SCHOOL OF
INFORMATICS, COMPUTING, AND ENGINEERING

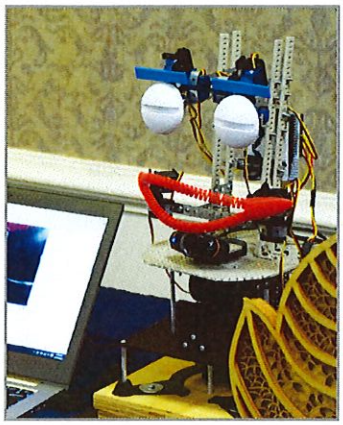
Artificial Intelligence

sice.indiana.edu/faculty-research/research/artificial-intelligence.html

Computers can now defeat the best humans in complicated games like Chess, Go, and even Jeopardy. But despite some 70 years of active research, computers still lack the general intelligence and capabilities of even a small child. Artificial Intelligence research at Indiana University includes diverse faculty and students investigating a wide variety of areas, problems, and approaches about artificial systems that perceive, understand, learn from, react to, and interact with the world around them.

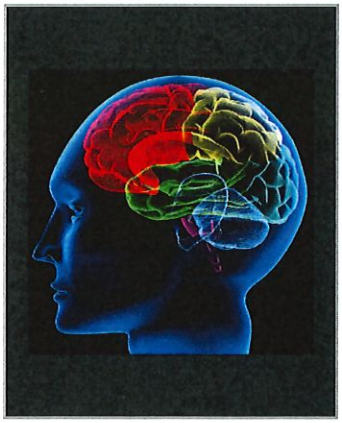
Audio and Language

Recognize speech and music in noisy environments, and on low-power devices. Understand spoken and written human natural language.



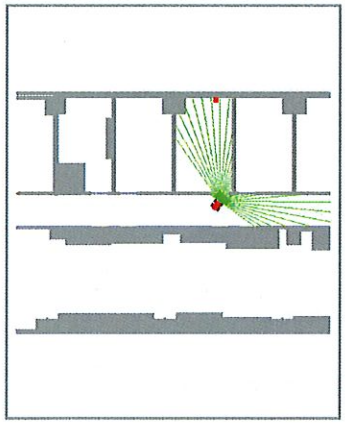
Robotics

Design and develop robotic systems that naturally learn from and interact with humans and the environment. Study the social and ethical implications of robots in the home and workplace.



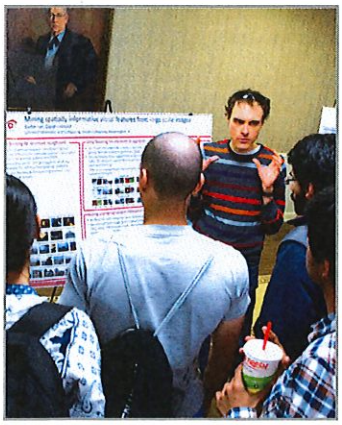
Cognitive Science

Develop and analyze computational and mathematical models of living systems.



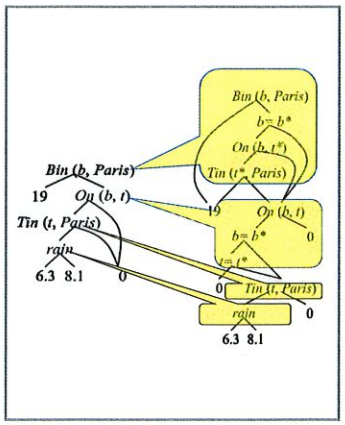
Planning

Develop algorithms and systems that act in their environment to optimize long term reward.



Computer Vision

Create techniques to recognize objects, scenes, and activities in images and videos.



Knowledge Representation and Inference

Develop general methods that can represent both logical and probabilistic information about a problem and use this information effectively to infer other properties of the same problem.

Faculty

Randall Beer, Ph.D. Computer Science
Professor, rdbeer@indiana.edu
Research areas: artificial life, evolutionary robotics, embodied cognition, and computational neuroscience.

David J. Crandall, Ph.D. Computer Science
Associate Professor, djcran@indiana.edu
Research areas: computer vision, machine learning, interactive and intelligent systems, and artificial intelligence.

Douglas Hofstadter, Ph.D. Physics
Professor, dughof@indiana.edu
Research areas: computational models of human thought, creativity in art and music, and philosophy of mind and consciousness.

