UC **SANTA BARBARA**

Computer Science

College of Engineering

40th Anniversary Newsletter

40 years

1979 2019

Leading the Charge for Responsible AI

Reverse-Engineering the Brain

Protecting Cyberspace

Message from the Chair

Welcome to the Computer Science Department at the University of California, Santa Barbara!

CS@UCSB is a special place where exciting research meets exceptional teaching against the backdrop of wonderful natural beauty. As faculty, students, and staff of CS@UCSB, we feel lucky to be part of an outstanding department in the most impactful academic discipline of our times while living in one of the most beautiful places in the world!

We are celebrating the 40th year of our Department this academic year, and we are extremely proud of our accomplishments. As one of the first four nodes of the Internet, UCSB has been at the forefront of computing discipline since its beginnings, and our award winning faculty, students and staff constantly demonstrate the strength of our department and its culture with their accomplishments.

The 21st century is the century of computing. Computing has had a tremendous impact on human civilization already, but we are still at the beginning of the computing revolution. Although the rapid change brought by computing technologies can be disorienting at times, as computer scientists, we believe that computing has tremendous power to do good. Computing has changed how we work, how we communicate, how we teach and learn, how we entertain, how we shop; the list goes on and on. The power of computing technologies in transforming businesses and the outstanding successes of computing companies are reported frequently, and the entrepreneurial spirit of computing is well represented in our department, which has resulted in many successful commercial ventures led by our students and faculty.

That said, the impact of computing is not limited to producing new technologies and startups. Since its conception, computing has played a key part in almost all significant human achievements. Alan Turing helped to bring an end to the 2nd World War by cracking the Enigma code using computing. NASA achieved the first moon landing with the aid of computing. Computing has influenced every academic discipline from the physical and social sciences to humanities, and it has transformed how modern science is done. Computing has become a fundamental tool for extending human knowledge, an essential part of creation, discovery, and innovation.

Although the history of computing is filled with tremendous achievements, its future is even brighter. Here at CS@UCSB, we are shaping the future of computing by our outstanding research and education programs. Our world-renowned faculty and exceptional students conduct exciting research in all areas of computer science. From harnessing the power of machine learning in a responsible manner to ensuring the security of cloud computing, from investigating the new horizons of human-computer interaction and visual computing to improving the energy efficiency of computing, our faculty and students are making impactful contributions in all frontiers of computer science. Our teaching faculty are innovators in teaching methods that enable us to provide an outstanding education to our students at all levels and broaden participation in computing.

In this newsletter you will see highlights from the outstanding research activities at CS@UCSB covering a wide variety of exciting research topics including democratization of networking research, quantum computing, cyberspace security, reverse-engineering the brain, responsible machine learning and AI, fighting hate speech, and IoT driven analytics systems for agriculture. We are also proud of our recruitment efforts: Shumo Chu (Ph.D. University of Washington, research area: database systems), Misha Sra (Ph.D. MIT, research area: human computer interaction and virtual reality), Michael Beyeler (Ph.D.

UC Irvine, research area: computational vision and neuroscience), and Prabhankan Ananth (Ph.D. UCLA, research area: cryptography) are the newest additions to our outstanding Faculty. Finally, we are happy to highlight the award winning Capstone Projects developed by our amazing undergraduate students. Capstone presentations are always a highlight in our annual departmental showcase CS Summit, and this year was no exception.

As the students, faculty, and staff of CS@UCSB, we work together, we help each other, we encourage each other, and, most importantly, we believe in each other. This is the key to our success at CS@UCSB!

Please take a look at our website for information about our research and education programs, and if you wish to be part of an energetic, collegial, and supportive computer science department that is at the forefront of the computing revolution, join us! If you have questions or comments you can reach me at coms-chair@cs.ucsb.edu.

As we are finalizing this newsletter, we are also witnessing the devastation caused by the COVID-19 pandemic. It is worthwhile to note that millions of people are able to work from home safely and continue to be productive because of the hardware and software built by computer scientists, demonstrating the importance of the research and education we provide as a computer science department. The positive, collaborative, and supportive culture of our department is enabling us to successfully continue our valuable teaching and research missions during these challenging times, which makes me especially proud to be a member of CS@UCSB!

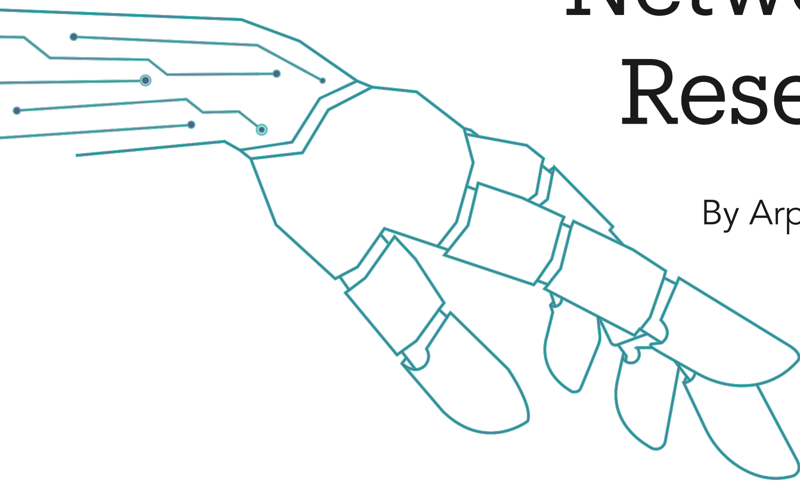
Best regards,

Tevfik Bultan
Professor & Chair
Computer Science Department, UCSB

contents

UC **SANTA BARBARA**
Computer Science

Democratizing Networking Research



By Arpit Gupta

AI/ML for Networking

The proliferation of networked devices (e.g., Internet-of-Things) and systems, as well as distributed applications (e.g., e-commerce), has highlighted the limitations that reliance on conventional network-management tools and systems. For one, the complexity of networks and services is overwhelming today's network operators. At the same time, to gain competitive advantages, network operators are also required to detect and react to different types of network events ever more quickly. As a result, these content (e.g., Google, Facebook, etc.) and Internet service (e.g., Verizon, AT&T, etc.) providers have reached a point where human network operators can no longer perform a growing number of network management tasks. In response, these entities have identified Artificial Intelligence (AI) and Machine Learning (ML), in conjunction with network automation, as critical for their business. They are actively developing AI/ML-based tools and systems for automating more and more of their day-to-day network operations and have been advocating for the pursuit of autonomous networks; that is, ``networks that can drive themselves."

Why do we need to Democratize Networking Research?

