heterogeneous market that supports a vast number of different kinds of applications. Network slicing in 5G networks refers to technologies that can accommodate such a heterogeneous market. At the core of network slicing is the combinatorial problem of virtual network embedding (VNE). ISI researchers have applied their experience in combinatorial optimization to this problem domain with a novel algorithmic framework, conflict-based search (CBS).

DETECTING SOCIAL ENGINEERING ATTACKS

Increasingly, threats to enterprise security come from social engineering attacks—attacks that fool trusted users (e.g., employees) into providing access to critical data. Our system, PIRANHA, automatically intercepts attacks before they reach the user, thereby eliminating human error as a security threat. We combine signals from message metadata, linguistic content, and information about how a message sender is known in the real world to identify a likely attack. In addition, the system learns to respond to attacks in a manner that elicits information about the attacker and distracts them from targeting additional victims.

SECURE, ADAPTIVE, ROBUST, RESILIENT, AND EFFICIENT SLICES

SABRES is part of DARPA’s Open, Programmable, Secure 5G (OPS-5G) program, which aims to address risks in 5G mobile networking. SABRES improves how network slices are constructed and secured using a novel approach to the network embedding problem that enables rapid calculation of large-scale network slices while ensuring valid slice constraints. SABRES also protects information transiting a slice, and protects the slice itself, from both direct and side-channel attacks.

LEARN MORE AT NC.ISI.EDU

Research Infrastructure

CENTER FOR CYBER DEFENSE TECHNOLOGY EXPERIMENTAL RESEARCH

The center focuses on cyber experimentation research, methods, and infrastructure– catalyzing a robust ecosystem of experimental infrastructure, capabilities, and communities – for research. Center researchers perform research into models, frameworks, testbeds, tools, and approaches to enhance the science of cyber experimentation and build experiments that are rigorous, reusable, and repeatable.

Complementing the research program, the center operates DeterLab and associated research infrastructure. The DeterLab Cybersecurity Experimentation Testbed is a public resource serving over 1,000 research teams from 46 countries. Additionally, the DeterLab has been extensively used for cybersecurity education and impacted more than 20,000 students. Numerous publications, master's projects, and Ph.D theses have resulted from the use of DeterLab, which has been operating since 2004. DeterLab is continuously undergoing hardware and software modernization to increase its capacity and experimental capabilities. The Deter testbed now offers three custom testbeds: DCOMP, a specialized distributed computing testbed; Searchlight Testbed, for enterprise control of application QoS at scale; and a Modernized DeterLab. Significantly, a new software stack has replaced the software control system originally derived from the University of Utah's Emulab system. All testbeds are now managed by the Merge Control Software.

VISIT DETER-PROJECT.ORG

Recent Distinctions

INVITED TALK | CYBERSECURITY EXPERIMENTATION OF THE FUTURE

Jelena Mirkovic | Learning from Authoritative Experiment Results Workshop (LASER 2023)

BEST PAPER AWARD | DEFENDING ROOT {DNS} SERVERS AGAINST DDOS USING LAYERED DEFENSES

ASM Rizvi, Jelena Mirkovic, John Heidemann, Wes Hardaker, and Robert Story IEEE International Conference on Communications Systems and Networks (COMSNETS 2023)

BEST PAPER AWARD | AUTOCPS: CONTROL SOFTWARE DATASET GENERATION FOR SEMANTIC REVERSE ENGINEERING

Haoda Wang , Christophe Hauser, and Luis Garcia | IEEE Workshop on the Internet of Safe Things (SafeThings 2022)

BEST PAPER AWARD | OLD BUT GOLD: PROSPECTING TCP TO ENGINEER AND LIVE MONITOR DNS ANYCAST

Giovane C. M. Moura, John Heidemann, , Wes Hardaker, Pithayuth Charnsethikul, Jeroen Bulten, João M. Ceron and Cristian Hesselman | Passive and Active Measurement Conference (PAM 2022)

OUTSTANDING SERVICE AWARD

Terry Benzel | IEEE Security & Privacy Magazine (2022)

DISTINGUISHED PAPER | ROLL, ROLL, ROLL YOUR ROOT: A COMPREHENSIVE ANALYSIS OF THE FIRST EVER DNSSEC ROOT KSK ROLLOVER

Morit Müller, Matthew Thomas, Duane Wessels, Wes Hardaker, Taejoong Chung, Willem Toorop, and Roland van Rijswijk-Deij | Internet Measurement Conference (IMC 2019)

USC STEVENS TECHNOLOGY COMMERCIALIZATION AWARD

Satish Kumar Thittamaranahalli | For work on multi-agent coordination in warehouses and fulfillment centers (2019)

Perspectives on NC@ISI

ABDUL QADEER
CONTENT ARCHITECT AT EDUCATIVE INC.

“I spent seven magical years at ISI's Networking and Cybersecurity Division. The openness to discuss research ideas and to help students sharpen their research made us confident to bounce our ideas off other veteran researchers. My advisor taught me to focus both on the big picture and details. I emulate his mentoring style in my job at an EdTech company where we build courseware for 1.7 million online learners."

RAJAT TANDON
SOFTWARE ENGINEER IV, CYBERSECURITY R&D, JUNIPER NETWORKS

“ISI is famous across the globe for its cutting-edge research in Networking, Cybersecurity and AI. I was fortunate to be a part of its prestigious NC division. I got the opportunity to work under the best researchers in the field. The institute provides an excellent infrastructure and domain experts for students to excel in their fields.”