Eduardo J. Izquierdo, Ph.D. Computer Science
Assistant Professor, edizquie@indiana.edu
Research areas: embodied cognition, cognitive systems, computational neuroscience, evolutionary and adaptive systems, and artificial life.

Minje Kim, Ph.D. Computer Science
Assistant Professor, minje@indiana.edu
Research areas: audio processing and recognition, machine learning, and artificial intelligence.

Roni Khardon, Ph.D. Computer Science
Professor, rkhardon@iu.edu
Research areas: machine learning, artificial intelligence, data mining, and theoretical computer science.

Sandra Kübler, Ph.D. Computational Linguistics
Professor, skuebler@indiana.edu
Research areas: computational linguistics, natural language processing, sentient analysis, and hate speech detection.

David Leake, Ph.D. Computer Science
Professor, leake@indiana.edu
Research areas: artificial intelligence, case-based reasoning, cognitive science, context, explanation, introspective reasoning, human centered computing, and machine learning.

Lantao Liu, Ph.D. Computer Science
Assistant Professor, lantao@iu.edu
Research areas: robotics, artificial intelligence, machine learning, unmanned ground, aerial, and aquatic vehicles.

Christopher Raphael, Ph.D. Applied Mathematics
Professor, craphael@indiana.edu
Research areas: music informatics, artificial intelligence, data science, and machine learning.

Luis Rocha, Ph.D. Systems Science and Computer Science, *Professor,* rocha@indiana.edu
Research areas: complex networks and systems, computational and systems biology, cognitive science, artificial life, artificial intelligence, machine learning, information retrieval, data mining, text and social media mining, collective intelligence, and evolutionary systems.

Michael S. Ryoo, Ph.D. Computer Engineering
Assistant Professor, mryoo@indiana.edu
Research areas: computer vision, machine learning, robotics, artificial intelligence, and human-robot interaction.

Selma Šabanović, Ph.D. Science & Technology Studies
Associate Professor, selmas@indiana.edu
Research areas: human-robot interaction, computing culture and society, human centered computing, cognitive science, interactive and intelligent systems, proactive health informatics, and human computer interaction.

Chung-chieh Shan, Ph.D. Computer Science
Assistant Professor, ccshan@indiana.edu
Research areas: programming languages, probabilistic programming, artificial intelligence, semantics, and cognitive science.

Donald Williamson, Ph.D. Computer Science and Engineering
Assistant Professor, williads@indiana.edu
Research areas: speech processing, machine learning, artificial intelligence, and music informatics.

Chen Yu, Ph.D. Computer Science
Professor, chenyu@indiana.edu
Research areas: interactive intelligent systems, cognitive science, and developmental psychology.

Centers, groups, and labs associated with Artificial Intelligence:

- Audio, SPeech, and Information REtrieval (ASPIRE) Research Group — aspire.sice.indiana.edu
- Center for Algorithms and Machine Learning — caml.indiana.edu
- Computational Cognition and Learning Laboratory — indiana.edu/~dll
- Computer Vision Lab — vision.soic.indiana.edu
- R-house Living Laboratory for Research in Human-Robot Systems — r-house.soic.indiana.edu
- Signals & Artificial Intelligence Group in Engineering — saige.sice.indiana.edu
- Vehicle Autonomy and Intelligence Lab — vail.sice.indiana.edu

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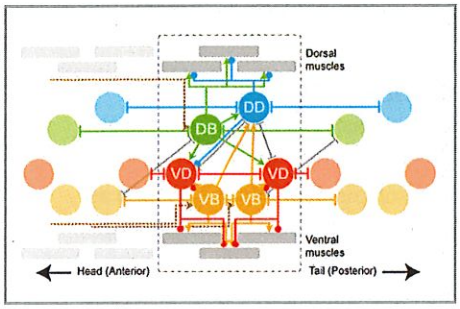
Complex Networks and Systems

cnets.indiana.edu

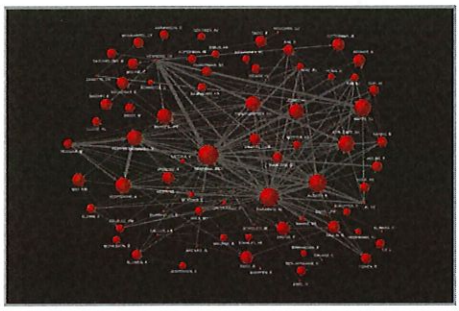
Our complex networks and systems program, part of the Indiana University School of Informatics, Computing, and Engineering (SICE) and the Network Science Institute (IUNI), fosters interdisciplinary research in all areas related to networks and systems, computational social science, and data science.

