# FY22 ANNUAL REPORT

## TRANSFORMING SOCIETY WITH DATA SCIENCE AND COMPUTING

**Boston University** Rafik B. Hariri Institute for
Computing and Computational Science & Engineering

BOSTON UNIVERSITY

# TABLE OF CONTENTS

2 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 3

# LETTER FROM THE DIRECTOR

It is impossible to imagine a time when Computing and Computational Science and Engineering was more central, not only to scientific and technological advances through research, but to every function of our society.

The Hariri Institute is extremely well positioned to be a catalyst for interdisciplinary research in this broad field. The Hariri Institute is a federation, and through its Centers and Initiatives spans artificial intelligence (AI), computational science, digital health, computer systems and the cloud, and cybersecurity. Arguably, these areas reach every facet of modern life, impact the natural and biomedical sciences, usher an era of digital health, and through information systems security affect the very essence of our democracy.

The Institute acts as a convergence accelerator where industry, such as the open-source software leader Red Hat, interfaces with academia. Through our own Software & Application Innovation Lab (SAIL), we support translational initiatives that bring academic ideas closer to production-ready systems. We are also very cognizant of the role that novel technological and algorithmic solutions can play to support diversity and inclusion and contribute to public good, supporting public-private partnerships such as the Boston Women's Workforce Council.

While I am new to the Director's position, I come with an appreciation of the Hariri Institute's accomplishments and growth. Through my own research I have been exposed to many of the Hariri Institute's areas of strength and I am hoping to add to its core expertise several areas of Engineering sciences that naturally interact with computing and computational science.

I am excited about the future. I am happy to announce that the Center for Information and Systems Engineering (CISE), is joining the Hariri Institute federation, bringing a robust research portfolio in data-driven engineering, robotics and automation, control and decision science, computer engineering, and information theory/systems.

## Returning to Campus

The Hariri Institute returned to campus in the fall of 2022 and held 14 successful hybrid and in-person events, not including the many in-person seminars hosted by our Centers and Initiatives. Hybrid administrative and technical staff continued to provide top-notch services and support to our communities of researchers, enabling novel projects, grants, and collaborations.

We will soon be moving into an iconic building – BU's Center for Computing and Data Sciences. The Hariri Institute will strive to maintain and strengthen its service mission, accelerate interdisciplinary research, and strengthen and multiply the collaborative work between AI and computational science and engineering experts with our colleagues on BU's medical campus.

## Commencing the MOC Alliance

The Mass Open Cloud (MOC), launched in 2013, has transformed into the MOC Alliance – a partnership between higher education, government, and industry to create an open production cloud which will provide domain researchers with predictable low-cost services while enabling innovation by a broad community of academic researchers and industry collaborators. To achieve these goals, the MOC Alliance supports and coordinates a set of interrelated projects, including production cloud services supported institutionally by BU and Harvard University, a national testbed for cloud researchers, the $20M Red Hat Collaboratory at BU, and a planned national center on cloud and datacenter-scale computing.

The MOC Alliance team is building mechanisms to enable the production cloud to be used for research and open source development, and to more broadly support the open source community in making experimental services visible to the entire user community. It is also working with the OpenInfra Foundation to enable everything it is doing to be replicated by others, with the vision of having a larger federated open cloud distributed across the world.

## Data & Computing for Social Impact

Over the past year, Hariri Institute researchers and staff devoted their energy to advancing research around topics of diversity, equity, and inclusion.

Derry Wijaya, Co-Director of the AI and Education Initiative and Assistant Professor in Computer Science at BU College of Arts & Sciences, worked with researchers at Kata.ai Research and Universitas Indonesia to improve AI technology, like Siri, for processing and understanding colloquial language. The team developed a dataset of colloquial Indonesian words that can be used for developing natural language processing (NLP) models.

The team's success in training their model is encouraging and AI technology for other languages with lots of colloquialisms, like Korean and Arabic, could benefit from their findings.

Deaf studies scholar Naomi Caselli, Co-Director of the AI and Education Initiative and Assistant Professor at BU Wheelock College of Education & Human Development, found that American Sign Language (ASL) signs might have evolved to be easier for people to recognize. Signs that are challenging to perceive—those that are rare or have uncommon handshapes—are made closer to the signer's face, where people often look during sign perception. By contrast, common ones, and those with more routine handshapes, are made further away from the face, in the perceiver's peripheral vision.

Cara Stepp, a Research Fellow at the Hariri Institute and Professor in Speech, Language, and Hearing Sciences at BU College of Health & Rehabilitation Sciences: Sargent College, was awarded a new five-year, $2.8 million grant from the National Institutes of Health (NIH) to elucidate how testosterone treatment impacts speech production in transgender men. The groundbreaking research stems from a Hariri Institute-funded pilot project and will be the first NIH grant dedicated to understanding speech production in transgender men.

SAIL engineers, in collaboration with the Boston Women's Workforce Council (BWWC) and the City of Boston's Mayor's Office of Women's Advancement, developed the Employer Wage Gap Calculator, enabling employers to calculate gender and racial wage gaps with just the click of a button. The free, online calculator can be used by anyone to better understand pay equity at their company. The platform requires only a few pieces of information that employers can collect from their payrolls to determine the difference in pay between all working men and women and all white employees and employees of color.
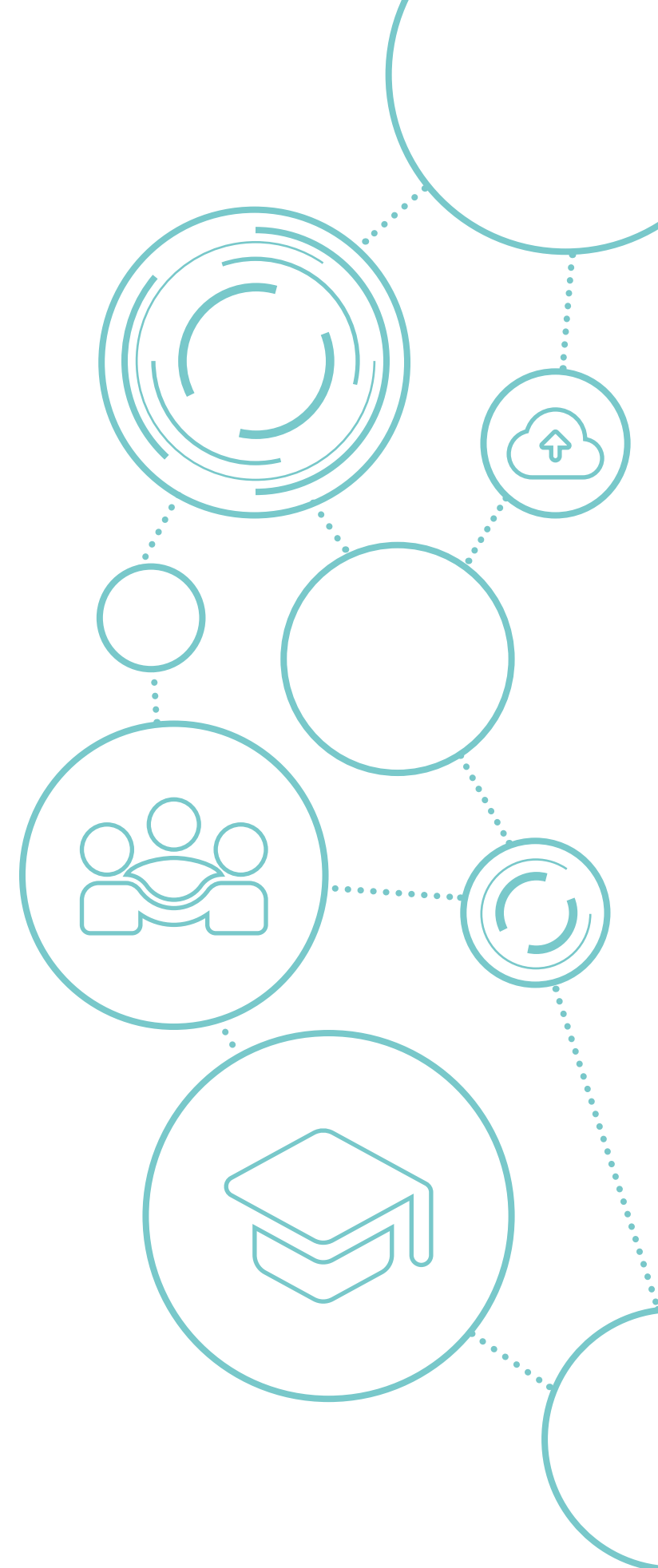
These are just a few examples of the transformative research happening at the Hariri Institute. I invite you to browse through our website and follow up with me or any of the Hariri Institute's Center and Initiative Directors or its vast collection of Fellows and Faculty Affiliates. You are also welcome to contact the Hariri Institute's administration with any questions you may have about future research, events, or seminars.

**Ioannis (Yannis) Paschalidis**

*Director*, Rafik B. Hariri Institute for Computing and Computational Science & Engineering

*Distinguished Professor of Engineering*, Department of Electrical and Computer Engineering, Division of Systems Engineering, and Department of Biomedical Engineering

*Founding Professor*, Computing & Data Sciences

4 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 5

# YEAR IN REVIEW

**351+** FACULTY AFFILIATES

**66** DEPARTMENTS

**13** SCHOOLS

**50+** TOTAL EVENTS

**2,000+** TOTAL ATTENDEES

**20+** TOTAL COUNTRIES

## SOCIAL GROWTH

**1,465** TWITTER FOLLOWERS

**5,260** SOCIAL MEDIA ENGAGEMENTS

**133%** INCREASE IN LINKEDIN FOLLOWERS

**42%** INCREASE IN NEWSLETTER SUBSCRIBERS

**9.7 million** INDIVIDUALS REACHED

# PROGRAMS FUNDED

**$550,055** Total Awarded to BU Faculty & Graduate Students

**$360,757** Awarded Across 3 Focused Research Programs

**$94,298** Awarded in Research Incubation Awards

**$60,000** Awarded to 6 Junior Faculty Fellows

**$35,000** Awarded to 7 Graduate Student Fellows

6 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 7

# AWARDS AND ACHIEVEMENTS

## $15 MILLION

### HARIRI-LED AND ENABLED FUNDING

*including funds from the National Institutes of Health (NIH), National Science Foundation (NSF), US Department of Energy (DOE),  US Department of Defense (DOD), and the Massachusetts Technology Collaborative.*

## 2 FOCUSED RESEARCH PROGRAM

## (FRP)-RELATED GRANTS

*Faculty members from the Machine Learning for Chemistry & Materials Science FRP were awarded a NSF Early-Concept Grant for Exploratory Research (NSF EAGER) and a Machine Learning in the Chemical Sciences & Engineering Award from The Camille and Henry Dreyfus Foundation.*

## 11 NEW GRANTS

## Future Investigators in NASA Earth and Space Science and Technology (FINESST)

### Awared to Sheng Huang

*Research on mahcine learning to study hiss waves in the plasmasphere and plumes.*

## $4.4 MILLION

### from Massachusetts Technology Collaborative

*to create the BU Robotics and Autonomous Systems Teaching and Innovation Center  (BU-RASTIC).*



Lei Guo, Professor, Emerging Media Studies, COM, Prakash Ishwar, Professor, Electrical and Computer Engineering, ENG, Derry Wijaya, Professor, Computer Science, CAS and Co-director of AIR Initiative Margrit Betke. The Artificial Intelligence and Emerging Media (AIEM) research group explores and creates techniques to interpret emerging media, their role in mass and interpersonal commnication, and understand the human and automated processes by which emerging media are developed, marketed, shaped and reshaped by users.