Unfortunately, this mostly industry-driven push for the development and application of AI/ML-based tools for automating network management tasks has also brought to light a gap between networking researchers in industry and academia that has been detrimental to progress in this area. More specifically, the development of AI/ML-based network automation tools for real-world production settings requires (i) access to fine-grained network data for developing relevant learning models and (ii) access to new testbeds for ``road-testing" these models in realistic settings. These resource-intensive requirements make it very difficult, if not impossible, for networking researchers in academia to make meaningful contributions and have a practical impact on this critical problem. In particular, unlike their counterparts in the industry, academic networking researchers generally lack access to fine-grained network data (which is often proprietary). They typically do not have the resources to build and operate a suitable testbed for evaluating their models and systems under real-world conditions. This lack of resources is also undermining the representativeness and reproducibility of artifacts associated with AI/ML-based research.

This gap has not been present in other research areas where AI/ML applications have recently had an enormous impact and have generated considerable excitement (e.g., computer vision, autonomous vehicles). AI/ML has been so successful in those areas precisely because of the very absence of such a divide, thanks in large part to the availability of rich sets of high-quality open-source (labeled) data. For instance, the availability of ImageNet, an extensive database of hand-annotated images, catalyzed the application of AI/ML in computer vision research in general and in visual object recognition in particular. The ImageNet dataset not only revolutionized but also democratized the field of computer vision. By enabling researchers to focus on developing new and better learning models and spend less or no time on data collection and labeling, ImageNet has fuelled AI/ML research in the area of computer vision by ensuring a level playing field for all interested researchers.

In contrast, the networking research area has no equivalent of ImageNet, especially if we consider such an equivalent as a data store populated by network data from a real-world production network. While for some problems, researchers can resort to existing testbeds (e.g., PlanetLab, GENI, etc.) that are important in their own right, the traffic that these platforms carry is, in general, not representative of real-world production networks. To get their hands on actual production network traffic, researchers typically have to start from scratch. First, conjecturing the critical features for the problem at hand, then developing the tools or systems for collecting the necessary data, and finally extracting the identified features from the obtained data. In effect, designing and running experiments to collect the data needed for feature extraction consumes most of the time for these researchers. The results tend to be under-developed learning models and insufficient time for their evaluation in settings that have any resemblance to a real-world production network.

How is UCSB changing the status quo?

A team of researchers that includes experts in networked-systems (Elizabeth Belding, Arpit Gupta) and privacy-preserving analytics (Trinabh Gupta) in collaboration with campus network administrators are transforming the campus networks as both data source and testbeds for networking research. In the process, creating a networking equivalent of ImageNet and serve as a realistic environment for developing and evaluating new AI/ML-based research artifacts. More concretely, UCSB is building a research infrastructure that lets networking researchers view and use campus networks as both vital sources of rich real-world data to fuel the development of new learning models and as accessible, diverse, production-level testbeds for testing AI/ML innovations in real environments.

Campus network as a rich data source.

The team at UCSB is developing new tools (and platforms) that leverage the latest network technologies (e.g., programmable network devices such as PISA-based switches, SmartNICs, etc.) to collect, store, and index the campus network traffic at scale. These tools address two fundamental challenges. First, collect network data in ways that give network administrators flexibility in expressing data privacy policies or rules for data access. Second, store the collected data in ways that maximize the data's value for the users (e.g., curated, cleaned, time-synchronized).

Campus networks as a versatile testbed.

UCSB researchers are also developing a new platform that enables networking researchers to use their campus network as a testbed for road testing their newly-designed AI/ML-based learning models. Key features of this platform are its flexibility, fidelity, and scalability. This testbed also enables the development of explainable or interpretable learning models. It demonstrates their utility for convincing network operators of the trustworthiness of modern AI/ML-based network automation tools.

Such a transformation of campus networks helps network administrators to develop a wide range of network-automation tools. For example, the UCSB team is actively developing tools for scaling its cyber-defense infrastructure, optimizing user's QoE, performing device fingerprinting, monitoring IoT devices, etc. This research infrastructure also improves reproducibility and transparency of AI/ML-based research artifacts by enabling the "ex-situ" evaluation of the learning model developed using "local" data in a privacy-preserving manner. UCSB researchers also plan to open-source all the related tools and software, allowing other universities to transform their campus networks. Such wide-scale transformation of campus networks will have profound implications for making AI/ML research more transparent and improving the reproducibility of its research artifacts.

New Faculty:

Shumo Chu

(Fall 2020)

Shumo completed his Ph.D. at the University of Washington working with Dan Suciu. Shumo's research focuses on building more trustless, secure, and privacy preserving data management systems by leveraging state of the art programming language and cryptography techniques. During his Ph.D., Shumo led the creation and development of Cosette, an open sourced automated reasoning tool for database queries. Cosette is the first tool of its kind that can reason about the equivalence of database queries by generating machine checkable formal proofs and performing model checking at the same time. To facilitate formal equality reasoning, Cosette uses ideas from database theory community to lift database queries to a new mathematical structure that extends commutative semirings. This new structure makes automated reasoning on database queries possible. Cosette has been used to verify query rewrite rules, symbolic testing, and automated grading. Its theory and implementation had been published in SIGMOD, VLDB, and PLDI, and won best demo award of SIGMOD. In addition, Shumo worked on query processing in distributed database systems and external memory graph algorithms. He had obtained "Best of" citation from KDD.