Our program draws on world-class faculty in a distinctly multi-disciplinary environment. Our researchers are experts in network science, data science, computation, computational biology, statistics, physics, cognitive science, and information science. They study multi-scale networks that extend across social, informational, technological, infrastructural, and biological systems.



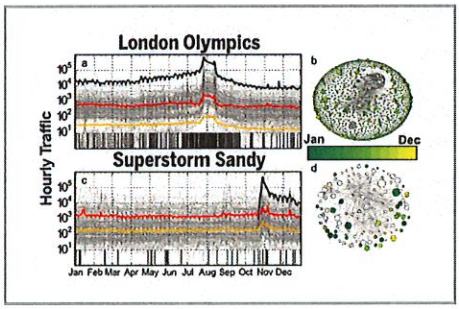
Biological and Cognitive Systems

Explore neural network structure and dynamics, and study how complex behaviors emerge from interactions between brain, body, and environment.



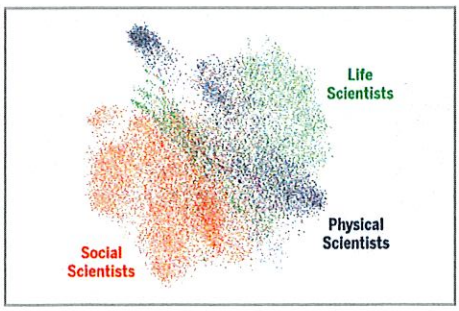
Networks

Work with some of the world's leading experts to unravel the community structure, robustness, multi-layer architecture, functions, and processes of complex networks.



Computational Social Science

Investigate the diffusion of information and misinformation in social media, and use large-scale computational models and big data analytics to study social and cultural phenomena.



Science of Science

Analyze massive datasets of scientific output to quantify impact, model citation and collaboration dynamics, and predict emerging trends.

Faculty

Yong-Yeol Ahn
Ph.D. in Physics
Associate Professor, yyahn@iu.edu

Research focuses on network science and machine learning, with applications in computational social, neural, and biological sciences.

Randy Beer
Ph.D. in Computer Science
Professor, rbeer@indiana.edu

Research interests include artificial life, evolutionary robotics, embodied cognition, and computational neuroscience.

Johan Bollen
Ph.D. in Experimental Psychology
Professor, jbollen@indiana.edu

Research interests include computational social science, social media analytics, infometrics, and digital libraries.

Ying Ding
Ph.D. in Information Science
Associate Professor, dingying@indiana.edu

Interested in bibliometrics, the semantic web, data-driven knowledge discovery, the science of science, communication in healthcare, and social networks.

Alessandro Flammini
Ph.D. in Physics of Condensed Matter
Professor, aflammin@indiana.edu

With a background in statistical mechanics, Flammini's research interests are in complex networks and computational social science.

Santo Fortunato
Ph.D. in Theoretical Physics
Center Director, santo@indiana.edu

Serves as director of Complex Networks and Systems (CNetS). His research areas include network science, computational social science, and the science of science.

Eduardo J. Izquierdo
Ph.D. in Computer Science
Assistant Professor, edizquie@indiana.edu

Research areas of interest include embodied cognition, computational neuroscience, evolutionary and adaptive systems, and artificial life.

Filippo Menczer
Ph.D. in Computer Science and Cognitive Science
Professor, fil@indiana.edu

Leads the Networks and agents Network (NaN) research group. Research spans computational social science, networks, and web and data science, with a focus on the spread of information in social media.

Staša Milojević
Ph.D. in Information Studies
Associate Professor, smilojev@indiana.edu

Focused on the dynamics of science as a social and intellectual endeavor in a historical context.

Filippo Radicchi
Ph.D. in Physics
Associate Professor, filiradi@indiana.edu

Research focuses on network science and machine learning, with applications in computational social, neural, and biological sciences.