"AI for Cloud Ops" team, funded by the Red Hat Collaboratory. From left to right: Alan Liu, Lesley Chou, Anthony Byrne, Ayse Coskun, Mert Toslali, Gianluca Stringhini, Saad Ullah. The project aims to address this gap in effective cloud management and operations with a concerted, systematic approach to building and integrating AI-driven software analytics into production systems.

8 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 9

# MISSION STATEMENT

An incubator and convergence accelerator in a university setting, the Rafik B. Hariri Institute for Computing and Computational Science & Engineering initiates research convergence and accelerates integrated initiatives with social impact at the nexus of the computational and data sciences.

It achieves this mission by promoting discovery and innovations across a broad set of disciplines, inspired by challenges in engineering; social, health and management sciences; and the arts. Through the use of computational and data-driven approaches, diverse groups of faculty, students, and staff work together to transform research.

10 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 11

# ACCELERATING IMPACT

## Red Hat Collaboratory Research Incubation Awards

Through Boston University (BU) and Red Hat's $20 million expanded partnership, announced in 2021, the Red Hat Collaboratory seeks to create more trustworthy, reliable, scalable, self-operating, distributed, heterogeneous compute platforms that stretch from edge devices to cloud datacenters. This year, the Red Hat Collaboratory awarded 16 projects from BU faculty members and industry collaborators, totaling more than $2.3 million in funding.

The Red Hat Collaboratory also enables innovative partnerships between academic researchers and open source communities. Collaboration in systems research at this scale can have a profound impact on society. Projects funded through the Red Hat Collaboratory Research Incubation Award are open source and focus on problems of distributed, operating, security, or network systems whose solutions show promise for advancing their fields and impacting the tech industry.

BU students benefited from the new funding program, as well. The Red Hat Collaboratory funded Student Research Projects this year, geared towards providing BU students with research and experiential learning opportunities that advance open source projects in cloud computing, systems engineering infrastructure, and security. 7 undergraduates received funding for open-source projects, totaling $80k, that aim to improve the security, efficiency, and intelligence of computing systems.

The AI for Cloud Ops Project aims to address the gap in effective cloud management and operations by intergrating AI-driven software analytics into production systems.

## Launching the AI and Education Initiative

This past year, the Hariri Institute launched an AI and Education Initiative, led by Naomi Caselli, Assistant Professor in Deaf Studies at Wheelock College of Education & Human Development, and Derry Wijaya, Assistant Professor in Computer Science at the College of Arts & Sciences. The AI and Education Initiative is a cross-disciplinary research initiative facilitating innovation by integrating AI and its social contexts and implications in education. The primary research focus is on new AI-driven innovations that transform the systems that impact equitable learning, education, and human development while providing education-inspired research results that impact foundational AI.

The initiative brought together 23+ faculty members from 9 departments across 4 colleges at BU. At the group's first meeting, researchers from the education side struggled to understand the AI lingo, and vice versa. The team held 10 workshops throughout the past year to transfer knowledge across disciplines and set common research goals and directions. The Hariri Institute is excited to see future applications of AI to teaching, education, and learning by the AI and Education affiliated faculty members over the coming years.

Will J. Tomlinson was hired as Director of SAIL in January 2022 to elevate the team's software development within and beyond Boston University. He is developing a diverse, resilient culture that researchers leverage to advance their projects and deploy their innovations at production-level quality. Since March, Tomlinson has met half of his software engineering hiring objectives for the year to support SAIL's service center. He has also instantiated recruitment pipelines with BU Spark! and the BU Metropolitan College to continue SAIL's search to find top entry level and mid-level engineers. Tomlinson's engineering expertise and commitment to community-building will help SAIL expand its services and support widely. He brings over 10 years of industry knowledge and a breadth of research and development experience to the Hariri Institute.

As Director, Tomlinson is building upon SAIL's technical competencies and expanding the team's services. SAIL excels in supporting software engineering projects on privacy and security, data science, and digital health. Tomlinson is working on internal research and development to create an infrastructure that supports more projects in emerging research areas, like artificial intelligence (AI), autonomy and edge computing. "I'm excited to help build up an infrastructure that creates additional opportunities across the university for research convergence and collaboration," he said.

His "crawl, walk, run" approach that focuses on improving research and development practices prior to rapid growth, informed by his industry experience, will provide SAIL with the foundation it needs to continue to expand its support of researchers. "I want to make sure that there is resiliency in place to deal with the changes that come," said Tomlinson, "When we do want to grow it should be smooth SAIL-ing."

Under Tomlinson's guidance, SAIL has participated in numerous grants and proposals. These include building platforms to leverage AI in education for student learning, assessment, and intervention; deploying mobile apps, backed by Blockchain technology, to enhance the farming and agriculture in east and west Africa; and employing natural language processing to various forms of journalistic content on the web to determine the context in which this information is being used. Any of these efforts, if materialized, would be a significant achievement towards the plans Tomlinson has for SAIL, creating more initiatives where SAIL can contribute to large-scale projects with a strong social impact.

William Tomlinson
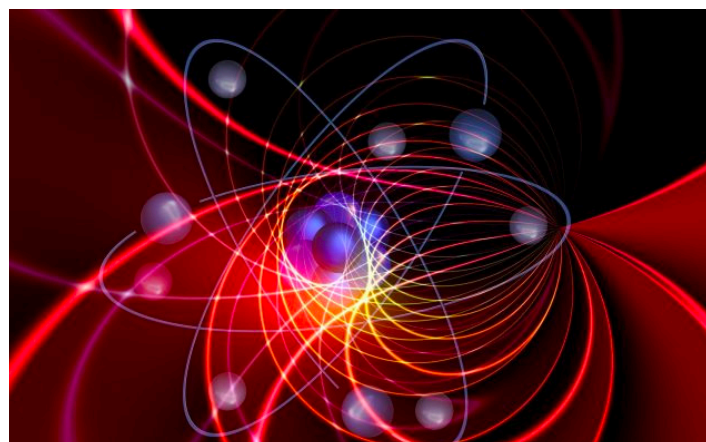*Director*, Software & Applications Innovation Lab (SAIL)

12 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 13

# Enabling Focused Research Programs (FRPs)

## FY23 FRPs

### Quantum Convergence

The goals of the Quantum Convergence FRP are to launch broad conversations and collaborations across BU that reveal cross-cutting themes around quantum science and engineering that will translate into competitive large-scale proposals and to highlight and promote quantum research to the general public.



### Predicting and Preventing Epidemic to Pandemic Transitions

The goal of the Predicting and Preventing Epidemic to Pandemic Transitions FRP, funded by the National Science Foundation (NSF), is to develop a comprehensive strategy and the required science base for predicting and preventing future pandemics. This Phase I project will engage a large interdisciplinary team and a network of collaborators from EcoHealth Alliance to develop models that can identify location hot spots for pathogens that could cause an outbreak, detect disease anomalies in healthcare settings, predict patient outcomes, characterize pathogen spread, and determine best methods for response.



### Teaching Machines Human-Like Intelligence

The goal of the Teaching Machines Human-Like Intelligence FRP is to create convergence around foundational research in artificial intelligence (AI) at BU through a year-long series of intensive discussions, working groups and seminars, with the ultimate goal of coalescing around research directions for future funding. This program seeks to strengthen the synergy and collaboration opportunities among researchers involved in cutting-edge development of AI methods and initiate impactful AI projects.



### Data and Misinformation in an Era of Sustainability and Climate Change Crises

The goal of the Data and Misinformation in an Era of Sustainability and Climate Change Crises FRP, a joint program between the Hariri Institute and the Institute for Global Sustainability (formerly the Institute for Sustainable Energy), is to understand the nature, origins, spread, impacts, and possibilities of disarming disinformation about the climate issue in an effort to address the climate crisis.



# Enabling Focused Research Programs (FRPs)

## FY22 FRPs

### Continuous Analysis of Mobile Health Data among Medically Vulnerable Populations

The goal of the Continuous Analysis of Mobile Health Data among Medically Vulnerable Populations FRP is to leverage mobile health data sources for developing dynamic models privately in the cloud that predict diseases and anticipate changes in physiology or behavior in large cohort studies and clinical trials among underserved populations. The FRP held three workshops and one virtual symposium with over 70 attendees.



