Carnegie Mellon University

MAKE
POSSIBLE

THE CAMPAIGN FOR CARNEGIE MELLON UNIVERSITY

$$\text{fun} \sqsubseteq : L_{cp} \rightarrow L_{cp} \rightarrow boolean$$

$$\text{fun} \sqsubseteq : L_{cp} \times L_{cp} \rightarrow boolean$$

$$\text{fun} \sqsubseteq_{lift} : \sigma_{cp} \times \sigma_{cp} \rightarrow boolean$$

$$Var : \sigma_1(x) \sqsubseteq \sigma_2(x)$$

$$\sqsubseteq_{lift} : \sigma \rightarrow \sigma \rightarrow boolean$$

$$(Var \rightarrow L_{cp}) \rightarrow (Var \rightarrow L_{cp}) \rightarrow boolean$$

$$\vdash [x \rightarrow \sigma(y) \; op_{lift} \; \sigma(z)]$$

$$n \; op_{lift} \; m = n \; op \; m$$

$$n \; op_{lift} \perp = \perp$$

$$n \; op_{lift} \top = \top$$

SCHOOL *of*
COMPUTER SCIENCE

PIONEERING RESEARCH.
LEADING PROGRESS.

MAKING COMPUTER SCIENCE *that* IMPROVES HUMANITY POSSIBLE.

"Carnegie Mellon has led the world in computer science for more than six decades, and we've always taken the responsibility of this position seriously. We do important work that benefits humanity — we always have, and we always will."

MARTIAL HEBERT
Dean of the School of Computer Science

Technology is a powerful tool. We should know — we lead the world in developing it. Since the founding of Carnegie Mellon University's School of Computer Science (SCS), we've focused on creating technology that changes the world for the better. Today, that mission is more important than ever. As our innovations become ever more interwoven in daily life, we're committed to not just pioneering the next technological revolution, but ensuring that our discipline evolves in ways that elevate and improve how people live, learn, work, connect and care for one another.

With your support of SCS through *Make Possible: The Campaign for Carnegie Mellon University*, we will:

- Develop groundbreaking computer science research.

- Lead the world in producing and supporting society's expert computer scientists.

- Grow the pipeline of talent for our field.

There are breakthroughs waiting to be discovered, and our visionaries are ready to lead the way.

TOGETHER, *we will*
MAKE IT POSSIBLE.

Software that anticipates behavior. Models of the evolutionary landscape of coronavirus proteins. These are just two of the innovations underway at the School of Computer Science. Our commitment to this kind of groundbreaking work means that we go beyond inventing things — we invent the future itself.

WHEN WE DEFINE THE FUTURE OF THE FIELD, *we lead the way to a*

BOLD NEW REALITY.

Hello, my name is
RATHU BAXTER

rethink robotics

BLAZING A TRAIL *that leads to*
SOCIETAL CHANGE.

> **"Rising to the challenge of enormous data sets isn't just about making algorithms faster or more efficient, but also about making them intelligent enough to pull out the right knowledge."**
>
> **ANDREAS PFENNING**
> Assistant Professor of Computational Biology

Anyone who has watched a loved one suffer from Alzheimer's disease knows how devastating it is for everyone involved. In the School of Computer Science, we're using artificial intelligence to study human intelligence, investigating how circuits in the brain influence and are influenced by neurological disorders — and making an important contribution to the quest for a cure for the debilitating disease.

Andreas Pfenning, assistant professor of computational biology at CMU, leads a team of researchers who combine machine learning and experimental genomic approaches to target specific cell types related to disease progression. This allows them to study how these cells respond to aging, Alzheimer's disease and Parkinson's disease.

Pfenning is also part of an international team of scientists who used this kind of genomic analysis to study how the novel coronavirus affects different species.

He notes that biological technologies like genomic analysis have advanced at an incredible rate in recent years. While this has allowed researchers to collect massive amounts of data on cell types and brain regions, the sheer size of these data sets makes it difficult to sift through them to find the right information. By integrating computer science, machine learning and genomics, Pfenning and his team can analyze this data efficiently, with the hope that their efforts lead to more effective treatments.