Luis Rocha
Ph.D. in Systems Science and Computer Science
Professor, rocha@indiana.edu

Serves as director of the NSF-NRT Interdisciplinary Training Program in Complex Networks and Systems. His research is focused on complex networks and systems, computations and systems biology, and computational intelligence.

Centers, groups, and labs associated with Complex Networks and Systems:

- Networks & agents Network (NaN) — cnets.indiana.edu/groups/nan
- Complex and Adaptive Systems and Computational Intelligence (CASCI) — cnets.indiana.edu/groups/casci
- SantoLab — cnets.indiana.edu/groups/santo-lab
- Web Science Lab — swl.slis.indiana.edu
- Adaptive Behavior and Cognition—West — cnets.indiana.edu/groups/abc-w

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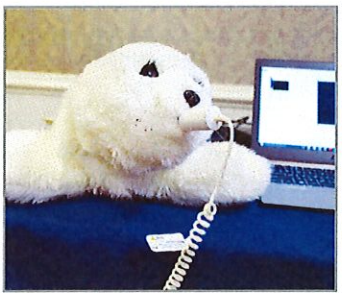
Machine Learning

www.sice.indiana.edu/faculty-research/research/machine-learning.html

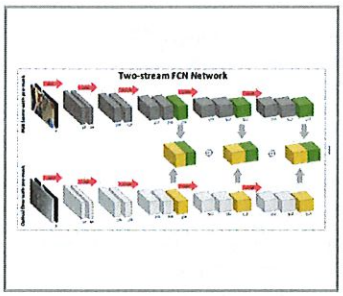
Machine learning is now in everything from smartphones that listen to voice commands to cars that drive themselves. But algorithms still fall far short of humans' abilities to learn, requiring huge amounts of training data and often making decisions that defy common sense.

IU researchers are investigating machine learning from many perspectives, including studying its theoretical properties and limitations, developing new algorithms and models, improving scalability for large, noisy data, understanding the connections to human learning, and applying to a wide variety of problems.



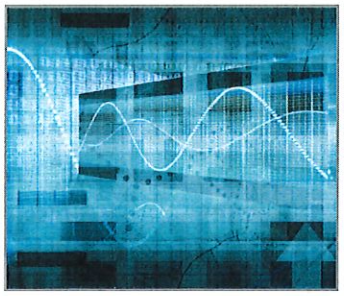
Applications

Apply machine learning to robotics, language understanding, computer vision, speech and music recognition, bioinformatics, health, etc.



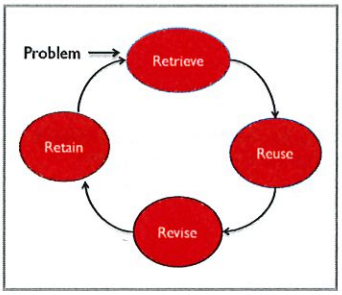
Deep Learning

Investigate deep neural network-based models that automatically learn feature representations.



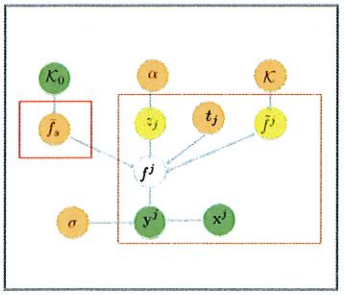
Algorithms

Create new algorithms and models that can efficiently analyze massive, noisy data.



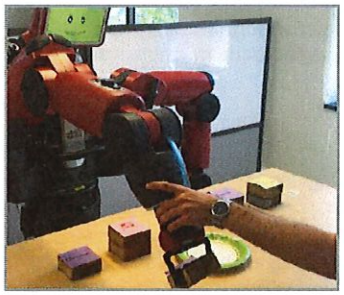
Case-based Reasoning

Integrate knowledge, memory and analogy to experiences to learn from large or small data sets.



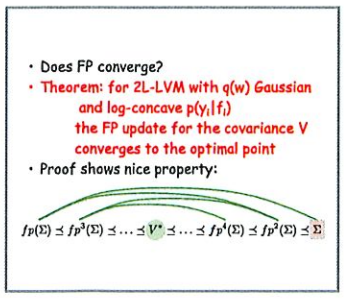
Statistical Models

Develop, analyze, and apply rigorous models of the relationships between data.



Reinforcement Learning

Create systems that "learn by doing"—taking actions and observing the outcome.