### Simulation Modeling for Population Health

The goal of the Simulation Modeling for Population Health FRP is to foster a multidisciplinary environment of faculty with interests in the application of simulation modeling to population health research and the development of methods used to design, build, validate, and ethically evaluate such models. This program addresses the key challenges faced in applying simulation modeling to population health through strategic partnerships, interdisciplinary collaborations, and the establishment of best practices in simulation modeling. The FRP held three workshops and one virtual symposium with over 147 attendees.
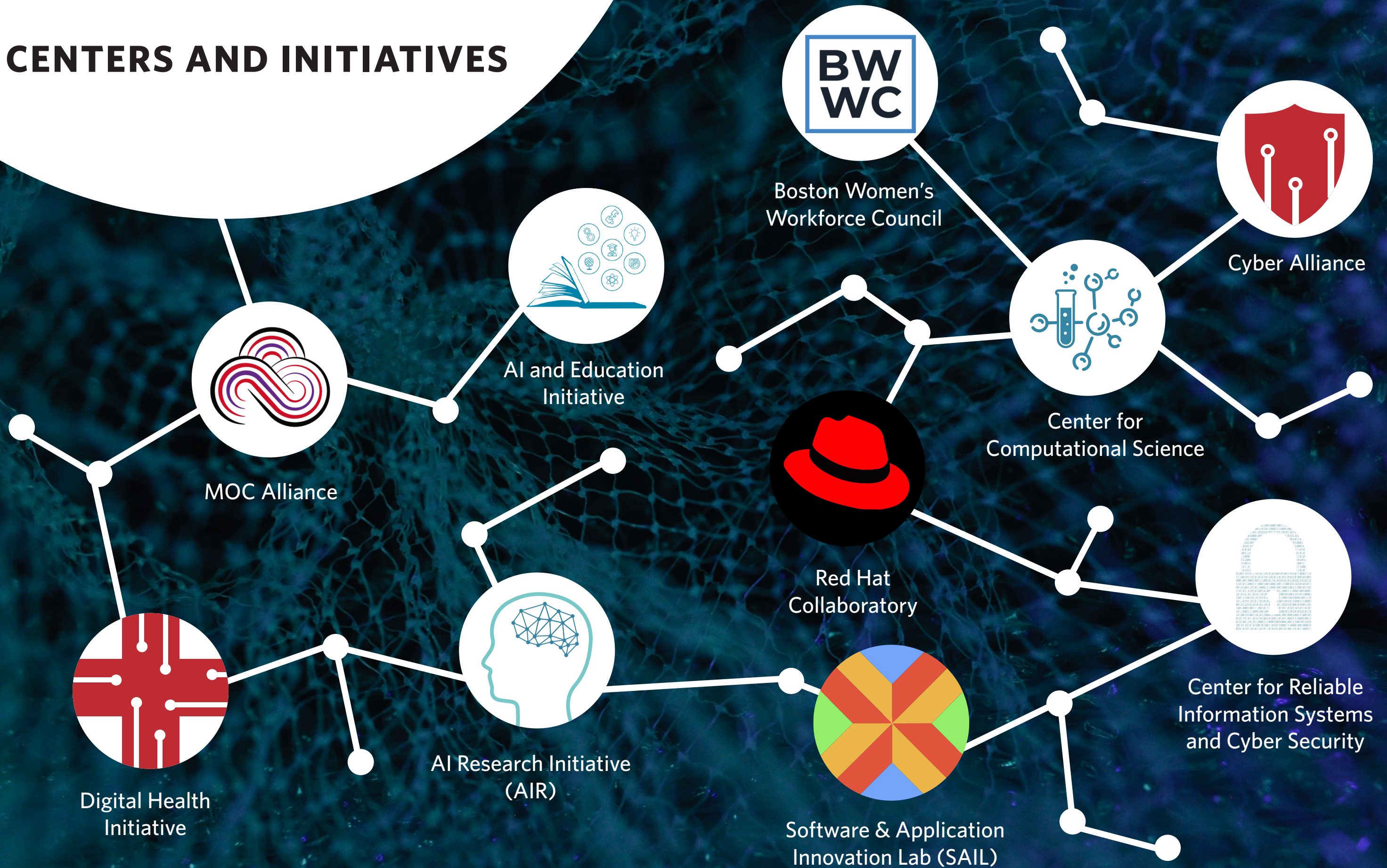


## Continuing FRP Successes

FY21 FRPs published numerous papers based on their funded research, including those in the Journal of Chemical Physics and the Journal of the American Medical Informatics Association. Faculty members were also awarded further funding from the National Science Foundation (NSF) and The Camille and Henry Dreyfus Foundation.



14 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 15

# CENTERS AND INITIATIVES

**BWWC**

Boston Women's Workforce Council

Cyber Alliance

AI and Education Initiative

Center for Computational Science

MOC Alliance

Red Hat Collaboratory

Center for Reliable Information Systems and Cyber Security

Digital Health Initiative

AI Research Initiative (AIR)

Software & Application Innovation Lab (SAIL)

## AI AND EDUCATION INITIATIVE

The goal of the AI and Education Initiative, jointly supported by the Hariri Institute and Wheelock College of Education & Human Development, is to pursue collaborative research opportunities at the nexus of AI and education, marking the beginning of a new frontier in applications of AI research.

This year, the AI and Education Initiative held a seminar series, with 21 presentations aimed at transferring knowledge between education and AI researchers. Faculty members submitted 2 grant applications to the National Science Foundation (NSF) and are excited to continue to build their capacity and research agenda collaboratively.

### 23+
**FACULTY MEMBERS FROM THE FIELDS OF AI & EDUCATION**

## ARTIFICIAL INTELLIGENCE RESEARCH INITIATIVE (AIR)

### 3
**DISTINGUISHED SPEAKERS FROM IBM, DEEPMIND AND COLUMBIA UNIVERSITY**

The Artificial Intelligence Research (AIR) initiative at BU is a cross-disciplinary research initiative focused on machine intelligence. It brings together researchers whose work aims to create intelligent systems that reliably make decisions, reason about data, and communicate with humans. AIR faculty members Prakash Ishwar and Margrit Betke collaborated with Swathi Kiran, James and Cecilia Tse Ying Professor in Neurorehabilitation at Sargent College, to develop AI models that predict a patient's responsiveness to aphasia rehabilitation using a complex set of brain and behavioral markers. Their work was published in the influential journal Stroke in November 2021.

There were many AIR student achievements over the last year. Andrea Burns, a PhD student in Computer Science advised by AIR faculty members Kate Saenko and Bryan Plummer, received the 2021 Google Fellowship for her research at the intersection of computer vision and natural language processing. Burns hopes to improve vision-language representations that can be applied to assistive technology. Nataniel Ruiz, a PhD student in Computer Science working with AIR faculty members Sarah Adel Bargal, Margrit Betke, and Stan Scarloff, received a best poster award for presenting "Affect Transfer Learning for Behavior Prediction in an Intelligent Tutoring System" at the IEEE International Conference on Automated Face and Gesture Recognition.

### 150+
**ATTENDEES AT THE AIR DISTINGUISHED SPEAKER SERIES**

## BOSTON WOMEN'S WORKFORCE COUNCIL (BWWC)

The Boston Women's Workforce Council (BWWC) is a public-private partnership between the Mayor's Office and the Greater Boston business community that, in collaboration with BU, aims to eliminate the gender/racial wage gap and remove barriers to women's advancement. Every two years the BWWC, in partnership with BU, collects and analyzes payroll data anonymously from its members to show a snapshot of the progress being made to close wage gaps.

This year, BWWC published their 2021 Wage Gap Report, which covered over 14% of the Greater Boston area workforce. Boston-area women, on average, were paid 70 cents for every dollar earned by men in 2021. Although the average gender wage gap hasn't shrunk over the past two years in Boston, the racial wage gap was slightly smaller in 2021 than in 2019. When compared to 2019 figures, Asian and American Indian/Alaskan Native women in 2021 were paid two and three cents more, respectively, for every dollar earned by men. BWWC also launched their Wage Gap Calculator in collaboration with the city of Boston's Mayor's Office of Women's Advancement. The calculator, created by the Software & Application Innovation Lab (SAIL), enables any employer to calculate gender and racial wage gaps with just the click of a button and can be accessed at wagegapcalculator.org.

### 11
**NEW 100% TALENT COMPACT SIGNERS**

REPRESENTING

### 2,572
**EMPLOYEES FROM THE GREATER BOSTON AREA**

## CENTER FOR COMPUTATIONAL SCIENCE (CCS)

### 6
**MULTI-INSTITUTIONAL GRANT PROPOSALS IN PARTICIPATION WITH 10 RESEARCH GROUPS**

The Center for Computational Science (CCS) serves as a conduit for collaborations between experimental researchers who are synthesizing and collecting real-world data and computational researchers with expertise in model building, simulation, and analysis.

This year, CCS hosted two research visitors focusing in the thematic area of computational biophysics. These visitors each spent a week visiting with CCS faculty affiliates and their research groups, kicking their visits off with an hour-long seminar.

CCS researchers participated in three newly funded collaborative projects supported by the National Institutes of Health (NIH), National Science Foundation (NSF), and Sloan Foundation. CCS faculty also helped lead the submissions of six multi-institutional and collaborative grant proposals with researchers from Arizona State University, Boston College, City University of New York, Massachusetts Institute of

18 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 19

## CENTER FOR RELIABLE INFORMATION SYSTEMS AND CYBER SECURITY (RISCS) AND CYBER ALLIANCE

The Center for Reliable Information Systems and Cyber Security (RISCS) promotes and coordinates research and education in system reliability and information security. This year, RISCS partnered with researchers within and beyond Boston University (BU) to expand the breadth of their work. RISCS established an alliance with physicists at BU to pursue quantum computing research, jointly hired Ngozi Okidegbe with the BU School of Law, and formed a new grant-funded partnership with BU Questrom School of Business to study disinformation from economic and security perspectives. RISCS faculty also represented BU in the steering committee of a new multi-university forum for law and computing research, and worked with researchers from Georgetown University Institute for Technology Law and Policy to compile a report containing advice for bridging computer science and law in academic environments.

Additionally, RISCS affiliated faculty members influenced national and international technology policies by contributing toward reports by the Advisory Committee on Data for Evidence Building, the United Nations Task Team on Privacy Enhancing Technologies, and the Israeli Ministry of Health.

The Cyber Alliance, a collaboration between computer science, law, business, and social science researchers, hosted 4 seminars this year featuring high-profile speakers in cybersecurity.

### 4
#### HIGH-PROFILE SEMINAR SPEAKERS

## DIGITAL HEALTH INITIATIVE (DHI)

### 22+
#### TRANSDISCIPLINARY TEAMS FUNDED BY DHI

The Digital Health Initiative (DHI) focuses on the essential role digital technologies play in the health and wellness of populations, and the integration of these technologies into people's lives and health systems. DHI projects focus on computing and data sciences, medical informatics, health behavior change, and healthcare delivery. Last year, the DHI had a funding call focused on two priority areas: translating basic science discoveries to mobile health in clinical and public health contexts to improve health and wellness, and developing and testing mobile health solutions to decrease disease risk, particularly among vulnerable populations. Three teams were funded and have already published and presented this work.

Additionally, DHI-funded faculty members received numerous external grants and published in prestigious journals. Dan Fulford was awarded a large R01 from the National Institute of Mental Health; Prakash Ishwar, Margrit Betke, and Swathi Kiran published a paper in the influential journal Stroke on their work developing AI models that predict a patient's responsiveness to aphasia rehabilitation; and Jennifer Bean-Ebel and Vijaya Kolachalama received a series of grants, totaling over $1 Million, and published a study in the prestigious journal, IEEE Trans Med Imaging, for their work using deep learning to detect cancer.