Bringing two disparate entities together to form something even better — that exemplifies our culture at Carnegie Mellon and SCS, and it's exactly what's happening in Pfenning's lab. And with additional resources for researchers like him and his team, we'll be closer to solving medical challenges that affect families all over the world.

DRIVING A

NEW ERA *of* COMPUTER SCIENCE

BREAKTHROUGHS.

Decades of inventive thinking have led to achievements unforeseen in our field. And with more support, we can build on that momentum to produce innovations that are beyond imagination.

With your support, we will:

Attract and retain faculty.

We'll bring together the very best minds — educators, researchers, thought leaders — to accelerate the work of the School of Computer Science, and to prepare the future leaders of the field.

Nurture big ideas.

We'll fuel the groundbreaking work of faculty and students by providing support for seed capital, research grants and fellowships, in order to turn big ideas into technological revolutions when they're needed most.

Enhance research facilities and equipment.

We'll advance discovery across the spectrum of computer science disciplines by creating research spaces that help innovation flourish — like maker spaces and labs where students can design, build and test full-sized prototypes of inventions like solar-powered vehicles.

YOU CAN PROVIDE THE WORLD-CLASS RESOURCES THAT LEAD TO WORLD-CHANGING WORK.

Help make it possible by providing critical support to our school's faculty and students through:

UNDERGRADUATE SCHOLARSHIPS

Recognize talented undergraduates with scholarships that free them to immerse themselves in their education, their passions and their work.

FELLOWSHIPS

Secure an education for graduate students, regardless of their financial circumstances, to prepare the next generation of computer science leaders.

RESEARCH SUPPORT

Assist SCS students and faculty by providing the resources they need to advance their work from idea to execution.

DEAN'S INNOVATION FUND

Enable the school's dean to galvanize innovative projects, research and initiatives in areas such as education equality, public health, accessibility and more with critical funding at the developmental stage.

FPS: 23

Confidence: 95%

Behavior Indicators

Smile Dynamics

Gaze Avoidance

Negative expressions (male)

Negative expressions (female)

Head rotation variation

MultiSense

The ambitious faculty and students at SCS produce revolutionary research that addresses global challenges and transforms our world for the better — and they're just getting started. When we give them resources and cutting-edge equipment, imagine how much more they will discover.

WHEN WE GIVE THE BRIGHTEST MINDS MORE OPPORTUNITIES TO FLOURISH, *they'll create*

NEW WAYS FOR SOCIETY TO THRIVE.

DEVELOPING TECHNOLOGY *to*
STOP POACHERS IN THEIR TRACKS.

Throughout the globe, poaching is reaching critical levels. The population of some of the world's most majestic animals is dropping dramatically as illegal hunters target them for both profit and sustenance.

To rebuild the ranks of these species, many countries have created protected wildlife reserves — some of which are so large that human resources can't possibly patrol them.

Now, thanks to Fei Fang, assistant professor at the Institute for Software Research in the School of Computer Science, the conservation agencies in these countries have a way to thwart poachers more efficiently and effectively.

Fang and her collaborators at Harvard University and Air Shepherd, an anti-poaching initiative of the Lindbergh Foundation, developed SPOT (Systematic POacher deTector), which uses augmented conservation drones that can automatically detect poachers and animals in near real time, eliminating the need for 24/7 human surveillance. After promising results from the test field, there are now plans for larger-scale deployment in a national park in Botswana.

Protecting endangered species from poaching is just one of the ways Carnegie Mellon researchers like Fang are using their technical prowess to solve real-world problems. With greater resources, we can draw more of those researchers to campus — and give them the tools and facilities they need to further their vital work.

"

"We're leveraging AI to achieve much higher efficiency, so ultimately, we can reduce illegal poaching activities and can fend off potential attacks."

FEI FANG
Assistant Professor,
Institute for Software Research

A SPACE TO *explore* THE NEW FRONTIER *of* AI.

CMU was one of the birthplaces of artificial intelligence. And we continue to push the leading edge of the field, developing machines that can take in data, make informed decisions and even predict human actions.

The newly opened JPMorgan Chase AI Maker Space in Tepper Quad allows students and faculty researchers to build on this exciting work, collaborating across disciplines to develop technological solutions that are as ethical as they are innovative.