XIYUE DENG
SOFTWARE ENGINEER AT GOOGLE

"I joined ISI as a Ph.D student majoring in networking security. Being part of an institution that has been a pioneer of Internet inception and innovation has been a privilege. I fondly remember the open culture, especially the discussions with fellow Ph.D students and researchers that sparked new ideas and further advanced our research. I hope this tradition can be passed on to newcomers."

JACOB LICHTEFELD
RESEARCH ENGINEER AT ISI

“I chose to join ISI to develop solutions to the large challenges ISI tackles. Building on a legacy of innovations we’re active contributors to the future of technology in our lives. The internet fundamentally changed how society operates and I want to be a part of the research that brings about the next (good) fundamental change.”

BRIAN KOCOLOSKI
RESEARCH LEAD AT ISI

"NC@ISI strikes a unique balance between purely academic work and purely engineering work, which I find to be very rewarding. I get to work with a large team that develops and engineers highly impactful technology in support of large government programs, but I also have the flexibility and freedom to pursue an individual research agenda, as typical of an academic position. This balance keeps me fresh and energized!"

Recent Ph.D Dissertations

PROTECTING ONLINE SERVICES FROM SOPHISTICATED DDOS ATTACKS

Rajat Tandon | Current position: Software Engineer, Juniper Networks

EFFICIENT PROCESSING OF STREAMING DATA IN MULTI-USER AND MULTI-ABSTRACTION WORKFLOWS

Adbul Qadeer | Current position: Member of Technical Staff, Educative.io

STUDYING MALWARE BEHAVIOR SAFELY AND EFFICIENTLY

Xiyue Deng | Current position: Software Engineer, Google

LEVERAGING PROGRAMMABILITY AND MACHINE LEARNING FOR DISTRIBUTED NETWORK MANAGEMENT TO IMPROVE SECURITY AND PERFORMANCE

Sivaramakrishnan Satyamangalam Ramanathan | Current position: Software Engineer, Facebook

ANYCAST STABILITY, SECURITY AND LATENCY IN THE DOMAIN NAME SYSTEM (DNS) AND CONTENT DELIVER NETWORKS (CDNS)

Lan Wei | Current position: Member of Technical Staff, Roblox

IMPROVING NETWORK SECURITY THROUGH COLLABORATIVE SHARING

Calvin Ardi | Current position: Computer Scientist, USC Information Sciences Institute

DETECTING AND CHARACTERIZING NETWORK DEVICES USING SIGNATURES OF TRAFFIC ABOUT END-POINTS

Hang Guo | Current position: Member of Technical Staff, Microsoft

BALANCING SECURITY AND PERFORMANCE OF NETWORK REQUEST-RESPONSE PROTOCOLS

Liang Zhu | Current position: Member of Technical Staff, Microsoft

Becoming an ISI Postdoc

USC Information Sciences Institute offers postdoctoral scholars the opportunity to interact with top researchers in the field of networking and cybersecurity.

They are able to build up their publication record under the mentoring of some of the most recognized scientists in their domain of expertise. Previous ISI postdocs have published up to three papers in only six months.

ISI is an ideal place to learn about the funding environment. ISI hosts a seminar series teaching postdocs how to navigate the research world and specifically understand how the funding of research works. Postdocs learn tools that will come in handy to practice research independently in the future.

ISI provides for and encourages networking. Postdocs have the opportunity to interact with tech startups in Silicon Beach and beyond. In 2022, an ISI postdoc was invited and attended the prestigious Heidelberg Laureate Forum alongside Nobel laureates.

Many ISI postdocs have gone onto research positions with other top tier educational institutions such as UCLA, MIT or John Hopkins University.

Featured Postdoc

MITCH PAUL MITHUN

On the PIRANHA project, Mithun looks at phishing emails from a natural language perspective to understand what causes both humans and machine learning based filters in still mis-identifying a phishing email. He trains machine learning models on subtle linguistic patterns in the phishing emails, contributing to enhancing human and machine training for identifying phishing emails.

On the LESTAT project, a script curation project, he created a technique to re-rank suggestions from GPT, which has improved the curation experience and the quality of schemas overall. Further he has been exploring the possibility of using quantum natural language processing-based models for creating a framework to evaluate the likelihood of an event given a schema.

Graduate Student Life

Students are an integral part of networking and cybersecurity research at ISI and many ISI researchers are former ISI students. The achievements of student alumni are a source of great pride to everyone at ISI.

Networking and cybersecurity graduates hold a variety of student events throughout the year. They provide an opportunity for students to present their research progress and include awards for the best papers and presentations.

REU

The NSF Research Experiences for Undergraduates (REU) program offers an intellectually and socially stimulating paid research experience to undergrads from a broad range of colleges and universities at ISI headquarters in Marina del Rey, CA. In addition to the stipend, students are provided with campus housing at USC and free shuttle service between campus and ISI. Each student concentrates on a specific research project and works closely with ISI research faculty and other ISI researchers.

Summer Internship Program

ISI welcomes Ph.D students, master's degree students, and undergraduates every summer as paid interns to work with senior research leaders and their teams. The internships are available at all three ISI locations, and interns may work on-site or remotely with their ISI mentors and research teams. Interns work in all ISI research divisions in data science, hardware security, machine learning, natural language processing, quantum information science, and other areas. In addition to research, interns participate in seminars, reading groups, and social activities. For more information and application details, visit Summer Research Institute Program.
www.isi.edu/join-us/students/summer-internship-program

Join Us!

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