Theory

Analyze machine learning algorithms to explain when and why they are successful.

Faculty

David J. Crandall
Ph.D. Computer Science
Associate Professor, djcran@indiana.edu
Research areas: computer vision, machine learning, interactive and intelligent systems, and artificial intelligence.

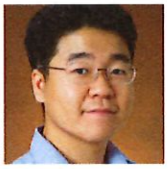
Minje Kim
Ph.D. Computer Science
Assistant Professor, minje@indiana.edu
Research areas: audio processing and recognition, machine learning, and artificial intelligence.

Roni Khardon
Ph.D. Computer Science
Professor, rkhardon@iu.edu
Research areas: machine learning, artificial intelligence, data mining, and theoretical computer science.

David Leake
Ph.D. Computer Science
Professor, leake@indiana.edu
Research areas: artificial intelligence, case-based reasoning, cognitive science, context, explanation, introspective reasoning, human centered computing, and machine learning.

Daniel McDonald
Ph.D. Statistics
Associate Professor, dajmcdon@indiana.edu
Research areas: time series prediction, statistical learning theory, machine learning, and high dimensional statistics.

Christopher Raphael
Ph.D. Applied Mathematics
Professor, craphael@indiana.edu
Research areas: music informatics, artificial intelligence, data science, and machine learning.



Michael S. Ryoo
Ph.D. Computer Engineering
Assistant Professor, mryoo@indiana.edu
Research areas: computer vision, machine learning, robotics, artificial intelligence, and human-robot interaction.

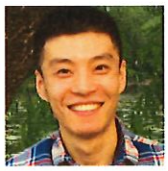
Michael Trosset
Ph.D. Statistics
Professor, mtrosset@indiana.edu
Research areas: multivariate statistics, analysis of proximity data, dimension reduction, and manifold learning.

Donald Williamson
Ph.D. Computer Science and Engineering
Assistant Professor, williads@indiana.edu
Research areas: speech processing, machine learning, artificial intelligence, and music informatics.

Andrew Womack
Ph.D. Mathematics
Assistant Professor, ajwomack@indiana.edu
Research areas: bayesian statistics, high dimensional data analysis, decision theory, non-parametric statistics, and clustering.

Grigory Yaroslavtsev
Ph.D. Computer Science and Engineering
Assistant Professor, gyarosla@iu.edu
Research areas: theoretical computer science, machine learning, and data mining.

Qin Zhang
Ph.D. Computer Science
Assistant Professor, qzhangcs@indiana.edu
Research areas: algorithms for big data, theoretical computer science, database theory and systems, data mining, machine learning, and data science.



Yuan Zhou
Ph.D. Computer Science
Assistant Professor, yzhoucs@indiana.edu
Research areas: theoretical computer science, machine learning, and operations research.

Centers, groups, and labs associated with Machine Learning:

- Audio, SPeech, and Information REtrieval (ASPIRE) Research Group — aspire.sice.indiana.edu
- Center for Algorithms and Machine Learning — caml.indiana.edu
- Computational Cognition and Learning Laboratory — indiana.edu/~dll
- Computer Vision Lab — vision.sice.indiana.edu
- R-house Living Laboratory for Research in Human-Robot Systems — r-house.soic.indiana.edu
- Signals & Artificial Intelligence Group in Engineering — saige.sice.indiana.edu

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Proactive Health

prohealth.sice.indiana.edu

The Proactive Health (ProHealth) Informatics group is internationally renowned for designing, building, and evaluating technologies to empower individuals to better understand, manage, and improve their everyday health. ProHealth researchers make valuable socio-technical contributions to aging-in-place, healthcare journeys, personalized consumer health sensing, the internet of things, environmental sensing, urban and rural health, online health communities, and social support. Current projects include women's health, older adults, stigmatized populations, chronic illness, wellness, accessibility, and mental health. We engage populations through user-centered design, participatory design, and novel social computing methods.

Proactive Health Informatics at Indiana University Bloomington has developed a pipeline of training programs for K-12, undergraduate, graduate, and postdoctoral researchers to develop the next generation of innovators and scholars.

Personal Tracking Devices

Study how the use and adoption of wearable trackers impacts self-regulation strategies including self-monitoring, goal setting reinforcement, and behavioral changes such as self-corrective actions.