With state-of-the-art hardware and software, this open area encourages cross-disciplinary work and features spaces dedicated to robotics, drones, virtual and augmented reality, entertainment, smart homes, machine learning, and computer vision and speech understanding.

In this space devoted to hands-on creation, students can see their research in action — and a gift dedicated to this important initiative will help them take AI to exciting new heights.
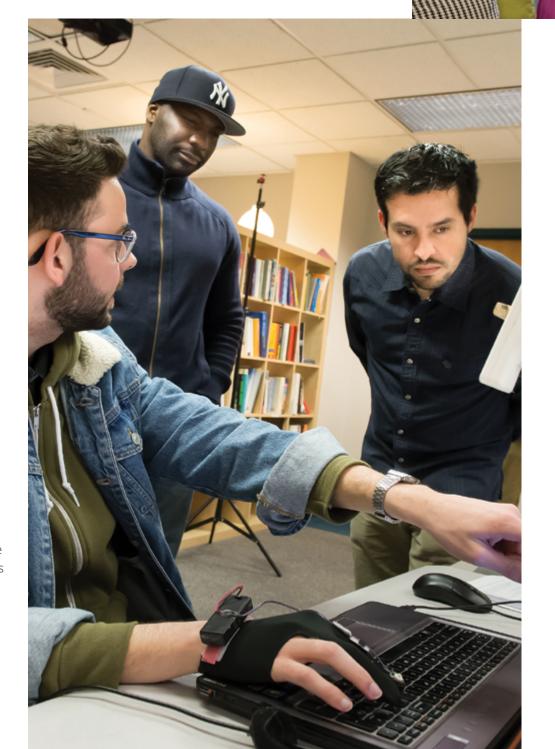
GIVING TALENT A PLACE TO
INVENT, INNOVATE
and INSPIRE.

The School of Computer Science is a place for bold thinkers. Our students and faculty share certain traits: an inventive spirit, a collaborative mindset and a deep desire to shape technology to humanity's benefit. By investing in people like this, the most important work of their lives — and ours — will happen here.

With your support, we will:

Attract and support great educators.

Tomorrow's expert computer scientists are today's students, and giving those students the deepest, most well-rounded education possible is the first step on their journey. When we make a concerted effort to draw in outstanding faculty from all over the world, we can make sure that happens.

Advance diversity and inclusion.

We believe that the computer science community should reflect the world around us. And at SCS, we're committed to doing our part in pursuing this goal. We are invested in programs like the Girls of Steel robotics team; All Star Code, a nonprofit computer science education organization focused on young men of color; and AI4ALL, a nonprofit program dedicated to increasing diversity and inclusion in AI education, research, development and policy. We've already made incredible strides, but there's still so much more we aim to do.

Boost learning in and out of the classroom.

Renovated facilities, advanced equipment and opportunities for internships, mentorships, service, travel and networking — all of these give our students critical opportunities to put their learning into practice, applying their knowledge to real-world scenarios so their research can have a tangible impact.

YOU CAN ADVANCE INNOVATION IN COMPUTER SCIENCE BY INVESTING IN OUR PEOPLE.

Help make it possible by providing critical support to our school's faculty and students through:

TEACHING PROFESSORSHIPS
Nurture the next generation of scholars and innovators by funding faculty positions that focus on teaching our students and inspiring their educational experiences.

EDUCATION FACILITIES
Fuel our students' journeys as leaders, scholars and computer scientists by providing for spaces that support and strengthen how they learn computing.

ENDOWED CHAIRS
Provide faculty with funding that inspires their teaching, fuels their research, and assists us in recruiting great educators and researchers to the School of Computer Science.

RESEARCH FACILITIES
Accelerate discovery across our departments and disciplines by creating research spaces that promote innovation and help it thrive.

WHEN WE EDUCATE ASPIRING COMPUTER SCIENTISTS,

WE CULTIVATE *the* VISIONARIES *of* TOMORROW.

By introducing computer science into K-12 classrooms, we're inspiring interest within younger students — and making an education (and a career) in computer science more exciting and accessible.

A BETTER TOMORROW *depends on* EMPOWERING THE YOUNG MINDS *of* TODAY.