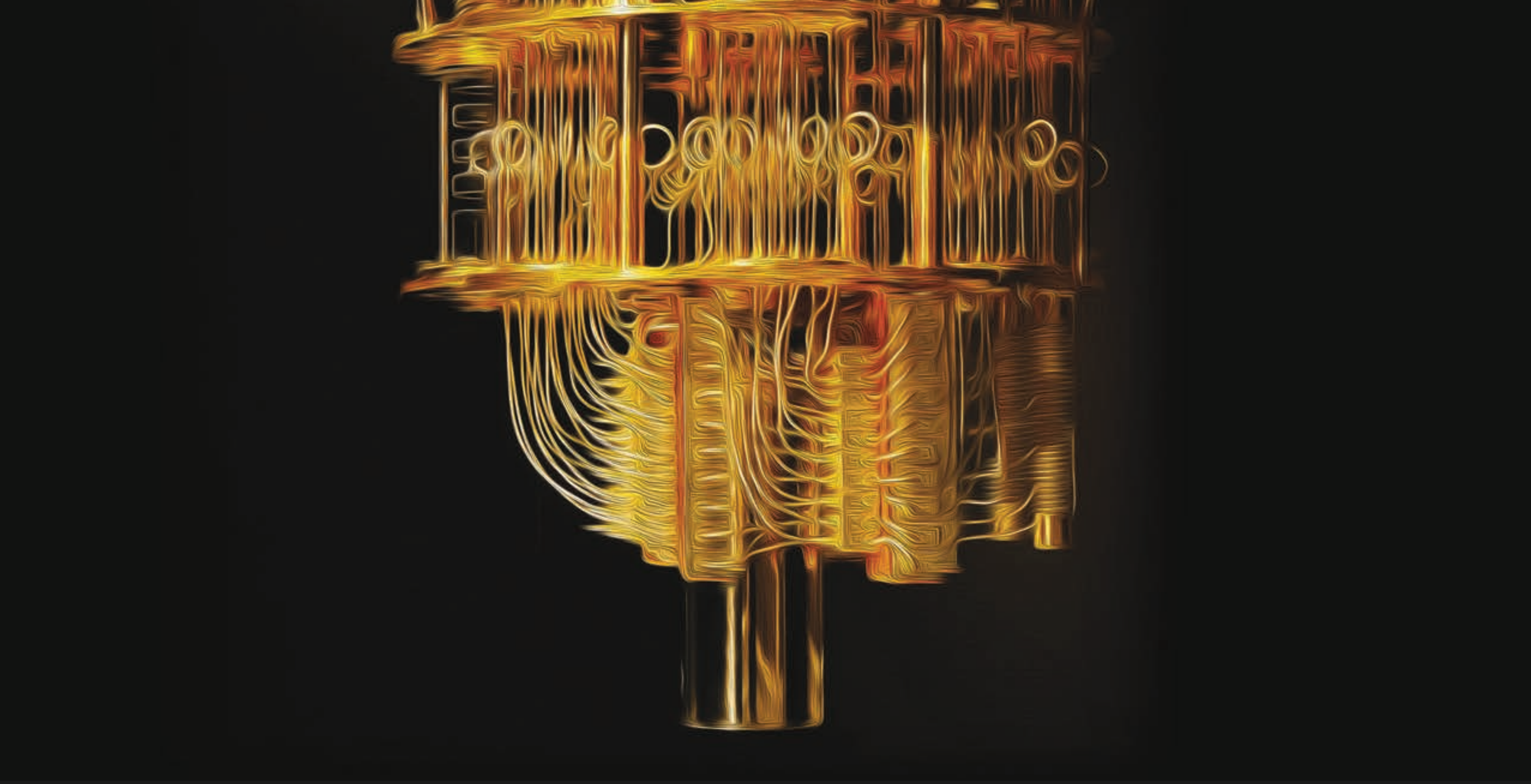
Leading the Quantum Computing Revolution

By Christopher Kruegel

All information processing systems today are based on classical computers, machines that make use of binary digits (bits) that can only assume one of two values -- 0 and 1. While we enjoy the power and benefits of these systems every day, there are certain types of problems that today's computers simply cannot solve. To address those problems, we need a new kind of computing paradigm. Quantum computing holds the promise to provide this kind of computational revolution. Using the rules of quantum physics, instead of classical logic, many intractable computational tasks could become feasible.

Quantum computers use quantum bits (or qubits), which encode data in a quantum mechanical manner, which is only possible under carefully controlled conditions. In fact, the qubits that make up today's experimental quantum processors operate at temperatures that are colder than outer space. Quantum computers leverage two important nonclassical phenomena: the superposition principle and the phenomenon of interference. Unlike classical bits (which can only be 0 or 1), qubits can be in a superposition of many classical states at the same time. Thanks to this feature, a quantum computer with several qubits in superposition can crunch through a vast number of potential computations simultaneously. To benefit from this superposition, a quantum computer uses interference to cancel out unneeded computational paths, while amplifying those paths that help solve the problem at hand. This interference is possible because, unlike in classical probability theory, different paths can have probability amplitudes, which can be negative or positive. Taken together, this quantum computational power opens the possibility for exciting advances in various fields, from cryptography, to materials science, to operations research.

Building a real quantum computer is extremely difficult, and researchers have tried for decades with limited success. However, last year, a group of scientists from Google and UC Santa Barbara made a significant breakthrough: They built the first actual device that demonstrated "quantum supremacy". That is, they built the first quantum computer that was able to solve a well-defined problem that would take much longer (orders of magnitude longer) to solve with the best known algorithm running on the best existing classical computer. This quantum processor -- called Sycamore -- had 53 qubits, and the researchers



demonstrated a program that took just minutes to perform a computation that would take today's most powerful supercomputers days. Of course, we are still far away from a general purpose quantum computer. In fact, the problem that the quantum computer solved with such incredible speed was carefully selected for the purpose of demonstrating the desired quantum supremacy effect, and not one with much practical impact. Nonetheless, the moment represented a distinct milestone in the effort to harness the principles of quantum mechanics to solve computational problems. For leading the efforts to create a quantum computer that outperforms classical computers, UCSB Professor John Martinis was selected by Nature as one of 10 people who had "a significant impact on the world, or their position in the world may have had an important impact on science."

> "The development of new quantum algorithms is greatly influenced by the specific strengths and weaknesses of the near-term quantum computers that we can expect"

Building a working quantum computer is an impressive feat, but it is not the end of the journey. Jack Hidary, the author of the book "Quantum Computing: An Applied Approach," recently remarked that "hardware is very interesting [but] it is really software that gets the majority of the value creation." The ability of a quantum computer to speed up computations can be impressive, but it requires specially-designed quantum algorithms to truly take advantage of these speed-ups. This is where researchers at the computer science department play an important role.

Professor Wim van Dam has worked on quantum computing since the beginning of this field and his expertise is on the design and development of quantum algorithms that outperform all possible classical computations. For a long time this line of research was agnostic about the kind of quantum hardware that it was supposed to run on, as the latter did not exist yet. With the recent experimental breakthroughs however, the development of new quantum algorithms is greatly influenced by the specific strengths and weaknesses of the near-term quantum computers that we can expect. Van Dam's research is therefore focused on algorithms that solve optimization problems on quantum hardware like that of Google's Sycamore computer.

Prof. Yufei Ding is another researcher who works on quantum computing, more specifically, she researches optimizations to build more reliable and higher performance quantum computing systems. "Many novel ideas have been proposed for optimizing classical computers. These ideas had a huge impact on both academia and industry, introducing better compilers, specialized hardware accelerators, and modular architecture simulators. It is time to apply these improvements to quantum computing as well." Prof. Ding works on quantum computing (QC) compiler optimizations, which will allow QC programs of larger sizes to be executed with higher fidelity. She also explores a number of novel architecture optimizations, such as quantum instruction set architecture (QISA) selections and qubit connection topology arrangements. These achievements are necessary to turn the vision of powerful and useful quantum computers from a dream to reality.