Mobile Health Applications

Design and deploy customized health application to gain insights into the factors that motivate and support people to manage their personal health and wellness. We incorporate the abilities and goals of underserved populations to effectively create solutions that meet their needs.

Internet of Things

Create opportunities to deploy appropriate, innovative, high-quality, and personalized solutions into daily life. We focus on design and integration for specific populations to improve user acceptance by making the invisible visible.

Smart Sensing Environments

Explore the concepts of smart environments where sensors, actuators, displays, and other technologies are embedded in everyday locations to monitor and visualize activities, behavior, and environmental exposures that impact the overall health and wellness of individuals and communities.

Faculty

Chia-Fang (Christina) Chung, Ph.D. in Human Centered Design and Engineering
Assistant Professor, cfchung@iu.edu

Chung's research focuses on designing systems and services to support healthcare, wellness, and relationships, particularly in areas of personal informatics, behavior change, ubiquitous computing, and computer-supported cooperative work.

James Clawson, Ph.D. in Human Centered Computing
Assistant Professor, clawsonj@indiana.edu

Clawson's research focuses on proactive health informatics, human centered computing, and design for human computer interaction. Specifically, he designs and evaluates holistic mobile health technologies that support individuals over the course of a healthcare journey by increasing patient engagement with their health and encouraging everyday wellness.

Kay Connelly, Ph.D. in Computer Science
Professor and Associate Dean for Research, connelly@indiana.edu

Connelly's research focuses on pervasive and mobile computing technologies to empower both the ill and the healthy to make healthy choices. Particular interests include displays of everyday information, wearable devices, and mobile applications, and how they help ensure that technology meets the needs of low socio-economic populations.

Dana Habeeb, Ph.D. in City and Regional Planning
Visiting Professor, dhabeeb@iu.edu

Trained as an architect and urban designer, Habeeb brings a design perspective to her research in environmental planning and health. She investigates ways to engage and empower individuals to respond to current and future environmental problems by synthesizing research in climate change, public health and environmental sensing.

Patrick C. Shih, Ph.D. in Information and Computer Science
Assistant Professor, patshih@indiana.edu

Director of the Societal Computing Lab (SoCo Lab). Shih's research focuses on the study of sociotechnical systems and mechanisms to enhance wellbeing, and to facilitate civic engagement and environmental stewardship. His current research focuses on sensor technologies, smart devices, social media, and online forums in the design and deployment of novel personal health informatics interfaces and civic engagement platforms.

Katie Siek, Ph.D. in Computer Science
Associate Professor, ksiek@indiana.edu

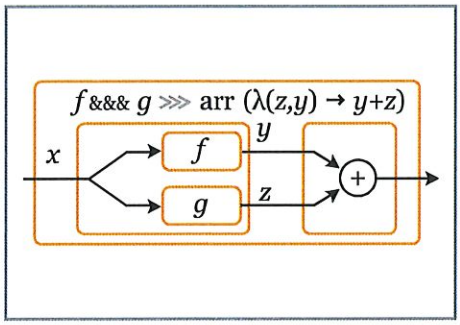
Director of the Proactive Health Informatics group. Siek is primarily interested in human computer interaction, health informatics, and ubiquitous computing, specifically how sociotechnical interventions affect personal health and wellbeing. She explores how to integrate underserved communities into the design process to create wearable, ambient, and mobile systems that meet their diverse needs.

ProHealth
Indiana University

Programming Languages

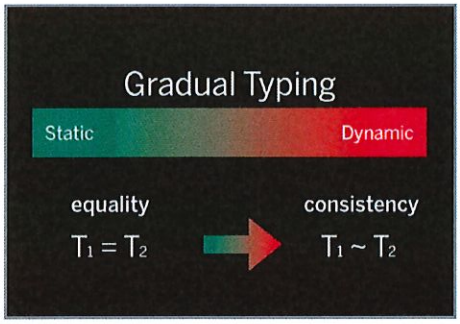
cs.indiana.edu/research/programming-languages.html

Research in programming languages ranges from the practical side to the philosophical. Our practical research helps programmers become more productive and efficient through approaches such as gradual typing and probabilistic programming. We are also working to build bridges between mainstream languages and cutting-edge approaches, such as logic programming, that will enable programming at a higher level. Our studies of the philosophical side of programming explores connections with other fields to discover how they are interrelated and attempt to identify patterns that can be useful in other disciplines, such as quantum physics.