The very best computer scientists aren't just smart — they're passionate about the field. For many, that passion starts at an early age. And in the School of Computer Science, we want to make sure that young people from all backgrounds have the chance to pursue it.

Whether it's robotics programs for girls, or a summer program for students from underrepresented communities, we make it a priority to connect bright young minds to the world of computer science, opening their eyes to new possibilities for their future.

At SCS, Mark Stehlik is both teaching professor and assistant dean for outreach. As co-founder of CMU CS Academy, he's made it his personal mission to take computer science into K-12 classrooms — through an online, engaging and graphics-based interactive curriculum for high schools that is entirely free.

"We're committed to ensuring that this program remains free for equity reasons," he says. "That means we have to cover expenses." The program has grown to include a development lead, a program manager, a content manager and a team of 30 undergraduates.

That growth illustrates the hunger for the program. With increased funding will come even greater opportunities for the young students the program serves.

By instilling an early love for computer science through our K-12 outreach programs, we're creating a community that's excited about our field — and that's committed to making our region, our world and our society a better place through technology. By making an investment in this initiative, you can open up a world of discovery and exploration for the gifted computer scientists of tomorrow.

> "Within CMU Computer Science, we have always been proud that we try to replicate real-world scenarios as faithfully as we can in a 16-week semester. Our students get to combine theoretical underpinnings with the tech of the moment. We teach the things that are enduring — the things that transcend."

MARK STEHLIK
Assistant Dean for Outreach, SCS
Dean's Office Teaching Professor,
Computer Science Department

ACTIVATE A DESIRE FOR
LIFELONG DISCOVERY.

When we spark students' interest in computer science early on, we can better grow our field and encourage passionate researchers.

With your support, we will:

Ignite a passion for computer science.

Our Computer Science Pathways program, housed in the new Educational Equity Office, offers support to students who are underrepresented, underresourced or both. We've already helped Pittsburgh-area students gain more reliable WiFi access for remote learning, and we are exploring what it looks like to provide STEM and computer science education during a global pandemic. With additional funding, we'll make even greater strides in sparking a love of the field today that will lead to a deep and diverse generation of computer scientists tomorrow.

End the knowledge gap.

Underresourced school districts are less likely to offer computer science classes — a situation that creates a big knowledge gap between kids in different socioeconomic circumstances. Our middle school bridge program helps ninth-graders catch up on the math skills they need before their first semester of high school, putting them on even footing with their peers and better preparing them to pursue STEM majors in college. Support for initiatives like these help close the gap and instill more equality in our field.

Give K-12 educators the resources they need.

The CMU CS Academy provides high school teachers with a free curriculum that is engaging, creative, rigorous and fun. When schools pivoted to remote instruction due to the COVID-19 pandemic, CS Academy offered free professional development opportunities to teachers interested in providing high quality computer science education virtually to their students. With more financial support, we will give these educators new and relevant training, additional curricula and more help for teaching their students about computer science — and getting them excited about all its possibilities.

YOU CAN INSPIRE A NEW GENERATION OF COMPUTER SCIENTISTS.

Help make it possible by providing critical support to our school's faculty and students through:

K-12 OUTREACH FUNDS

Attract more students to computing, information technology and robotics, through initiatives that provide educational programs for teachers and students from the primary grades through high school.

DEPARTMENTAL DEI FUNDS

Provide resources to department-level initiatives that promote diversity, equity and inclusion at the School of Computer Science.

TECHNOLOGY THAT HELPS
THE WORLD CHANGE *for the better*
IS WHAT WE MAKE POSSIBLE.

JOIN US.
TOGETHER, *we can make*
THIS POWERFUL FUTURE *for the*
SCHOOL OF COMPUTER SCIENCE
POSSIBLE.

"For the last half-century, the
School of Computer Science has
been synonymous with excellence
in computer science education
and research. It helped define and
shape the discipline, and pioneered
revolutionary breakthroughs
at the intersection of technology
and humanity. SCS has never
been better positioned for
transformative, real-world impact
than it is right now. I know it will
forge the future of our world."

FARNAM JAHANIAN
President
Henry L. Hillman President's Chair

Carnegie Mellon University

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