## MOC ALLIANCE

The goal of the Mass Open Cloud (MOC) Alliance is to create an open production cloud that provides domain researchers with predictable low cost resources and facilitator support while enabling academic researchers and developers in the open source community to participate in the kind of close interactions between research, development, and production operations that has resulted in so much innovation in today's public clouds.

The current focus of the MOC Alliance is to enable BU and Harvard University Research IT to offer production cloud services this coming academic year to a broad community of researchers and students. The team of four MOC engineers and more than five Red Hat engineers are working with the Research IT team on this effort, including integrating reporting and billing software, self service onboarding tools, monitoring tools, and automation around new cloud services. The MOC Alliance has hired additional technical project managers to coordinate efforts across partners, and plans to continue to expand its staff and services over the coming year. Harvard University and BU Research IT will be ramping up additional operations and facilitation staff as the production cloud becomes used by academia.

## RED HAT COLLABORATORY
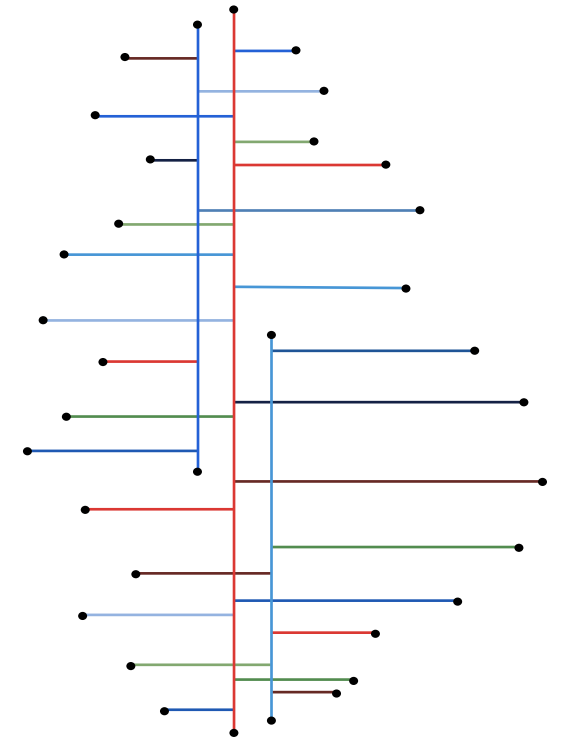
### 13
#### BU STUDENTS INTERNED AT RED HAT THIS YEAR

The Red Hat Collaboratory is a partnership between Red Hat and Boston University that connects BU faculty and students with industry practitioners working in open-source software communities. The Collaboratory aims to advance research focused on emerging technologies in a number of areas including operating systems, cloud computing services, machine learning and automation, and big data platforms.

This year, the Red Hat Collaboratory launched a new Systems Seminar series to bring together systems researchers in academia and industry in a forum for discussing design, implementation, analysis and applications of computer systems at various scales. 22 researchers, including a number of external speakers, presented their state of the art work at the seminar on topics ranging from operating, distributing, and networking systems to system architectures.

Additionally, BU faculty members and Red Hat engineers engaged with the community through courses and numerous prestigious talks. Red Hat Collaboratory-funded faculty members Alan Liu and Eshed Ohn-Bar presented their research at a Red Hat Greater New England Research Interest Group Meeting, and the AI for Cloud Ops and Foundations in Open Source Education project teams discussed their work at two Red Hat Research Day events. Red Hatters Lance Galletti, Sally O'Malley, and Bandan Das also taught courses on programming and software engineering through the Faculty of Computing & Data Sciences.
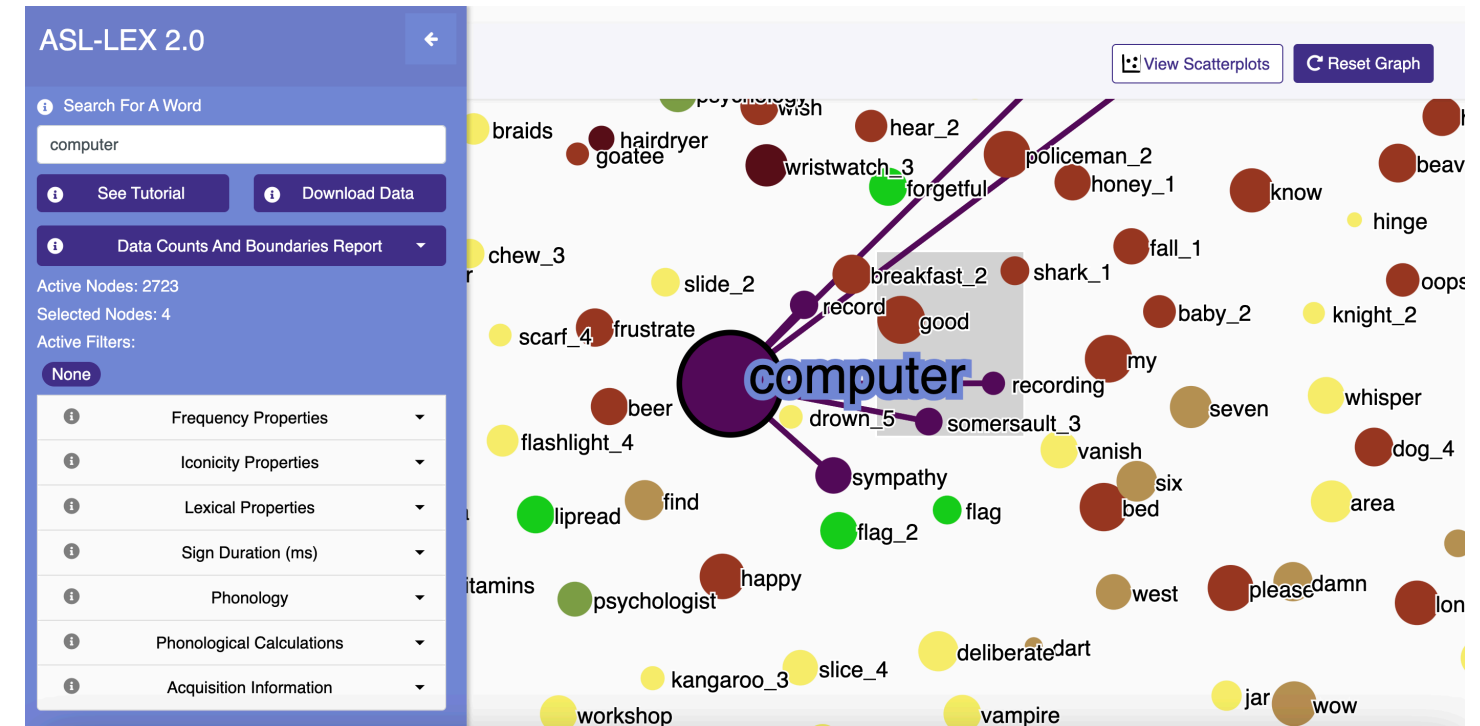
# SOFTWARE APPLICATION AND INNOVATION LAB (SAIL)

The Software & Application Innovation Lab (SAIL) is the premier professional research, software engineering, and consulting lab at BU that works with academic and industry professionals to solve meaningful problems. SAIL creates cutting-edge solutions for the data-driven, computational, and software engineering aspects of research. SAIL software engineers are experts working in a unique professional engineering environment where they can develop their skills by working with the latest technologies and through access to university classes. SAIL projects have direct impacts on academic research, public service, and industry.

This year, SAIL engaged in many successful efforts including project relaunches, continuations, and brand-new initiatives. A few projects that garnered significant media attention were the ASL-LEX, the world's largest interactive American Sign Language (ASL) database created in partnership with AI and Education Initiative Co-Director Naomi Caselli, and the Wage Gap Calculator, a tool created in partnership with the BWWC and the Boston Mayor's office which aims to help businesses close their gender and racial earnings gaps.

SAIL also partnered with new groups within and beyond BU to develop platforms that transform research and society. The team worked with the Black Women's Health Study to create a web portal where other researchers can request access to their team's 25+ years of data easily. Additionally, SAIL worked with Scott Solberg of the Coalition for Career Development Center to launch the State Career Readiness Resources map, which highlights states whose educational efforts have improved outcomes for the workers in that state.