Protecting Cyberspace

By Christopher Kruegel

About ten years ago, the venture capitalist Marc Andreessen famously wrote that “software is eating the world.” Billions of people are on the Internet today, players in every industry sector are reinventing themselves as technology companies, and virtually every aspect of our lives has moved online. With the Internet of Things (IoT) emerging and critical infrastructure increasingly getting connected, providing cyber-security -- already difficult under the best of circumstances --is becoming much more challenging. The sheer amount of data and devices on the network multiply the chances of a large-scale disruption, whether through an unintentional bug, or worse, a malicious program. Unfortunately, malicious actors are currently able to compromise and use with impunity large numbers of devices that range from laptops to home routers, from cars to TV sets and industrial control systems. This affects the security and privacy of individual users, but it is also a threat to national security.

Researchers at UC Santa Barbara have been at the forefront of defending cyberspace against hackers and malicious actors. And recently, they received support from DARPA to boost their work on identifying exploitable software bugs (vulnerabilities) and to gain control of and clean up infected devices. These two DARPA awards, in collaboration with national and international researchers, provide almost $20 million in funding to develop innovative security solutions.

One project focuses on novel techniques to automatically exploit vulnerabilities to gain control of infected devices and to safely remove the presence of malicious code. In other words: Can we build a machine that can automatically hack into devices that are under the control of an adversary and take back control? In popular culture, hackers are often depicted as wizards, hooded characters with almost magical powers that can access the inaccessible. The goal of the UCSB scientists and DARPA is to capture and reproduce this wizardry in a principled, scientific fashion. This will require advances in systems security and program understanding, and the ability to scale up and automate analysis to millions of lines of code.

The goal of building autonomous systems that can reason about software flaws, automatically exploit them, and provide patches to remove them from software has been a long-standinglong standing goal that DARPA has pursued for many years. In 2014, DARPA launched the Cyber Grand Challenge (CGC), a competition seeking to create fully automatic defensive systems in cyberspace. The CGC was part of a series of challenges that DARPA issued to researchers to stimulate breakthroughs in areas that are critical to the US. Other such challenges included the famous self-driving cars and robots that carry out “complex tasks in dangerous environments.” The Cyber Grand Challenge was designed as a hacking contest among autonomous systems, without any humans being involved. During the contest, Cyber Reasoning Systems had to battle each other; one machine trying to hack into services that other machinesanother machines had to keep running at all costs. Researchers from UC Santa Barbara participated in this competition as Shellphish, and they won third place (and a $750K prize) at the final competition in 2016. Given their groundbreaking work in this area, it was only logical that DARPA tapped the UCSB scientists to keep pushing the edge of what is possible.

Stepping back and looking at a war between machines, it is only natural to ask about the role of humans. We know that we cannot keep up with the raw speed and computation power of computers. However, there is still a place for human creativity and ingenuity. The second DARPA project explores ways in which humans can be useful actors in the

> UCSB researchers work on innovative techniques to leverage human insight as input into the vulnerability discovery process

fight between machines. After all, finding and fixing flaws in software is still a tremendously complicated challenge. A computer can look at millions of instructions every second, but it has a much harder time to understand the big picture: A complex user interface, the required format of an input field, or the goal of an application are semantic concepts that are easy to grasp for a human but difficult to express in a way that is actionable for a computer. But why is the understanding of the big picture important to find software bugs and vulnerabilities? The critical insight is that, in order to inspect a piece of code for flaws, a machine first needs to "get there." And successfully reaching functionality that is deep into the application logic is hard when you randomly throw inputs at the program. The chances are that random inputs exercise only the first few layers of a program but fail to get deep into the internals of an application. This is a problem that humans can help solve. They can guide the exploration of programs and help computers shine their bright light into the deeper layers of the application logic. The UCSB researchers work on innovative techniques to leverage human insight as input into the vulnerability discovery process, enabling a symbiosis between humans and machines to find more and deeper bugs than ever before.

Finding and fixing vulnerabilities in critical software is only one area of interest for the security group at UCSB. The researchers are also finding better ways to protect IoT devices, securing the "things" that make your home smart and that track you and your health. They work on ideas to keep attackers out of our networks and the cloud. And they invent novel solutions to protect users' privacy and sensitive data, because the task of protecting the Internet and its users is never complete.

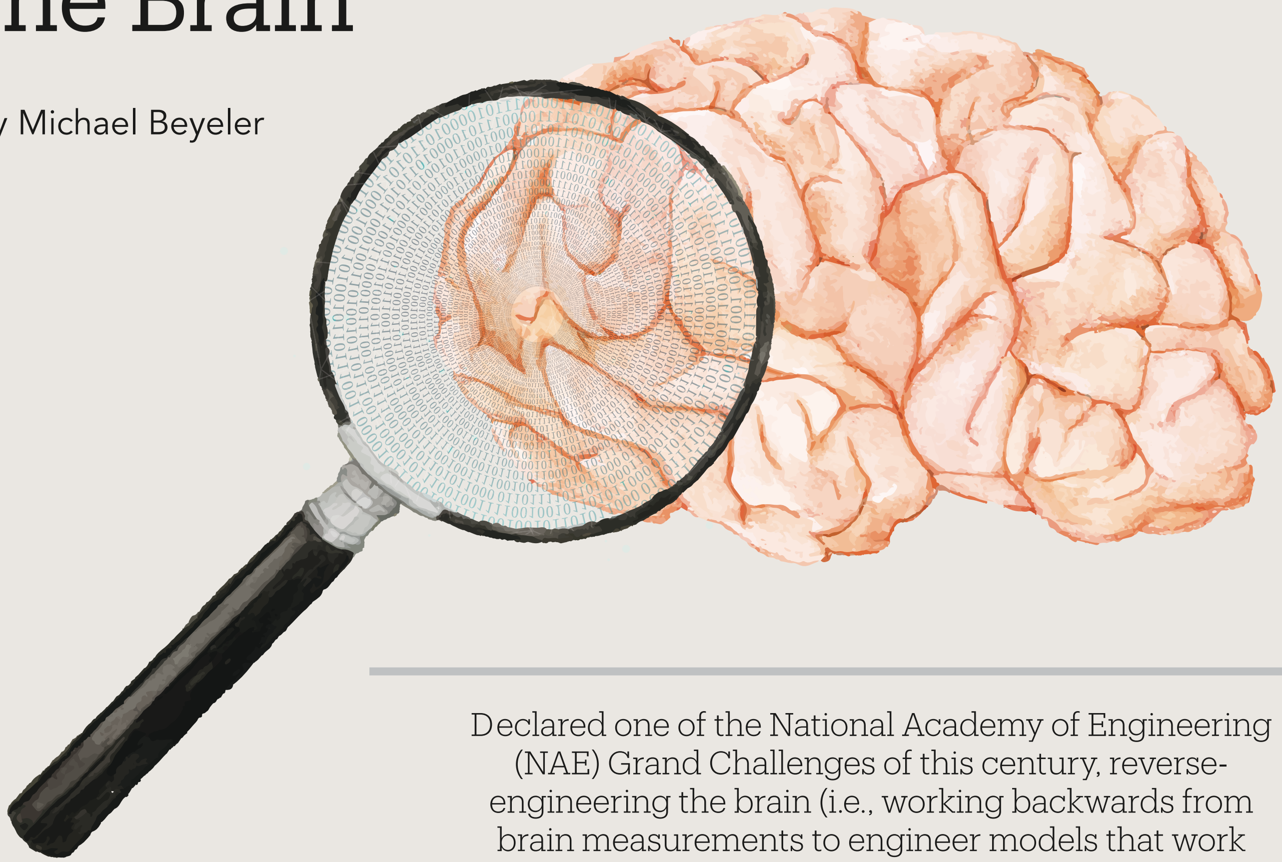
New Faculty:
Misha Sra

(Fall 2020)