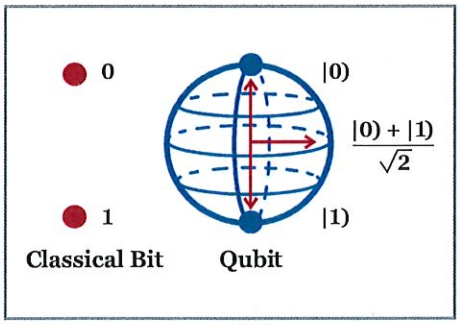
Functional Programming Languages

Functional programming languages treat functions as first-class entities that circumscribe side effects. Functional programming eliminates side effects as the program state changes making it easier to understand and predict the behavior of a program.



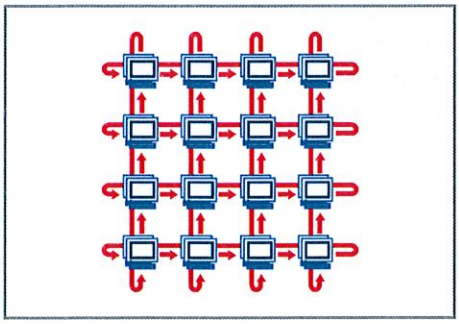
Gradual Typing

Support programming languages that enable programmers to choose which parts of a program undergo compile-time checking for errors and which parts undergo checking at run-time. Gradual typing enables the programmer to choose which "time" is appropriate for each piece of code, and it enables migration of code between run-time and compile-time checking.



Quantum Computing

Our research has two thrusts: (i) revisiting the foundations of computing based on advances in quantum mechanics, and (ii) revisiting the foundations of quantum mechanics based on a computational resource-aware perspective. The main results include a new model of computation based on reversible deformations that naturally accounts for preservation of information, a precise accounting and analysis of some of the claimed speedups of quantum computing, and a resolution of an important debate on the relevance of the Kochen-Specker quantum-information theorem in a resource-bounded setting.



Parallelism and Complier Optimizations

Focus on the ubiquity of parallel hardware and its increasing heterogeneity to facilitate the advancement of programming languages that aid the parallel programmer by ensuring safety and by automating compiler decisions related to performance.

Faculty

Daniel Friedman, Ph.D. in Computer Science
Professor, dfried@indiana.edu

Research areas include programming language principles, design and implementation, and theoretical foundations of computer science.

Ryan Newton, Ph.D. in Electrical Engineering and Computer Science
Associate Professor, rrnewton@indiana.edu

Research areas include parallel computing, programming language design, and compiler implementation.

Amr Sabry, Ph.D. in Computer Science
Chair of Computer Science Department, sabry@indiana.edu

Research interests are in the semantics, logical foundations, and implementations of programming languages.

Chung-chieh Shan, Ph.D. in Computer Science
Assistant Professor, ccshan@indiana.edu

Research areas include artificial intelligence, cognitive science, and machine learning. He is a member of the Center for Algorithms and Machine Learning.

Jeremy Siek, Ph.D. in Computer Science
Associate Professor, jsiek@indiana.edu

Siek designs new language features to help programmers create and use software libraries and domain-specific languages. He invented the gradual typing approach to mixing static and dynamic type checking within the same language.

Sam Tobin-Hochstadt, Ph.D. in Computer Science
Assistant Professor, samth@indiana.edu

Tobin-Hochstadt works on dynamic languages, type systems, module systems, and metaprogramming, including the creation of the Typed Racket system and popularizing the phrase "scripts to programs." He is a member of the ECMA TC39 working group responsible for standardizing JavaScript, where he co-designed the module system for ES6, the next version of JavaScript.

Centers associated with Programming Languages:

- Center for Programming Systems www.sice.indiana.edu/faculty-research/research/center-programming-systems.html

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Security and Privacy

spice.sice.indiana.edu

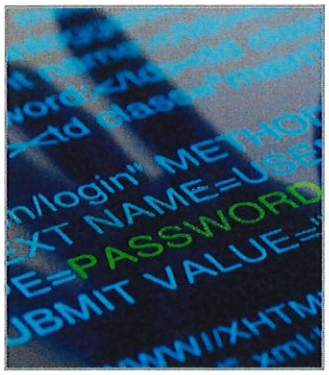
Securing information technology for individuals and society through research, education, and outreach is our goal. Capitalizing on interdisciplinary studies and practical research focuses, we aspire to make a real impact on users, economics, and our social environments. Using technologies that support suitable user interfaces, organizational priorities, economic factors, and legal compliance, we take the complexities of mathematics and computer science and reduce them to appear more magic than science. Our targeted but personalized approach includes numerous connections and collaborative efforts with research groups representing a wide range of security application areas and complementary sciences.

