COMPUTE

FALL 2022

Faculty Additions

New BS in Software Development

Professor Van der Merwe receives Distinguished Research Award

SCHOOL OF COMPUTING
THE UNIVERSITY OF UTAH

WELCOME

Fall 2022 is shaping up to be a semester of post-Covid renewal and new beginnings for the School of Computing. We are developing plans for the John and Marcia Price Computing and Engineering Building, the future home for the School of Computing. Since July, a series of brainstorming workshops with the architectural team are establishing a vision for the environment where computing education, student engagement, research collaboration, and industrial partnerships will be conducted over the next several decades. The new building cannot arrive soon enough. The School has by far the largest incoming undergraduate and graduate classes in its history. In fact, the number of students taking introductory programming courses in Fall 2022 is 30% more than in Fall 2021.

Also new in Fall 2022 is the Bachelor of Science in Software Development degree program. It complements our existing degree programs, offering an option for students who want to focus on full-stack development and human-centric skills. To support this program, new courses in web development, computing ethics, and professional development have been added, and existing courses have been updated.

The sustained growth in our student population as well as this new degree demand that we offer more and different courses. To make this a reality, we welcomed twelve new faculty in 2022, with an additional eight faculty already committed to join in 2023.

The School of Computing is indeed buzzing with energy and excitement, ushered in by the new faculty. We look forward to working with the community to make the 2022-2023 academic year another year of strength and impact.

Editorial Board

Rajeev Balasubramonian
Sheri Carp
Chris Coleman
Mary Hall
Erin Parker

Mary Hall

Mary Hall
Director, School of Computing

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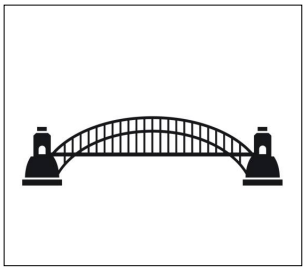
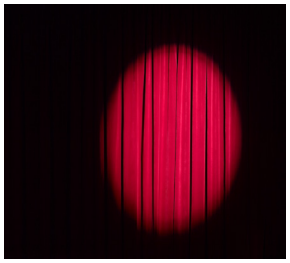
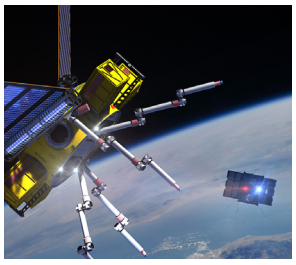






UNIVERSITY OF UTAH
FEB. 28TH
MDCCCL

12 new faculty join the School of Computing in 2022

Daniel Brown
Assistant Professor
Robotics

Anton Burtsev
Assistant Professor
Operating Systems

Shireen Elhabian
Associate Professor
Image Analysis
Statistical Machine Learning

Kate Isaacs
Associate Professor
Data Visualization
High Performance Computing

Nabil Makarem
Assistant Professor, Lecturer
Internet of Things

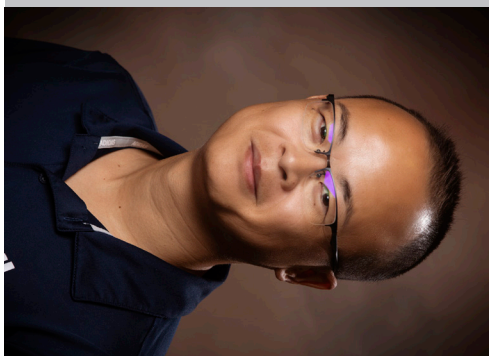
Ana Marasovic
Assistant Professor
Natural Language Processing
Artificial Intelligence

Yin Yang
Associate Professor
Computer Graphics

Paul Rosen
Associate Professor
Visualization
Computational Geometry

Stefan Nagy
Assistant Professor
Computer Security
and Systems

Jun Xu
Assistant Professor
Software and System Security



Haitao Wang
Associate Professor
Computational Geometry
Theoretical Computer Science

Prashant Pandey
Assistant Professor
Data Structures and Algorithms

Introducing the Bachelor of Science in Software Development

The School of Computing has introduced a new rigorous undergraduate degree for software development (SD), with the goal of capturing more students' interests and further grow our program to meet the workforce demands of the state of Utah. Following the evolution of the software industry, this degree focuses on full stack development with coursework in web and mobile software, databases and backends, and UI/UX design. SD further trains students in human-centric skills such as product design, team and business management, ethics, and entrepreneurship. Graduates of this program will have skills suitable for professional careers as well as graduate programs in certain interdisciplinary areas of computer science.