Misha Sra is the John and Eileen Gerngross Assistant Professor and directs the Perceptual Engineering Lab in the Computer Science department at UCSB. Misha received her PhD at the MIT Media Lab in 2018. She has published at the most selective HCI and VR venues such as CHI, UIST, VRST, and DIS where she received multiple best paper awards and honorable mentions. From 2014-2015, she was a Robert Wood Johnson Foundation wellbeing research fellow at the Media Lab. In spring 2016, she received the Silver Award in the annual Edison Awards Global Competition that honors excellence in human-centered design and innovation. MIT selected her as an EECS Rising Star in 2018. Her research has received extensive media coverage from leading media outlets (e.g., from Engadget, UploadVR, MIT Tech Review and Forbes India) and has drawn the attention of industry research, such as Samsung and Unity 3D.

Reverse-Engineering the Brain

By Michael Beyeler



Declared one of the National Academy of Engineering (NAE) Grand Challenges of this century, reverse-engineering the brain (i.e., working backwards from brain measurements to engineer models that work just like it) will not just further our understanding of brain function but is poised to transform current artificial intelligence (AI) systems and illuminate new approaches to supporting those who live with severe blindness, autism, schizophrenia, learning disabilities, or age-related memory loss.

UC Santa Barbara is at the forefront of this "neuro revolution" with the launch of the UCSB Brain Initiative, a campus-wide program to foster collaborative work aimed at fundamentally altering the landscape of brain research by coming up with completely new devices and strategies. "We have world-class engineering, physics and computer science departments," said Bridget Queenan, neurophysiologist and former full-time campaign manager, "but we also have the right culture of idealism, innovation and teamwork—all of which combine to create a unique environment for collaborative breakthroughs."

One goal of the initiative is to pull all of this work together into a high-powered neural computing center. "We have people who are figuring out what the brain does, people who are writing programs inspired by the brain, people who are building hardware to mimic that behavior," said Queenan. Today's computers have electronic logic gates that are either on or off, but if engineers could replicate neurons' ability to assume various levels of excitation, they could create much more powerful computing machines. Dr. Timothy Sherwood is working on

> Enabling engineers to simulate the brain's activities could also lead to deeper insights about how the brain works and why it sometimes fails.

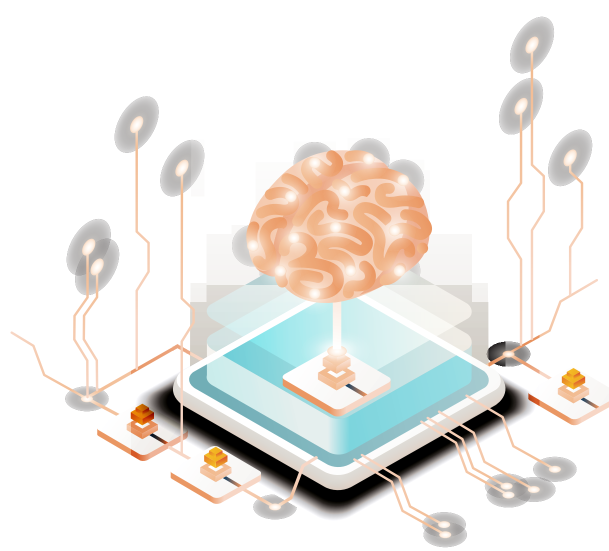
such 'neuromorphic' algorithms by studying how the brain processes multiple streams of information in parallel, and how it represents information sparsely in time. His research shows that 'time-based representations' (i.e., an encoding where the temporal relationship between events carries useful information) could lead to radically more energy efficient forms of computing

Enabling engineers to simulate the brain's activities could also lead to deeper insights about how the brain works and why it sometimes fails. Dr. Linda Petzold recently discovered how the 20,000 neurons in the suprachiasmatic nucleus act as a cognitive clock, keeping track of time and regulating circadian rhythms. Her research focuses on the development and structure of brain networks, light-driven plasticity, and the physical basis of intercellular communication.

Of potentially even greater impact on human health and well-being is the use of new AI insights for repairing broken brains. To this end, Drs. B.S. Manjunath and Ambuj Singh are developing deep learning, statistical, and optimization frameworks to aid in the interpretability of medical image datasets supporting trained physicians in detecting diseases and labeling malignant tissue.

Even more ambitious programs are underway for systems to control artificial limbs, literally read the thoughts of immobilized patients, or even restore some sensory function lost due to incurable disease or stroke. For example, neural prostheses have been put to use in the form of cochlear implants to treat hearing loss and stimulating electrodes to treat Parkinson's disease. Similarly, Dr. Michael Beyeler is researching the neural basis to develop algorithms for artificial retinas ('bionic eyes'), which are light-sensitive chips that could help restore vision to people living with incurable blindness.

The progress so far is impressive. But to fully realize the brain's potential to teach us how to make machines learn and think, further advances are needed in the technology for understanding the brain in the first place. The Brain Initiative puts UCSB in a prime position to contribute to that challenge.



Leading the Charge for Responsible AI

By Michael Beyeler

Today, machine learning (ML) and artificial intelligence (AI) power many of the programs and services we use to navigate our daily lives, ranging from finding the quickest route to our destination to predicting our creditworthiness.