Internet of Things and Wearables

Give people control over personal devices both wearable and in the home.

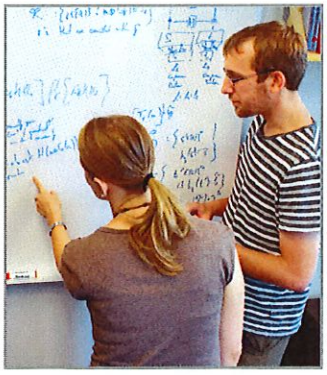
Usable Security

Ensure that people can easily and efficiently make proper security decisions aligned with their mental models.



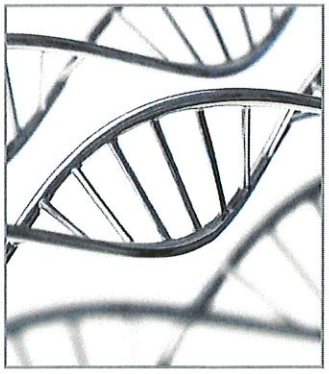
Cryptography

Use cryptography to build secure systems that preserve user privacy and enable secure data collaboration.



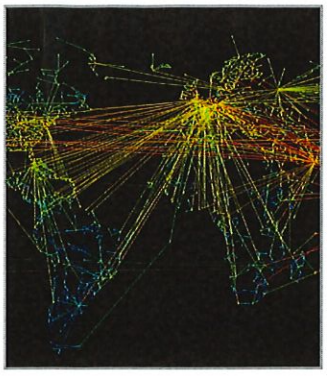
Secure Systems

Build secure systems that preserve the privacy of users.



Data Privacy

Ensure that even snippets of genetic code published in online databases can't be used to identify individuals.



eCrime and Malware

Protect against phishing and the economic incentives for eCrime.

Faculty

L. Jean Camp
Ph.D. Engineering and Public Policy
Professor, **ljcamp@indiana.edu**

Research areas include security, social informatics, and proactive health informatics.

Raquel Hill
Ph.D. Computer Science
Professor, **ralhill@indiana.edu**

Research interests are in the area of data protection, including designing, developing, and evaluating mechanisms for securing access and preserving privacy of sensitive data.

Yan Huang
Ph.D. Computer Science
Assistant Professor, **yh33@indiana.edu**

Research interests include computer security and privacy, applied cryptography, programming languages, data mining, and artificial Intelligence.

Apu Kapadia
Ph.D. Computer Science
Associate Professor, **kapadia@indiana.edu**

Research focuses on computer security and privacy issues in the context of social networks and wearable and sensor-enabled computing.

Xiaojing Liao
Ph.D. Computer Engineering
Assistant Professor, **xliao@indiana.edu**

Research interests include data-driven security, web security, and privacy, with the specific focus on the investigation of cybercrime and cyber threat intelligence.

Sameer Patil
Ph.D. Information and Computer Science
Assistant Professor, **patil@indiana.edu**

Explores topics at the intersection of privacy and security and human computer interaction (HCI), covering application domains such as social computing, mobile and ubiquitous computing, and software engineering.

XiaoFeng Wang
Ph.D. Computer Engineering
Professor, **xw7@indiana.edu**

Research focuses on system security and data privacy, particularly in mobile and cloud computing, and the dissemination and computation of human genomic data.

Luyi Xing
Ph.D. Security Informatics
Assistant Professor, **luyixing@indiana.edu**

Research focuses on the security of a wide range of systems, including mobile OSes, desktop OSes, IoT, web, cloud and applications on these systems.

Centers, groups, and labs associated with Security and Privacy in Informatics, Computing, and Engineering:

- Security and Privacy in Informatics, Computing, and Engineering (SPICE) — **spice.sice.indiana.edu**
- Center for Applied Cybersecurity Research (CACR) — **cacr.iu.edu**
- IoT Research Center — **iot.sice.indiana.edu**