The Software Development major joins existing undergraduate majors in the School of Computing: Computer Science, Data Science, and Computer Engineering. Software Development students can take courses from the other programs as electives. Moreover, just as with the Computer Science degree, we offer an optional Entertainment Arts and Engineering emphasis.

We anticipate this program will help the School of Computing reach more students interested in computing-related careers, and increase the number of graduates from our program. As early evidence of Software Development's popularity, thirty students have already applied for the major.

Collaboration with NVIDIA Leads to a Breakthrough in Real-Time Graphics

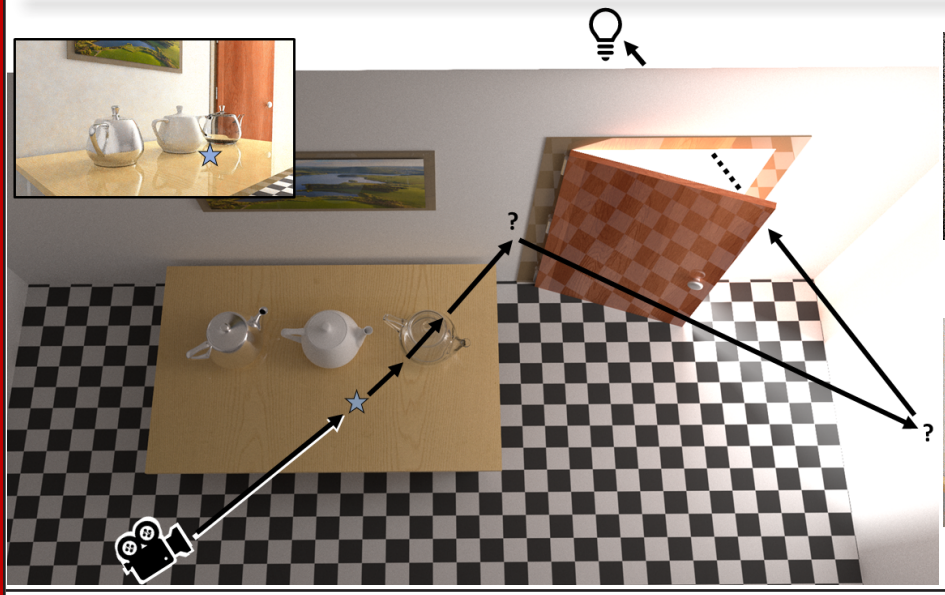
At ACM SIGGRAPH 2022 this August, researchers from the U's School of Computing and NVIDIA presented a technical paper on "Generalized Resampled Importance Sampligh: Foundations of ReSTIR." This paper generalizes recently developed statistical resampling techniques that have enabled virtual environments with a lighting complexity never before seen in real-time, including scenes with millions of dynamic lights, real-time global illumination, and even dynamic participating media. U of U researchers include Daqi Lin and Cem Yuksel. They collaborated with Markus Kettunen, Benedikt Bitterli, Jacopo Panaleoni and Chris Wyman of Nvidia.

From a practical perspective, this new research enables real-time rendering of glass, metal, and shiny or glossy surfaces, even in scenes where such objects are lit by hidden light sources (like those from another room). These surfaces introduce long "light paths" where light bounces many times between the light and eye. The expensive computations to follow such paths, known as path tracing, have traditionally been limited to offline and film rendering.

Why are these paths so hard to capture in real time? As seen below, paths contributing to each pixel may be multiple ray segments long. This requires sufficient ray tracing capacity to afford 5 to 10 rays per pixel. But tracing one path is insufficient. To achieve complex lighting, we must integrate over all possible paths contributing to each pixel. Our new ReSTIR PT resampling algorithm allows us to efficiently approximate this integration with only a few paths per pixel.

Underlying all spatiotemporal resampling algorithms, including our new generalized form, is the idea that important paths in neighbor pixels likely contain information highly relevant for our current pixel. This helps inform how we sample, and essentially acts as a form of filtering. But rather than postponing filtering until image generation is complete (as in most widely used filtering algorithms), ReSTIR-based techniques filter during rendering.