COLLABORATED WITH

**60+**
FACULTY MEMBERS

ACROSS

**20+**
DEPARTMENTS

ON GRANTS AND PROPOSALS TOTALLING

**$30 MILLION**



ASL-LEX 2.0 Database, the world's largest interactive American Sign Language Database, created at SAIL.
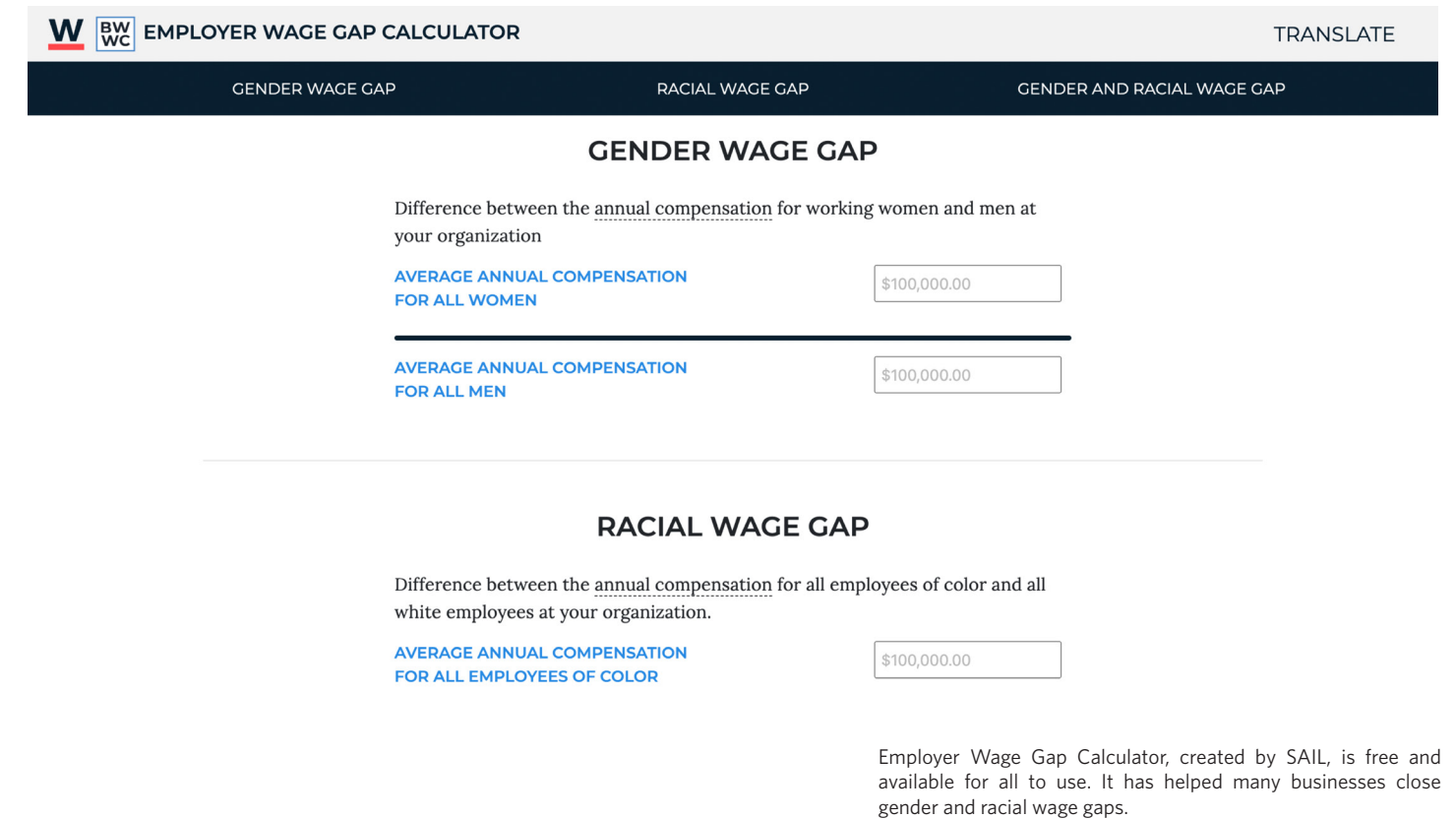


Employer Wage Gap Calculator, created by SAIL, is free and available for all to use. It has helped many businesses close gender and racial wage gaps.

22 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 23
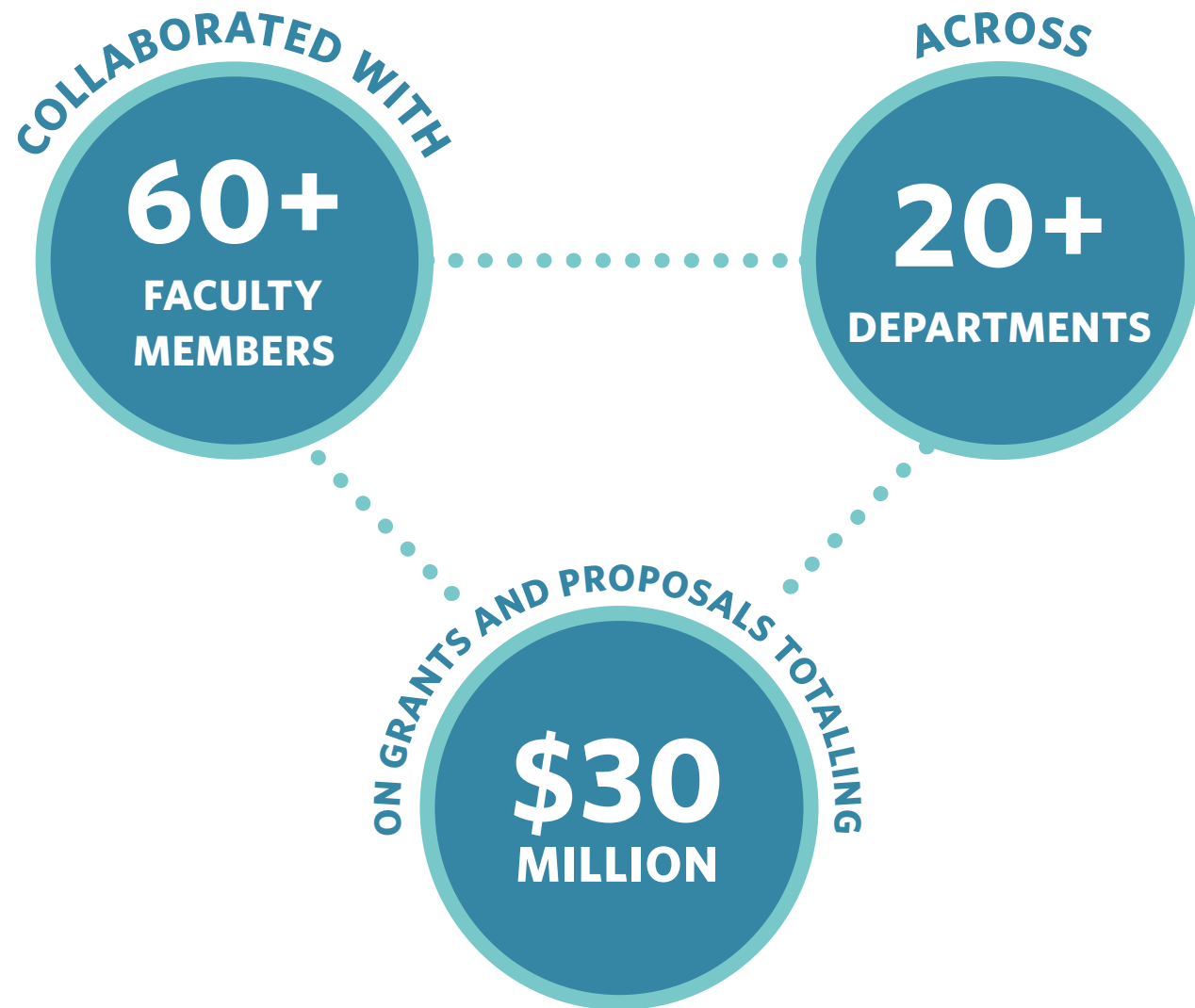
**Ioannis (Yannis) Paschalidis**
*Director*, Hariri Institute for Computing

**Mayank Varia**
*Co-Director*, Center for Reliable
Information Systems & Cyber Security

**Ran Canetti**
*Co-Director*, Center for Reliable
Information Systems & Cyber Security

**Margrit Betke**
*Co-Director*, Artificial Intelligence
Research

**Kate Saenko**
*Co-Director*, Artificial Intelligence
Research

**Kim Borman**
*Executive Director*, Boston Women's
Workforce Council

24 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 25

# WHO WE ARE — Leadership

**William Tomlinson**
*Director,* Software & Application
Innovation Lab

**Belinda Borrelli**
*Director,* Digital Health Initiative
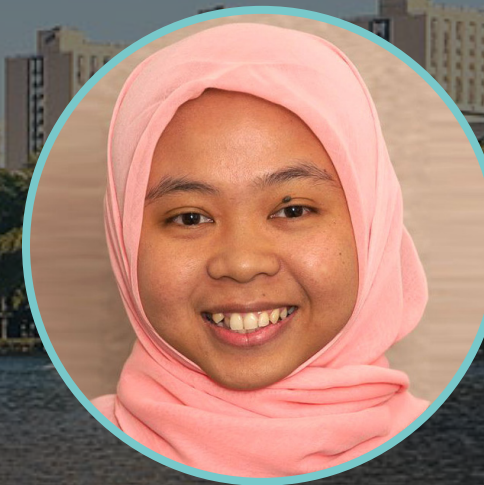
**Naomi Caselli**
*Co-Director,* AI & Education
Initiative

**Derry Wijaya**
*Co-Director,* AI & Education
Initiative

**Orran Krieger**
*Co-Director,* Red Hat Collaboratory

**Hugh Brock**
*Co-Director,* Red Hat Collaboratory
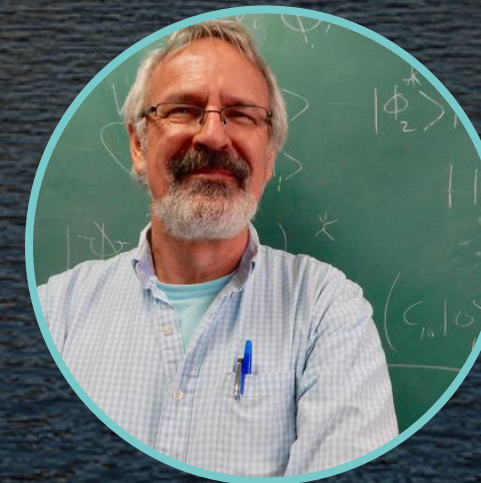
**David Coker**
*Director,* Center for
Computational Science

# STEERING COMMITTEE

Members of the Institute's Steering Committee are appointed by the Office of Research to assist the Director with overall strategic planning and management of the Institute's operations. Members assist in reviewing ongoing activities, identifying and evaluating opportunities for investment of resources, developing proposals for new programs or initiatives, communicating the Institute's vision, and promoting its goals to the constituents they represent.