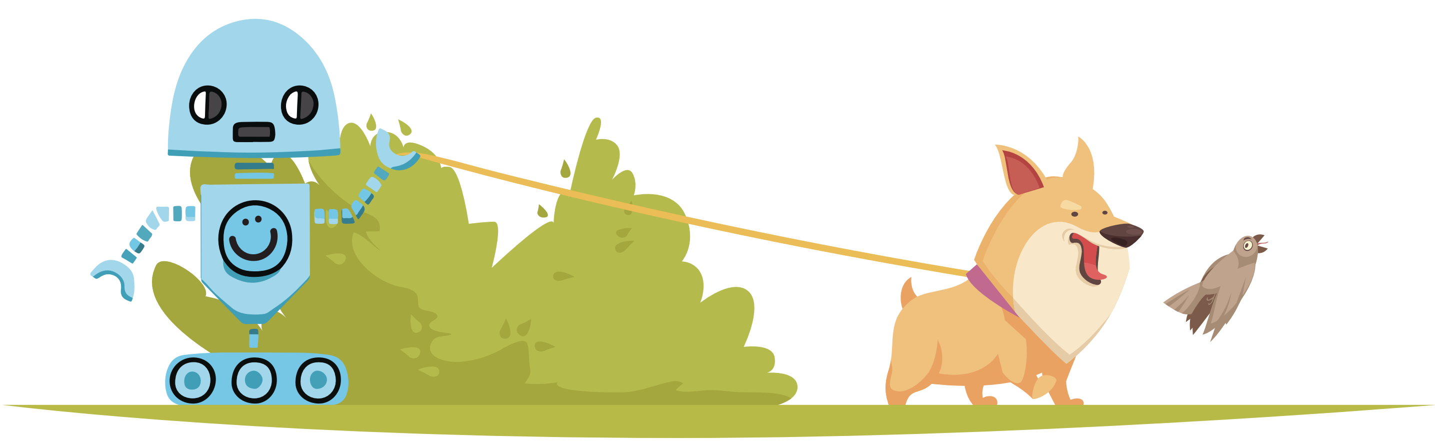
However, because ML/AI algorithms learn patterns from vast pools of data, these models are at risk of perpetuating biases present in the information they are fed. This may result in outcomes that unfairly—and in some cases illegally—discriminate against protected groups, such as women and minorities. For instance, some facial recognition systems have been found to be less accurate at differentiating between dark-skinned faces as opposed to lighter-skinned ones, leading a state judicial system to rate black prisoners as having a higher risk of re-offending than white prisoners with similar criminal records. In this sense, AI's mimicking of real-world, human decisions is both a strength and a great weakness for the technology—it's only as 'good' as the information it accesses.

UC Santa Barbara is at the forefront of this ongoing discussion, with the instantiation of the Center for Responsible Machine Learning (CRML), the university's new commitment to define and build the future of ML algorithms and human-aware AI systems. "UCSB is one of the fastest growing research hubs in artificial intelligence and machine learning," said UCSB Chancellor Henry Yang. "The center establishes a truly interdisciplinary vision of ML research that bridges engineering, the social sciences, and humanities to establish an ethical and responsible foundation for machine learning."

Building on these strengths, a number of faculty efforts in our department are focused on building AI systems that can identify and combat ethical and privacy issues in today's information networks, computer systems, and social media. For example, Dr. William Wang, Director of the CRML and the UCSB NLP Group, has been investigating how misinformation spreads online, and his team is using the insights gained to build AI systems that can identify fake news and combat hate speech. The NLP Group also worked with UCLA to create a comprehensive literature review on the gender bias issue in natural language processing. In a similar vein, Drs. Ambuj Singh and Xifeng Yan are studying information flow and opinion formation in social networks from a quantitative and systems-oriented viewpoint. The computational models developed by Singh's team provide insight into the evolution of competing polar opinions in social networks, and provide a means to combat malicious external influences on the mass opinion in these networks.

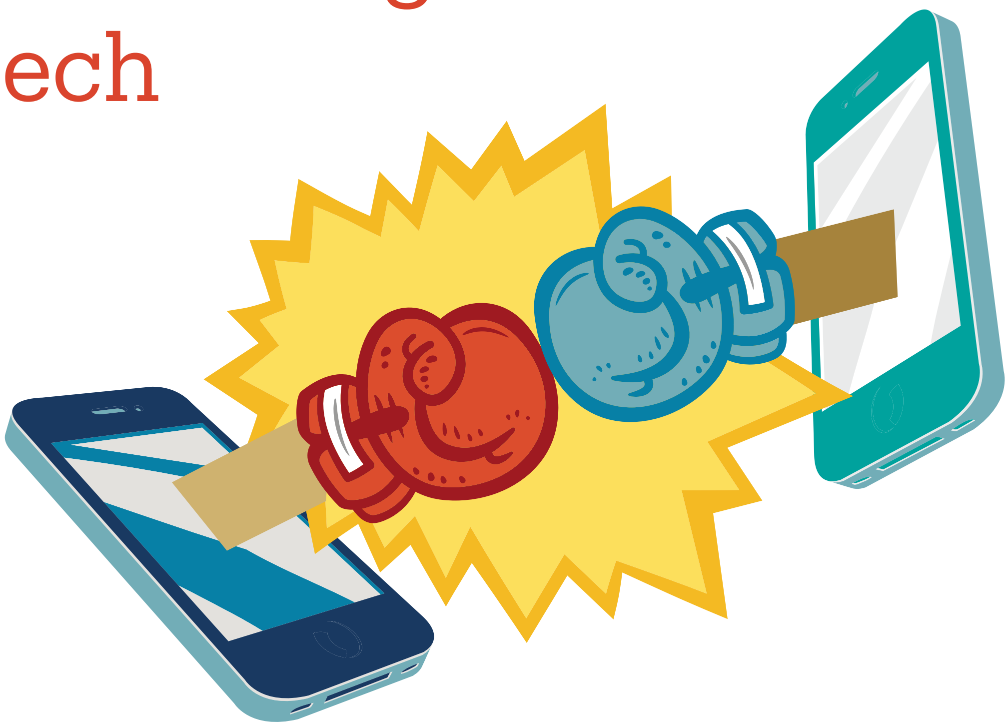
Another big issue in responsible ML is data privacy. Dr. Yu-Xiang Wang, a co-director of the CRML, has been working on differential privacy in ML systems; that is, findings ways of publicly sharing information about a dataset by describing the patterns of groups within the dataset while withholding information about individuals in the dataset. Relatedly, Dr. Tao Yang is investigating how privacy can be preserved in cloud-based information services and developing algorithmic solutions for private cloud data search.

Drawing on its world leading engineering programs, rich history of engagement on issues of societal importance, and deeply interdisciplinary nature, UCSB is uniquely poised in the world to be the center of gravity for this new line of work in Responsible Machine Learning.



UCSB's Crusade Against Hate Speech

By Arpit Gupta



Hate speech affects our mental health.

The growing popularity of online interactions through social media has been shown to have both positive and negative impacts. While social media improves information sharing, it also facilitates the propagation of online harassment, including hate speech. These negative experiences can have a measurable negative impact on users. Recently, the Pew Research Center (Center, 2017) reported

"Roughly four-in-ten Americans have personally experienced online harassment, and 63% consider it a major problem. Despite this broad concern over online harassment, 45% of Americans say it is more important to let people speak their minds freely online; a slightly larger share (53%) feels that it is more important for people to feel welcome and safe online."