To achieve these improvements, our paper goes beyond engineering insights and also makes fundamental theoretical advancements that allow us to stably and controllably achieve such groundbreaking quality. This overcomes fundamental assumptions from earlier work that cannot be made in arbitrary virtual environments.



Old Path Tracing + basic ReSTIR (in 40 ms)

The New ReSTIR PT (in 40 ms)

JACOBUS (KOBUS) VAN DER MERWE RECEIVES PRESTIGIOUS RESEARCH AWARD

Congratulations to Professor Kobus Van der Merwe, the Jay Lepreau Professor in the School of Computing, who is one of six U faculty to receive this year's Distinguished Research Award from the Office of the Vice President for Research at the University of Utah.

The award was created to highlight the outstanding achievements of U research faculty. Nominees are evaluated on the "impact and significance of their career research, scholarly and creative work in their field, transformative achievements or innovations, and their history of broadening or enhancing equity, diversity, and inclusivity in their discipline, department, and/or research."

"All of the award recipients this year are researchers of the highest caliber and purpose," said Jake Jensen, interim associate vice president for research. "Their work has shaped — or reshaped — entire fields and disciplines. It is such a privilege to honor these faculty for their outstanding contributions." Recipients received special recognition during General Commencement and a $10,000 grant to pursue their research.

Professor Van der Merwe is the lead on POWDER, the Platform for Open Wireless Data-driven Experimental Research. POWDER is run by the University of Utah in partnership with Salt Lake City and the Utah Education and Telehealth Network. It is an end-to-end platform for research on mobile wireless networks. It provides radios that are programmable down to the waveform, attached to a network that can be configured by the user, connected to a wide variety of compute, storage, and cloud resources. Researchers can use this platform to build their own wireless networks using existing protocols or technologies (such as 4G, 5G and massive MIMO), or new ones that they invent and build from the ground up. In this environment, they can experiment with novel networks, devices, and applications.

POWDER is built over a 10 km^2 area of Salt Lake City, encompassing the downtown area, the University of Utah campus, and a residential neighborhood. This area includes a variety of terrain types, building sizes, and densities, making for a dynamic environment in which to perform real experiments. Within the area there will be dozens of fixed stations and a hundred couriers, such as buses and utility vehicles, carrying mobile devices around the city. The result is that Salt Lake City is being transformed into a "living lab" for research in mobile wireless networking.

Van der Merwe received bachelor's and master's degrees in electronics engineering from the University of Pretoria/Universiteit van Pretoria in South Africa and a doctorate in computer science from the University of Cambridge.

After 14 years with AT&T Labs Research in New Jersey, he joined the University of Utah as an associate professor in the School of Computing in 2012. He was then named a full professor in 2020. He is currently the director of the U's Flux Research Group.

Van der Merwe has received the AT&T Science and Technology Medal in 2010 for his work on Intelligent Route Control and the USENIX Test of Time award for "developing a logically centralized BGP routing controller, which was an important step towards the centralized routing controllers of Software-Defined Networks".

Bridge Program for New Student Retention and Success

Navigating college courses can be confusing and even overwhelming for new students to our program. Exposure to the field of computing, a little bit of preparation, and making some new friends ahead of the semester can go a long way towards readying incoming students for the challenges of our program. For this purpose, Professors David Johnson and Erin Parker created a summer bridge program for incoming first-year students. This two week session at the beginning of August brought twenty-seven new computing undergraduates to campus. The program offered an introduction to Python programming and practice using typical course tools for submitting assignments, getting feedback, asking questions, and seeking assistance. Attendees also learned about university and School of Computing resources for students, got to know the campus, and heard from a variety of guest speakers on computing and career opportunities. Funding for the bridge program was provided by the Western Alliance to Expand Student Opportunities, the Utah Center for Inclusive Computing, and the School of Computing. Student feedback was very positive and participants now feel ready to start the semester well prepared for success!

Professor David Johnson addressing the bridge program students.

FACULTY AWARDS

Det Norske Videnskaps-Akademi
The Norwegian Academy of Science and Letters

Professors Emeriti Richard Riesenfeld and Elaine Cohen were elected as members of the Mathematics and Science class of the Norwegian National Academy of Science and Letters. The academy was founded in May of 1857, with the purpose of supporting and promoting outstanding research to shape policy in both Norway and other parts of the world.