**Bill Adams**
Professor, Pediatrics, MED

**Margrit Betke**
Professor, Computer Science, CAS

**Hugh Brock**
Co-Director, Red Hat Collaboratory
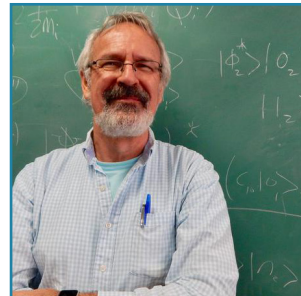
**David Coker**
Professor, Chemsitry, CAS

**Rhoda Au**
Professor, Anatomy & Neurobiology, MED

**Kim Borman**
Executive Director, Boston Women's Workforce Council

**Ran Canetti**
Professor, Computer Science, CAS

**Ziba Cranmer**
Director, BU SPARK!
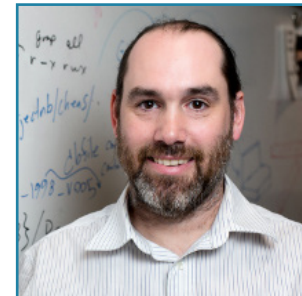
**Michael Dietze**
Professor, Earth and Environment, CAS

**Orran Krieger**
Professor, Electrical & Computer Engineering, ENG

**Heather Schoenfeld**
Associate Professor, Sociology, CAS

**Wesley Wildman**
Professor, Philosophy, Theology, and Ethics, STH

**Stacey Dogan**
Professor, School of Law, LAW

**Cathie Jo Martin**
Professor, Political Science, CAS
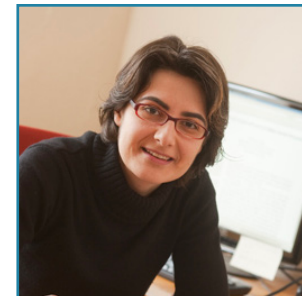
**Evimaria Terzi**
Professor, Computer Science, CAS

**Jonathan Woodson**
Professor in Management and Professor of the Practice; Markets, Public Policy, and Law, QST

**Evan Johnson**
Associate Professor, Medicine and Biostatistics, MED

**Emily Ryan**
Associate Professor, Mechanical Engineering, ENG

**Mayank Varia**
Professor, Computer Science, CAS
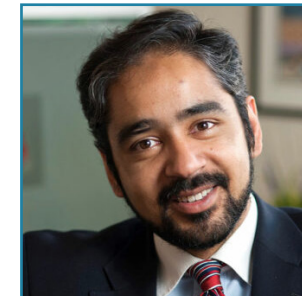
**Muhammad Zaman**
Professor, Biomedical Engineering, ENG

**Swathi Kiran**
Professor, Speech, Language, and Hearing Sciences, SAR

**Kate Saenko**
Professor, Computer Science, CAS

**Laura White**
Associate Professor, Biostatistics, SPH

**Giorgos Zervas**
Associate Professor, Marketing, QST

# ADMINISTRATIVE STAFF

# SAIL STAFF

The Hariri Institute has assembled a team of talented and dedicated professionals to help researchers make connections, identify additional support resources, and lift the burden of administrative support, so that more research is accomplished with far fewer barriers.

The Institute's administrative staff provide program and project management, grant administration, event planning, communications support, and more.

SAIL consists of a small team of professional software architects and developers who are assigned to work directly with faculty members (and their research teams) on specific software and application development projects. Additionally, these professional software engineers supervise a team of BU student interns through the SAIL Internship Program.

Professional SAIL staff act as the clearing house for software developed by students, thus allowing the research community to leverage the untapped software development capacity of undergraduate and graduate students at BU, while ensuring project continuity.

**Stephen Brown**
Director of Finance and Administration

**Daniela Demaestri**
Financial Manager

**Katherine D'Angelo**
Assistant Director, Program and Events Manager

**William Tomlinson**
Director
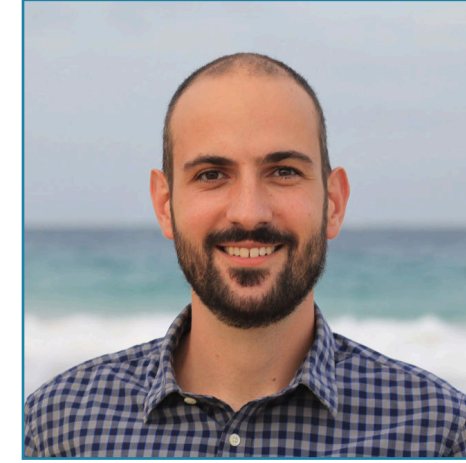
**Jeff Simeon**
Associate Director, Programs and Product Management

**Arezoo Sadeghi**
Software Engineer

**Marion Flanagan**
Administrative Coordinator

**Emily Johnson**
Assistant Director, Grants and Operations Manager

**Gina Mantica**
Assistant Director, Marketing Communications

**Collin Bolles**
Software Engineer

**Hazim Ab Halim**
Software Engineer

30 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 31

# RESEARCH FELLOWS

Faculty who are part of project teams awarded support by the Hariri Institute through one of our funding mechanisms.

**Jonathan Appavoo**
Associate Professor, Computer Science, CAS

**Emelia Benjamin**
Professor, Medicine, MED; Epidemiology, SPH

**Ksenia Bravaya**
Professor, Biomedical Engineering, ENG

**Ran Canetti**
Professor, Computer Science, CAS

**Manos Athanassoulis**
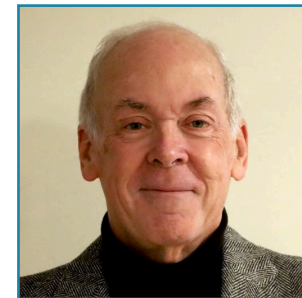Assistant Professor, Computer Science, CAS

**Margrit Betke**
Professor, Computer Science, CAS
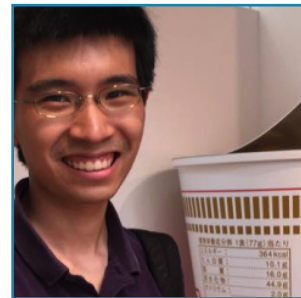
**Mark Bun**
Assistant Professor, Computer Science, CAS

**Luis Carvalho**
Assustant Professor, Mathematics & Statistics, CAS

**Jennifer Beane-Ebel**
Assistant Professor, Computational Biomedicine, MED

**David Bishop**
Professor, Electrical & Computer Engineering, ENG

**David Campbell**
Professor, Physics, CAS

**Claudio Chamon**
Professor, Physics, CAS

**Anushya Chandran**
Assistant Professor, Physics, CAS

**Nicholas Crossland**
Assistant Professor, Pathology & Laboratory Medicine, MED

**Luca Dal Negro**
Professor, Electrical & Computer Engineering, ENG
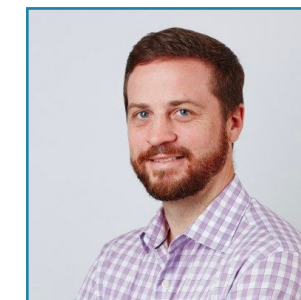
**Daniel Fulford**
Assistant Professor, Occupational Therapy, SAR

**Don Christenson**
Associate Professor, Political Science, CAS

**Mark Crovella**
Professor, Computer Science, CAS

**Linda Doerrer**
Professor, Chemistry, CAS

**Ashita Gurnani**
Research Assistant Professor, Neurology, MED

**Ayse Coskun**
Professor, Electrical & Computer Engineering, ENG

**Qiang Ciu**
Professor, Chemistry, CAS

**Manuel Egele**
Associate Professor, Electrical & Computer Engineering, ENG

**Martin Herbordt**
Professor, Electrical & Computer Engineering, ENG

**Alice Cronin-Golomb**
Professor, Psychology, CAS
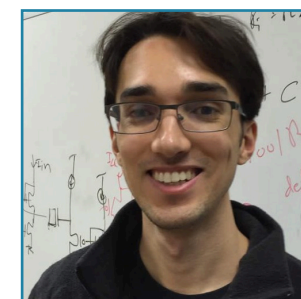
**Ashok Cutkosky**
Assistant Professor, Electrical & Computer Engineering, ENG

**Mark Friedl**
Professor, Earth & Environment, CAS
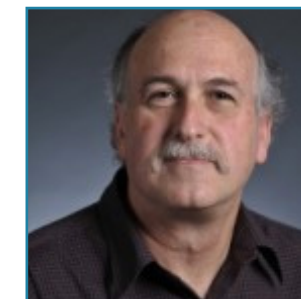
**Steven Homer**
Professor, Computer Science, CAS

32 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 33

# RESEARCH FELLOWS - (CONTINUED)

**Lucy Hutyra**
Professor, Earth & Environment, CAS

**Ajay Joshi**
Associate Professor, Electrical and Computer Engineering, ENG

**Swathi Kiran**
Professor, Speech, Language, and Hearing Sciences, SAR

**Christopher Laumann**
Associate Professor, Physics, CAS

**Phillip Hwang**
Postdoctoral Associate, Anatomy & Neurobiology, MED

**Vasiliki Kalavri**
Assistant Professor, Computer Science, CAS

**Orran Krieger**
Professor, Electrical & Computer Engineering, ENG
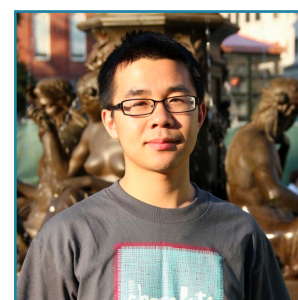
**Dan Li**
Assistant Professor, Earth & Environment, CAS

**Prakash Ishwar**
Professor, Electrical and Computer Engineering, ENG

**Maria Kamentska**
Assistant Professor, Chemistry and Physics, CAS

**Brian Kulis**
Assistant Professor, Electrical & Computer Engineering, ENG
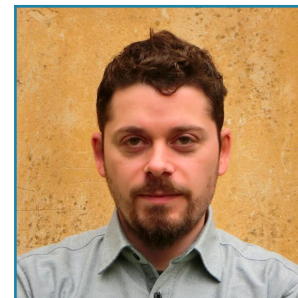
**John Liagouris**
Adjunct Assistant Professor, Computer Science, CAS

**Alan (Zaoxing) Liu**
Assistant Professor, Electrical & Computer Engineering, ENG

**Eshed Ohn-Bar**
Assistant Professor, Electrical & Computer Engineering, ENG

**Bryan Plummer**
Assistant Professor, Computer Science, CAS

**Emily Ryan**
Associate Professor, Mechanical Engineering, ENG

**Renato Mancuso**
Assistant Professor, Computer Science, CAS

**Alex Olshevsky**
Associate Professor, Electrical & Computer Engineering, ENG

**Anatoli Polkovnikov**
Professor, Physics, CAS

**Kate Saenko**
Professor, Computer Science, CAS

**Pankaj Mehta**
Assistant Professor, Physics, CAS

**Francesco Orabona**
Associate Professor, Electrical & Computer Engineering, ENG

**Siddharth Ramachandran**
Distinguished Professor, Electrical & Computer Engineering, ENG

**Marie-Helene Saint-Hilaire**
Professor, Neurology, MED

**Abdoulaye Ndao**
Assistant Professor, Electrical & Computer Engineering, ENG

**Ioannis Paschalidis**
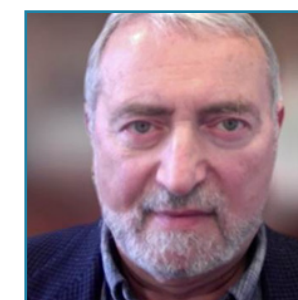Professor, Electrical & Computer Engineering, ENG

**Andrei Ruckenstein**
Professor and Department Chair, Physics, CAS

**Venkatesh Saligrama**
Professor, Electrical & Computer Engineering, ENG

34 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 35

# RESEARCH FELLOWS - (CONTINUED)

**Anders Sandvik**
Professor, Physics, CAS

**Allyson Sgro**
Assistant Professor, Bio-medical Engineering, ENG

**David Starobinski**
Professor, Electrical & Computer Engineering and Systems Engineering, ENG

**John Straub**
Professor, Chemistry, CAS

**Kaija Schilde**
Associate Professor, International Relations, CAS

**Sahar Sharifzadeh**
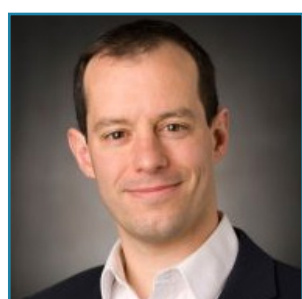Professor, Electrical & Computer Engineering, ENG

**Cara Stepp**
Professor, Biomedical Engineering, ENG

**Gianluca Stringhini**
Assistant Professor, Electrical & Computer Engineering, ENG

**Alexander Sergienko**
Professor, Electrical & Computer Engineering, ENG

**Adam Smith**
Professor, Computer Science, CAS

**Jessica Stern**
Professor, Pardee School of Global Studies, CAS
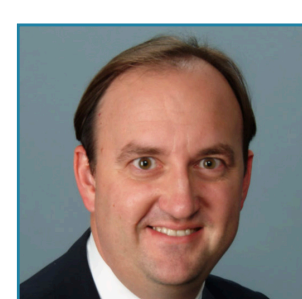
**Richard Stuebi**
Lectureer, Strategy and Innovation, QST