What can we do about it?

The special rapporteurs representing the Office of the United Nations High Commissioner for Human Rights (OHCHR) have recommended that "The strategic response to hate speech is more speech." They encourage to change what people think instead of merely changing what they do, so they advocate more speech that educates about cultural differences, diversity, and minorities as a better strategy to counter hate speech. Changing what people think is a much harder problem to solve.

UCSB to the rescue

A team of researchers from UC Santa Barbara came up with a novel idea of changing how people think by developing a novel system that can reactively intervene to deter people from using hate speech. The key idea behind their "generative hate-speech intervention system" is to collect data from sections of social media platforms that are well-known for spreading hate speech (e.g., r/The_Donald). To automate intervention, the team collected more than 5 conversations from Reddit and over 12,000 from Gab. To label and create intervention suggestions, the researchers used the crowdsourcing platform, Amazon Mechanical Turk (AMT). For each conversation, a worker is asked to answer two questions: (1) which posts or comments in this conversation are hate speech? and (2) how would you respond to intervene hate speech conversations? Input from nearly a thousand workers helped create a novel dataset. This dataset can be used to train learning models that can not only detect hate speech but also synthesize intervention messages to deter it.

Journey ahead

The crusade against hate speech is far from over. The next step is to productize the current intervention system, which will require making the learning models more accurate, which in turn requires collecting and labeling hate speech data at scale. UCSB's Center for Responsible Machine Learning (CRML), lead by Dr. William Wang, plans to leverage UCSB's expertise in other areas such as communications, humanities, behavioral science, etc. to improve the system further. In the future, the team at UCSB plans to make the deterrence more effective. Given that the spread of hate speech heavily relies on bots, the team plans to request "CAPTCHA" on detecting usage of hate speech--deterring bots from spreading hate speech.

SmartFarm: IoT-driven Analytics Systems for Agriculture

By Yufei Ding

Why do we need SmartFarm?

Studies from the U.S. Department of Agriculture and the United Nations Food and Agriculture Organization reveal some scary findings: more food will be needed to feed the growing global population using fewer resources, while farm labor is in short supply or too expensive. 80% of the freshwater and 30% of global energy is used to produce food, half of which we waste in spoilage. Farming also has some particularly formidable foes: Changing weather and climate, reflected in water scarcity and extreme events, altered pest and disease pressure, and increasing energy demands all make it increasingly difficult to produce food consistently and in ways that are economically and environmentally viable.

UCSB SmartFarm Research and Innovation

Drs. Chandra Krintz and Rich Wolski, both computer science professors at UCSB, work to bring recent advances in computing (e.g. cloud computing, the Internet-of-Things, sensing, data analytics and machine learning, etc.) to farming to optimize food production, automate farm processes, and to capture and curate provenance information for individual food items from "farm to fork". To this end, the SmartFarm Research Team investigates the design and implementation of an open-source, hybrid cloud approach to agriculture analytics for enabling sustainable farming practices.

A key design goal of UCSB SmartFarm is to develop a system that is a low cost, easy to use, that provides reliable decision support in real-time while giving farmers control over when and how they share their data. To enable this, SmartFarm runs on-farm, "near" where the data is produced and collected -- precluding the need for expensive cellular connections, Internet connectivity, and lock-in to any particular vendor. The system combines inexpensive consumer-grade electronics, novel sensor systems, and advanced analytics to extract actionable insights from the data at low cost. Doing so facilitates fast and energy efficient response for automatic actuation and control of farm operations. "The system runs on-farm so it must work without an IT staff. To enable this, we designed it to be self-managing and autonomous and to operate for extended periods of time without requiring manual intervention -- it is an appliance, like your refrigerator", said Krintz.

Uniquely, SmartFarm mirrors public cloud systems so that it is similarly easy to use and provides compatible services for security, data analytics, visualization, and mapping -- simplifying and expediting the development of farm apps by others. If there is Internet connectivity on-farm, SmartFarm automatically interoperates with public cloud systems to facilitate controlled sharing and data anonymization (for privacy protection). The SmartFarm team has also developed a new runtime system that executes apps across sensors, the edge cloud, and public cloud systems if/when available. By optimizing the system for battery-powered devices, the team has shown it is possible to reduce energy consumption by over 100 times versus existing cloud/edge solutions.

Krintz and Wolski currently have deployments

and interesting test cases (e.g., site-specific farm management, precision irrigation, frost prevention) across California. Their research is integrated into almond fields at Fresno State, citrus blocks at the University of California's Lindcove Research and Extension Center (LREC), and UCSB's Edible Campus, which grows a wide range of fruits and vegetables for food-insecure students.

In the long-term, SmartFarm will provide farmers with a secure, easy to use, low-cost system for data-driven decision support, actuation, and control, into which custom analytics apps can be plugged (using a smartphone App Store model). Specifically, SmartFarm will integrate disparate environmental and Internet-of-Things (IoT) sensor technologies, data from external cloud sources (weather predictions, satellite imagery, state and national datasets, etc.), and historical farm records, to automate, actuate, and control additional on-farm processes (e.g., precision agriculture, application of inputs like water and fertilizer, and pest and disease mitigation, among other applications).

The new computer science that the SmartFarm team investigates includes advances in programming, runtime, operating, and distributed systems as well as in low-cost sensing, data analytics (inference and prediction), and energy efficiency. The researchers then customize and tailor their advances to real and emerging problems that farmers face -- with the help of multidisciplinary collaborations with farmers, farm consultants, and researchers from UCSB, Fresno State, CalPoly, and other universities around the world, with expertise in ecology, conservation science, and precision agriculture, among other areas. By doing so SmartFarm has the potential for significantly enhancing and expediting safe, high-quality, food production, sustainably, and for helping farmers -- particularly small holders, scale their operations, reduce costs, and increase efficiencies.

New Faculty:
Michael Beyeler

(Winter 2019)

Michael Beyeler directs the Bionic Vision Lab at UC Santa Barbara.

He received a PhD in Computer Science from UC Irvine as well as a BS in Electrical Engineering and a MS in Biomedical Engineering from ETH Zurich, Switzerland. Prior to joining UCSB, he completed a postdoctoral fellowship in the labs of Ione Fine (Psychology, Institute for Neuroengineering) and Ariel Rokem (eScience Institute) at the University of Washington, where he developed computational models of bionic vision. He is Associate Director of the UCSB Center for Virtual Environments and Behavior (ReCVEB) and recipient of the National Institutes of Health (NIH) Pathway to Independence Award.

summit.cs 2020

First Place team, Minimum Viable Team (left to right): Steve Bako (instructor), Michelle Nguyen, Ekta Shahani, Terrell Marshall, Adtya Nadakarni, and Chris Lianides

This year's summit.cs was hosted on March 11, 2020 at UC Santa Barbara. Each year, the summit brings past and current students, faculty and industry partners together for a whole day of idea-sharing and networking. The summit was available via zoom, making it accessible to those who were unable to physically attend.