NATIONAL SCIENCE FOUNDATION CAREER AWARDS

A Measure Theoretic Framework for Topology-Based Visualization
PI: Bei Wang-Phillips
NSF: $599,369; 2022-2027

Making Smart Hospital Rooms Useful
PI: Jason Wiese
NSF: $600,000; 2022-2027

NATIONAL SCIENCE FOUNDATION COLLABORATIVE RESEARCH

PPoSS: Large: A Comprehensive Framework for Efficient, Scalable, and Performance Portable Tensor Applications
PI: Ponnuswamy Sadayappan
Co-PIs: Pierre-Emmanuel Gaillardon, Rajeev Balasubramonian, Vivik Srikumar, Hari Sundar, Ganesh Gopalakrishnan, and Shireen Elhabian
NSF: $3,649,636; 2022-2027

CCRI: reVISit: Scalable Empirical Evaluation of Interactive Visualizations
PI: Alex Lex
Co-PIs: Lane Harrison of Worcester Polytechnic Institute; and Carolina Nobre, University of Toronto
NSF: $1,252,178; 2022-2025

Hope Welch
Bachelor of Science in Computer Science

Q: **How did you first get interested in computing?**
A: I first became interested in computer science when I was a sophomore in high school. I was taking a graphic web page design class that taught me HTML and CSS. The teacher approached me and the two other girls in the class about a conference for girls in high school called SheTech. I decided to go, and I participated in several different classes about animation, coding, robotics, etc. We heard several women tech leaders from Utah speak about their careers and experiences too. It opened my eyes to this world of STEM, and I realized that I, too, could be a smart, successful woman in STEM. My senior year, I took my school's only computer science class where we learned C#. Computer Science was a field that I knew absolutely nothing about—and it excited me! After having a lot of fun in that class, I wanted to learn all I could about Computer Science, so I chose it as my major.

Q: **How did you choose the University of Utah?**
A: Before I found my new love of computer science, I was all about music. I have been playing the flute since I was eight and I knew that I wanted to keep it in my life. I chose the U because I knew minoring in music would be a good fit for me. I love the campus here, and I haven't looked back since!

Q: **How has your experience at the U been so far?**
A: I love the U! It's where I belong! That's not to say it hasn't been a rollercoaster of ups and downs. I never participated in any official mentor/mentee program, but I have found people who have filled that role. I think some of my biggest mentors came into my life when I first joined the Women in Computing club. All of the upperclasswomen in leadership were girls I looked up to, who gave me advice and shared their experiences with me. Classes are a funny thing. There are some that were incredibly hard for me to work through, but I look back fondly on them now.

Q: **What do you like to do outside of class?**
A: Outside of class, I like to read, watch movies with friends and family, mountain bike and play card games. Recently I've been learning how to play volleyball. I've been working on writing a young adult fantasy fiction novel. I have wanted to be a book author since kindergarten. There's no reason why I can't make both dreams come true!

Q: **What career path do you see yourself choosing?**
A: I want to work as a software engineer. I recently finished a software engineering internship this summer at Podium, a software technology company based in Lehi, Utah. I have been attracted to fullstack web development, and my internship experience confirmed my interest in being a fullstack SWE.

Q: **Where do you see yourself in 10 years?**
A: I see myself fully engaged in a software engineering career, either still as a developer or maybe somewhere in product management or design. I also see myself having a family and working my way to being a leader and role model in the tech industry for other women. I want to inspire potential software engineers, especially for those who come from underrepresented populations, to pursue their interests and embrace their interests in STEM.

Rian Brumfield
Master of Software Development

Q: What degree are you pursuing?
A: Master of Software Development. The Master of Software Development program's excellent curriculum is fast-paced and well-designed for students without a computer science background. I earned my Bachelor's in Mathematics, so the MSD program is a perfect fit for me.

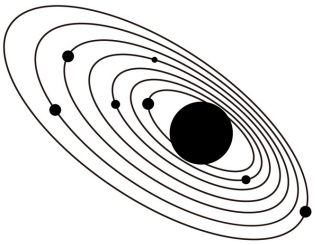
Q: How did you get interested in software development?
A: Through an AmeriCorps fellowship, I had the privilege of teaching AP Calculus and Precalculus at an underserved high school from 2019-2021. In response to COVID-19, my courses moved entirely online. To combat an already severe lack of resources, I created my own interactive, virtual mathematics lessons. I used a variety of educational software, but became frustrated by the limitations of depending on other people's platforms. I joined the MSD program to learn how to design my own educational software.