**Alexander Sushkov**
Associate Professor, Physics, CAS

**Kia Teymourian**
Assistant Professor, Computer Science, MET

**Lauren Tracy**
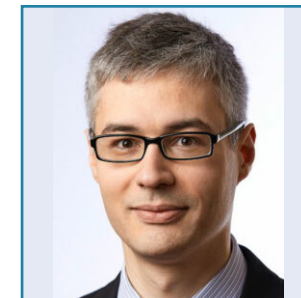Assistant Professor, Otolaryngology (Head & Neck Surgery), MED
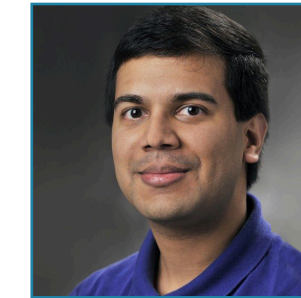
**Mayank Varia**
Associate Professor, Faculty of Computing & Data Sciences

**Evimaria Terzi**
Professor, Computer Science, CAS

**Cathi Ann Thomas**
Assistant Clinical Professor, Neurology, MED

**Ludovic Trinquart**
Associate Professor, Biostatistics, SPH

**Derry Wijaya**
Assistant Professor, Computer Science, CAS

36 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 37

# JUNIOR FACULTY FELLOWS

Our Junior Faculty Fellows program aims to both recognize outstanding early-career computing and data-driven researchers at Boston University and support their continued development by connecting them with one another and with the Institute community at large through various mechanisms and activities. Junior Faculty Fellows are early-career faculty researchers who are selected for a three-year appointment.

**Gerdus Benade**
Assistant Professor,
Information Systems, QST

**James Feigenbaum**
Assistant Professor,
Economics, CAS
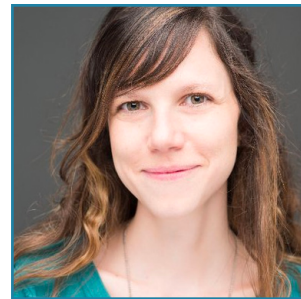
**Ana Fiszbein**
Assistant Professor,
Biology, CAS

**Andrey Fradkin**
Assistant Professor,
Marketing, QST

**Scott Hirst**
Assistant Professor, Law,
LAW

**Garrett Johnson**
Assistant Professor,
Marketing, QST

**Yuhei Miyauchi**
Assistant Professor,
Economics, QST

**Prasad Patil**
Assistant Professor,
Biostatistics, SPH

**Jonathan Huggins**
Assistant Professor,
Mathematics & Statistics, CAS

**Emma Lejeune**
Assistant Professor,
Mechanical Engineering, ENG

**Shariq Mohammed**
Assistant Professor,
Biostatistics, SPH

**A. Max Reppen**
Assistant Professor, Finance,
QST

**Jonathan Jay**
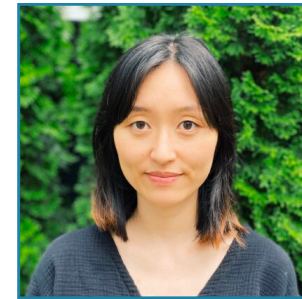Assistant Professor, Community
Health Sciences, SPH

**Laura Lewis**
Assistant Professor, Biomedical
Engineering, ENG

**Elaine Nsoesie**
Assistant Professor,
Global Health, SPH

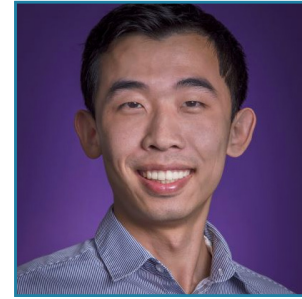**Chris Wells**
Assistant Professor, Emerging
Media Studies, COM

**Jihye Jeon**
Assistant Professor,
Economics, CAS

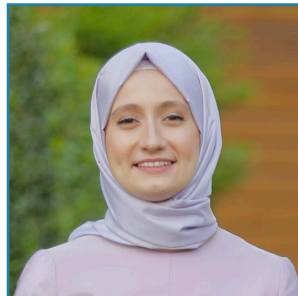**Tesary Lin**
Assistant Professor, Marketing,
QST

**Eshed Ohn-Bar**
Assistant Professor, Electrical &
Computer Engineering, ENG

**Jinglong Zhao**
Assistant Professor, Operations and
Technology Management, QST

# GRADUATE STUDENT FELLOWS

Our Graduate Student Fellows program recognizes outstanding PhD students who are pursuing computing and data-driven research at Boston University. These fellows have a a three-year appointment.
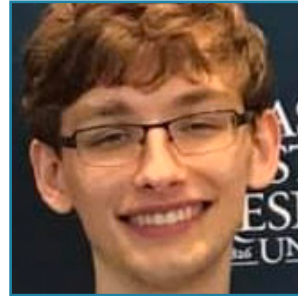
**Beverly Setzer**
Ph.D Student, Computational Neuroscience, CAS
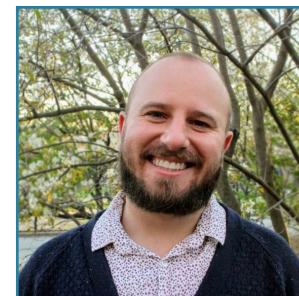
**Marika Swanberg**
Ph.D Student, Computer Science, CAS

**Hasini Weerathunge**
Ph.D Student, Biomedical Engineering, ENG

**Lingyi Xu**
PhD Student, Information Systems, QST

**Afra Feyza Akyurek**
Ph.D Student, Computer Science, CAS

**Munib Hasnain**
Ph.D Student, Biomedical Engineering, ENG

**Hiba Kobeissi**
Ph.D Student, Mechanical Engineering, ENG

**Devlin Moyer**
Ph.D Student, Interdisciplinary Programs, Bioinformatics

**Michael Silverstein**
Ph.D Student, Interdisciplinary Programs, Bioinformatics
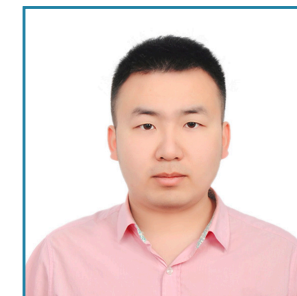
**Hao Wang**
Ph.D Student, Electrical and Computer Engineering, ENG

**Si Wu**
Ph.D Student, Political Science, CAS

**Sheng Huang**
PhD Student, Speech, Language & Hearing Sciences, SAR

**Sheng Huang**
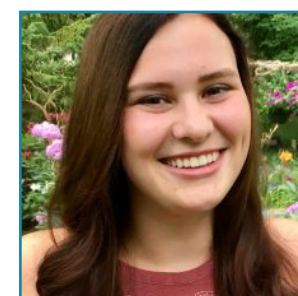Ph.D Student, Astronomy, CAS

**Yunzhe Li**
Ph.D Student, Electrical and Computer Engineering, ENG

**Chika Onubogu**
Ph.D Student, Astronomy, CAS

**Adrianna Spindle-Jackson**
Ph.D Student, Social Work, SSW
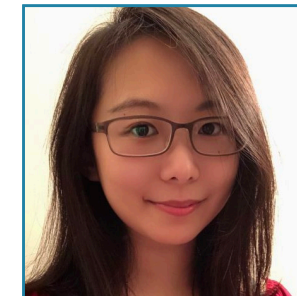
**Jianing Wang**
Ph.D Student, Interdisciplinary Programs, Biostatistics

**Olivia Wyatt**
PhD Student, Counseling Psychology & Applied Human Development, Wheelock

**Anqi Guo**
Ph.D Student, Electrical and Computer Engineering, ENG

**Anil Kag**
Ph.D Student, Electrical and Computer Engineering, ENG

**Chen Ling**
Ph.D Student, Computer Engineering, ENG

**Adam Samuels**
Ph.D Student, Astronomy, CAS

40 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 41

# POSTDOCS

Postdoctoral Research Associates have recently earned a PhD from Boston University or other institutions. They are currently collaborating with faculty researchers and other PhD students on projects at the Hariri Institute.

**Maryam Aliakbarpour**
Postdoctoral Associate, RISCS
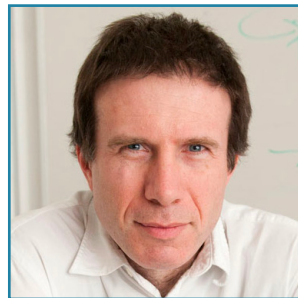
**Venkitesh Ayyar**
Postdoctoral Associate, CCS

**Marcel Neunhoeffer**
Postdoctoral Associate, RISCS
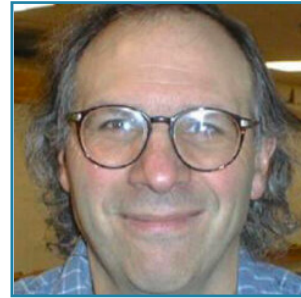
# VISITING SCHOLARS

Visiting Scholars are scholars from other institutions spending time at the Hariri Institute in collaborative research endeavors.