We would like to give special recognition to the three winning teams:

First Place: Minimum Viable Team *sponsor:* Well Health
Team: Ekta Shahani (Lead), Terrell Marshall (Scribe), Chris Lianides, Michelle Nguyen, Aditya Nadkarni
Project Overview: A telemedicine platform to make virtual doctor's visits effective and efficient by enhancing patient-doctor communication.

Second Place: No Cap Stone *sponsor:* Logmein
Team: Andrew Doan (Lead), Bikram Nandy (Scribe), Adjon Tahiraj, Ryan Gormley, Tim Chang
Project Overview: Creating more personalized and engaging online interviews to better simulate a real, in person interview.

Third Place: 2B || !2B - *sponsor:* PowWow Energy
Team: Daniel Shu (Lead), Richard Rodriguez (Scribe), Anna Ivannikova, Bryan Wu, Yiyang (Meredith) Xu
Project Overview: A tool that will analyze satellite data to help farmers more efficiently use water and energy.

Tevfik Bultan, Professor and Chair of the Computer Science Department at UCSB shared his reaction to the summit -

"It was great to see the innovative projects and high-quality research produced by our students. CS Summit is a wonderful event since it provides you glimpses of the future of the computing industry and computing research."

Bultan believes the Capstone presentations were one of the best parts of the event, and overall the event went very well. In future summits, he thinks the Department should "investigate more virtual attendance options in the future, such as taking questions from people who are listening to talks online [and] would like to see more attendance from outside of UCSB such as local computing companies, or students from local high schools or from SBCC."

Bultan would also like to give special thanks to Samantha Oglesby and Greta Carl-Halle for the effort they put into the preparation of the event.

Steve Bako, Capstone Instructor at UCSB, shares that he was thoroughly impressed with the event. For Bako, the highlights of the event included the student presentations and the smiles from the winning teams! He emphasized that he is very proud of his students and their hard work paying off. In future summits, he would like to "increase the attendance even more with additional advertising and potentially introducing new panels/sessions".

Second place team, No Cap Stone (left to right): Ryan Gormley, Adjon Tahiraj, Bikram Nandy, Andrew Doan, Tim Chang, and Steve Bako

Third place team, 2B ll !2B (left to right): Richard Rodriguez, Anna Ivannikova, Daniel Shu, Yiyang (Meredith) Xu, Bryan Wu, and Steve Bako

Bako would like to give special thanks to the following:

Jake Guida, who did a fantastic job as the TA for the winter quarter (CS189B)

Prof. Chandra Krintz for doing all the heavy lifting in the fall quarter (CS189A)

Prof. Tevfik Bultan and Prof. Tobias Hollerer for holding this event for the CS department despite the current circumstances

Greta Halle and Samantha Oglesby for the tremendous effort in organizing

Libby Straight, Tony Mastres, Lillian McKinney for photographing the event and the class

Brian and the audio team at Corwin.

Steve Ramirez and his team for helping to search for judges.

Rob Dunton for making the judges flier.

Carlos Torres, John Delaney, and Alex Harvill for being our judges.

The companies and their mentors that sponsored the projects and guided the students

All the teams for their 6 months of hard work and amazing projects!

Thank you to everyone involved for another great summit and we look forward to seeing you next year!

New Faculty:

Prabhanjan Ananth

(Fall 2020)

Prabhanjan Ananth is currently the Glenn and Susanne Culler chair assistant professor in computer science. He completed his doctoral studies at UCLA followed by a stint at MIT as a postdoctoral associate. During his Ph.D., he won the Simons award for graduate students in theoretical computer science and also the Symantec outstanding graduate student research award. He works on cryptography and more broadly on theoretical computer science. The theme of his research revolves around preserving privacy of outsourced computations.

Prabhanjan Ananth was born and raised in Bengaluru, India. He likes music, plays ukulele in his free time and enjoys reading books.

Computer Science Rankings

Everybody likes rankings; they help to find a tasty restaurant for dinner, a great movie on Netflix, or the best product on Amazon. Naturally, people also want to know about the best universities and computer science programs in the country. Unfortunately, good rankings for CS programs have been notoriously difficult to compile. In some cases, rankings are purely based on reputation, without looking at data at all. In other cases, the rankings are based on data, but how to account for the vastly different fields in computer science, or how to combine research and teaching into one meaningful score? To tackle this problem, a number of computer scientists got together and introduced the concept of GOTO rankings [http://gotorankings.org]. GOTO is an acronym that stands for Good data, Open, Transparent, and Objective. That is, the goal is to compile rankings based on good, open data, and to make sure that the rankings are representative and meaningful. The two main GOTO rankings for computer science are CSRankings [http://csrankings.org] and CSMetrics [http://csmetrics.org], which both measure the output of top scientific publications.

These two rankings reflect very well the strengths of our computer science department. We reinvent the field in many areas that are critical for the future. Among these, there are three key thrusts that the department focuses on: responsible machine learning, cloud security and privacy, and interactive and visual computing. That is, we aim to build ubiquitous and smart systems that are secure and that support seamless interactions so that they can unlock the full human potential. We are fortunate that the CS department is highly ranked in all these critical areas.

Looking at both CSRankings and CSMetrics (with their default settings), we see that computer security is ranked Number 8 and Number 6, respectively. When selecting natural language processing and web & information retrieval, two key areas of AI, the CS department is ranked Number 8 on CSRankings. When selecting distributed systems and web technologies, two key areas that power cloud computing, CSMetrics puts the department at Number 8. And when checking computer graphics and visualization on CSRankings, the department is listed at Number 13. This clearly shows that CS at UC Santa Barbara is recognized as a Top-10 department.

The top scores in the GOTO rankings are also confirmed by other assessments that take a broader view beyond just publications. In the most recent ranking by the National Research Council (NRC), the PhD program of the Computer Science department scored within the Top-10 departments in the country [https://www.cs.ucsb.edu/about/ucsb/rankings]. Moreover, in its 2019 listing of the top public US universities, the US News & World Report has ranked UC Santa Barbara at Number 5 [https://www.news.ucsb.edu/2018/019172/top-five]. The US News & World Report also sees the College of Engineering graduate program (which CS is a part of) as Number 12 among top US public universities [https://engineering.ucsb.edu/news/ucsb-s-college-engineering-ranks-among-nation-s-best].

We do appreciate the prestige and recognition that comes with the rankings. But it is the tireless work of the students and faculty that makes these results possible.





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