Q: What is your favorite class?
A: CS6011: Computer Programming. After learning the fundamentals of software development in CS6010, we moved on to create more dynamic projects in CS6011. We designed websites and created video games, which was what I came to this program to learn. I was excited at how quickly I gained the skills I needed to bring my ideas to life.

Q: Where do you see yourself in 5 years?
A: I see myself creating advanced mathematics learning games and interactive lessons which shy away from the traditional "watch-video, solve-problems" model. I will develop software that can be used at home or incorporated into classrooms to strengthen students' mathematical intuition. My dream is to change the culture around mathematics education, showing students that it is an engaging and playful subject that is fun to learn.

Q: What do you think is the most important thing you have learned so far?
A: Whatever your vision is as a programmer, there are languages, tools, and people out there to help you make it a reality.

TOSSED IN SPACE



Thanks to new University of Utah-developed technology that is a better way of manipulating objects in space, a space robotics company will be able to capture satellites tumbling out of control in Earth's orbit more easily.

Rogue Space Systems, a New Hampshire-based company that produces orbital robots (Orbots™) for satellite servicing, will apply new research from U mechanical engineering professor Jake J. Abbott and U School of Computing associate professor Tucker Hermans on manipulating certain metal objects using magnetic eddy currents.

The U technology, dubbed "Omnimagnet," will be developed for use with Rogue Space System's Orbots, robotic spacecraft designed to move satellites in and out of different orbits as well as to monitor and inspect satellites. The work will be funded by the U.S. Space Force, a new branch under the U.S. Air Force whose function is to conduct global space operations.

With Abbott's and Herman's technology, Rogue's robots will be able to gently detumble uncontrolled space scrap or crippled spacecraft without actually touching it, and allow them to safely capture and repair malfunctioning objects to extend their life. The U research was detailed in a paper published last year in the science journal, *Nature,* and developed at the University of Utah Robotics Center. The concept involves moving metallic, non-magnetized objects in space with spinning magnets. When the metal, which could be space debris or a satellite spinning out of control, is subjected to a changing magnetic field, electrons circulate within the metal in circular loops. The process turns the metal into essentially an electromagnet that creates torque and force, which can allow you to control where the debris goes without physically grabbing it.

While the idea of using these kinds of magnetic currents to manipulate objects in space is not new, what the U team has discovered is that using multiple magnetic-field sources in a coordinated fashion allows them to move the objects in six degrees of movement, including rotating them. Before, it was only known how to move them in one degree of movement, like just pushing them.

The use of this technology will have great impact on being able to control an object so that it can safely be touched, fixed, moved to another orbit, or deorbited, according to Rogue Systems. Satellites that are out of control pose a high risk of colliding with other objects in space and creating more space debris, so Rogue hopes this new technology can help the company operate in space in a safer manner and by mitigating the creation of more "space junk."

The "Fred" Orbot from Rogue Space Systems is an orbiting robot that can move satellites and other assets in space to and from different orbits. The New Hampshire-based company will be using technology developed by University of Utah engineering researchers for the Fred Orbot that allows it to more easily manipulate satellites and space junk in orbit.

Faculty Retirement Celebration

Emeriti Professors Elaine Cohen and Joe Zachary were celebrated for their dedicated careers and accomplishments at the School of Computing. Elaine retired this year, after 48 years of teaching; and Joe's retirement in 2020 was commemorated late due to Covid. His career at the U spanned a total of 33 years. Thank you Elaine and Joe for the tremendous impact you made on us and our students!

Update on the New Price Computing and Engineering Building

The School of Computing will receive funding from the Utah State legislature towards the realization of a new building to address the fast growing needs of our computing student population.

Plans are underway as both LMN and GSBS architectural firms have started working on preliminary data gathering to begin planning for this project to address the fast growing needs of the school. LMN, based in Seattle, designed the Bill and Melinda Gates Center for Computer Science and Engineering at the University of Washington. They are partnering with GSBS, a Salt Lake City architect firm that has worked on such projects as the innovative Entertainment Arts and Engineering building here on campus.

Jason Wiese PhD, Assistant Professor and Personal Data and Empowerment Lab Director, was awarded a 2022 Career Impact Award through the Career and Professional Development Center. This award highlights the positive impact that Dr. Wiese makes on his students' career paths.

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