**Heidi Dempsey**
Research Directory of the Northeast US, Red Hat

**Peter Desnoyers**
Associate Professor, Computer Science, Northeastern University

**Larry Rudolph**
Principal Research Scientist, Computer Science and Artificial Intelligence Laboratory, MIT



Mengting Song, Boran Hao, Samad Amini, and Yannis Paschalidis and the rest of their team developed a model that detects cognitive impairment accurately and efficiently from voice recordings.

42 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 43

# LOOKING AHEAD

## Moving to The Center for Computing & Data Sciences

The Hariri Institute will be moving to floors 11 and 12 of the BU Center for Computing and Data Science building in the Fall of 2022! The new space will distinguish the Hariri Institute as an accelerator of convergent data science and computational research in the region. The Center for Computing and Data Science will be BU's most sustainable building: even at 19 stories and 345 square feet, it will be fossil-fuel free. 31 geothermal wells will provide the majority of the heating and cooling and the exterior will feature triple-glazed windows to help insulate the air inside. Additionally, the building will work towards being zero-waste and will have centralized waste collection areas, encourage reusable resources, and install energy-efficient shared printing areas.



Mock-up of the new Center for Computing & Data Sciences, which will house the Hariri Insititute for Computing

## Integrating the Center for Information & Systems Engineering

The Center for Information & Systems Engineering (CISE) will join the Hariri Institute's federation starting in FY23. CISE, led by Ayse Coskun, was established in 2001 with its 50 affiliated faculty and their graduate students to develop hardware and software systems that acquire, analyze, and act upon information from a range of networked sources to solve critical problems in fields such as health care, communications, energy, and national security.

CISE will bring with it the new Robotics and Autonomous Systems Teaching and Innovation Center (RASTIC). The Baker-Polito Administration granted $4.4 million to Boston University in May 2022 to build a 2,000-square-foot robotics lab that will enable the development of new innovations and increase the university's capacity to support experiential learning for students through industry partnerships.



Ayse Coskun
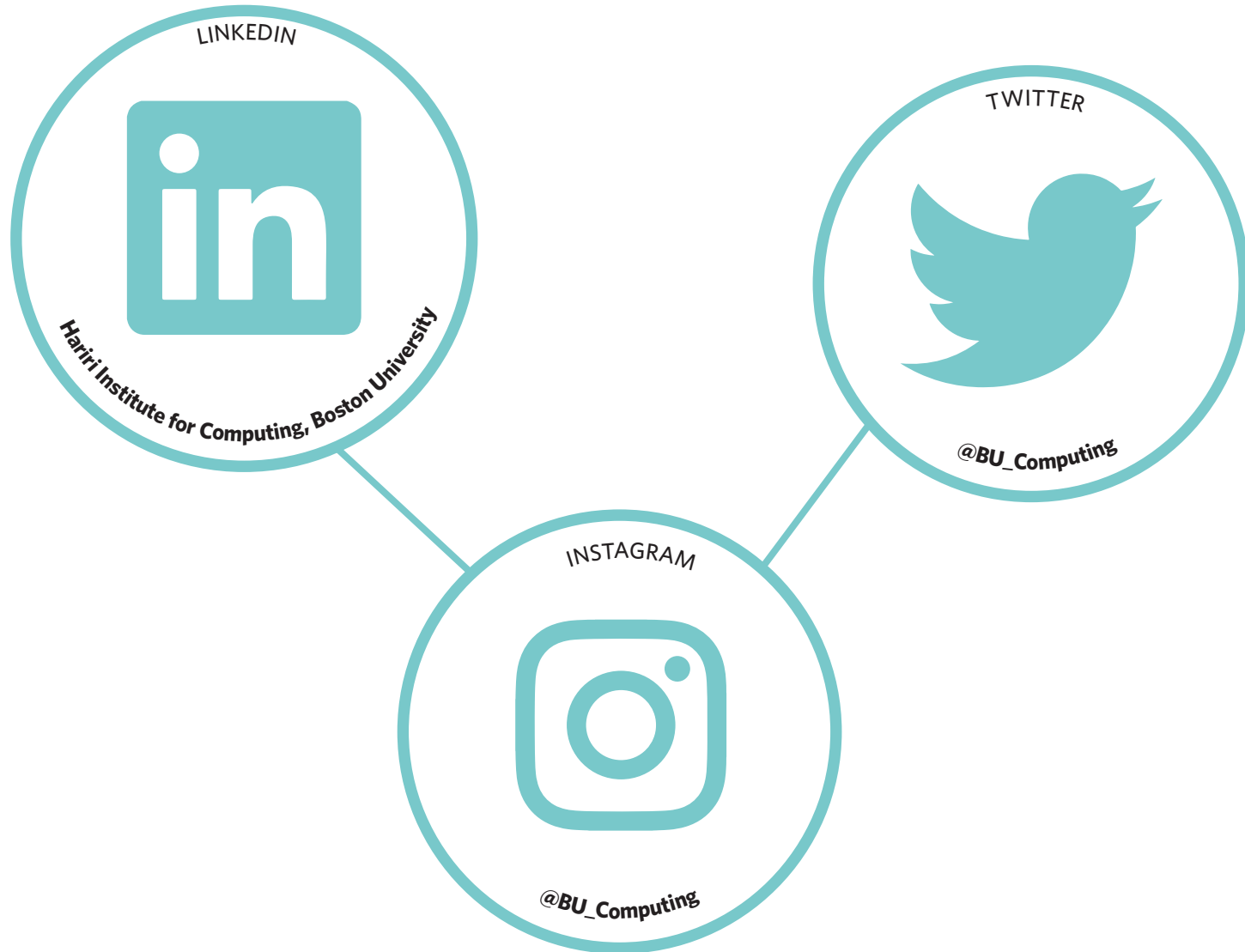*Director*, Center for Information & Systems Engineering (CISE)

After the press conference announcing BU RASTIC, students demonstrated the types of robotics work that will be done in the new lab. Franco Julia Wise (ENG'22) (right) explains the workings of his team's Soft Robot with Integrated Soft Optical Sensing for Minimally Invasive Surgery to ENG's Sean Andersson (left).
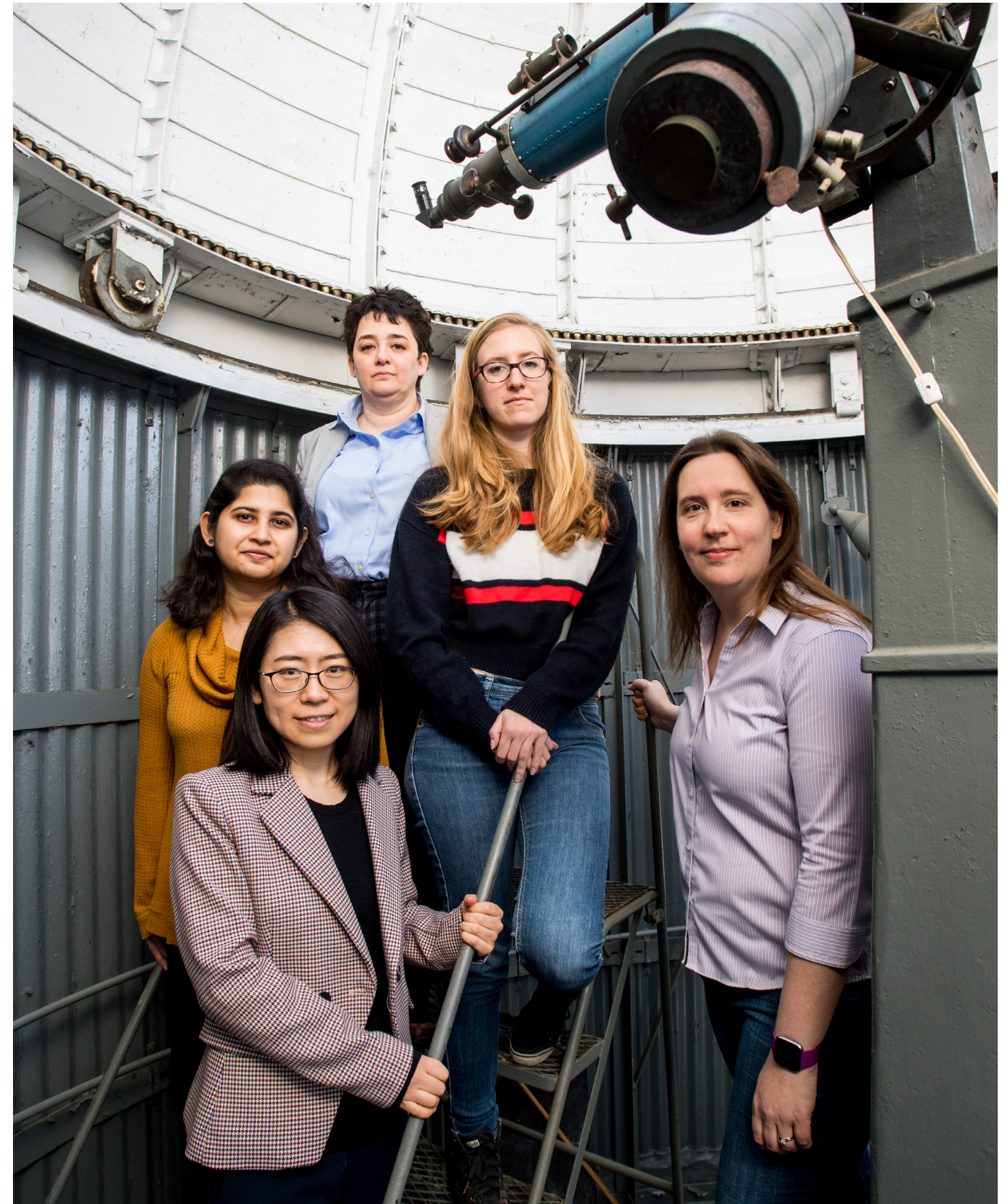
44 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 45

# CONNECT WITH US

**If interested in joining any of our collaborative initiatives please visit our website for more information at https://www.bu.edu/hic/**



Junior Faculty Fellow Wen Li, Professor, Astronomy, CAS, and research team at BU Astronomy Lab. Li uses computational models to simulate energetic particle dynamics due to wave-particle interactions and applies machine learning techniques to specify and predict the state of the space environment by taking advantage of various satellite data.

46 | **Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report

**Boston University** Rafik B. Hariri Institute for Computing and Computational Science & Engineering 2022 Annual Report | 47