



**ANNUAL REPORT**  
**'19**

# RESEARCH ECOSYSTEMS



Hariri Institute for Computing

## A LETTER FROM THE DIRECTOR



Since its inception, the Hariri Institute for Computing has experienced substantial growth in size, scope, and impact, making it a recognizable landmark at the crossroads of BU's Computing and Data Sciences research, with achievements spanning the incubation of new initiatives, pursuit of significant sponsored research projects, development of experiential learning opportunities, partnerships with industry and public sector organizations, and community building and outreach. After undergoing an extensive five-year review in 2018 it has been amazing to take stock of the growth we have experienced since inception. Following up on our successful review and renewal of our charter, the Institute stood poised to continue to permeate BU's research landscape. In the fiscal years since our five-year review, our return-on-investment has remained steady even as we take on the risks associated with investing in incubated research.

### Expanding Partnerships

As the federal research funding landscape continues to contract, the Institute is increasing its collaboration with industry, nonprofits, and public entities, in a collaborative model in which partners are viewed not as sponsors but rather as co-investors. A perfect exemplar of this new approach to industrial collaboration (and associated funding) is the Red Hat Collaboratory, which in its third year has become a fixture of the Institute ecosystem and a major catalyst for open-source innovation by our faculty and students. Red Hat has benefitted tremendously from the partnership, sending staff to serve as entrepreneurs-in-residence who advise undergraduate students within the Institute's ecosystem. In FY19, the Institute was able to replicate this model by launching the Honda Research Collaboratory which builds on the Institute's recent successes in support of secure and privacy-preserving smart-city applications to seed-fund research at the nexus of data privacy, artificial intelligence, consumer personalization, and user control of mobility solutions and autonomous systems. Combined with other industrial funding, these partnerships bring in an excess of \$2M a year in support of Institute research.

The Institute also launched its first Advisory Board in Spring 2018. The most valuable takeaway that we gained from their inaugural visit in February 2018 is just how unique the Institute is. Board members associated with other peer institutions noted that while their institutions attempted to launch many initiatives that the Institute is home to (software engineering, experiential learning, and incubating research), their attempts were in vain. Indeed, it was after this meeting that we came to realize that the Institute is greater than a sum of its parts – we are truly a vibrant ecosystem which thrives when all of our initiatives work together. It is because we have our most critical initiatives within the same federation that we are able to thrive where other peer and peer + institutions have struggled.

### Research Dollars

In FY19 we executed two rounds of seed funding through the Institute's Research Incubation Award (RIA) program. We also collaborated with the Institute for Health System Innovation & Policy, the Urban Climate Initiative, and Red Hat, to create specialized funding tracks, which were co-funded,

enabling our research dollars to have an even greater reach. In total, there were 39 proposals for a total of \$1.513M in requested funding. These proposals were reviewed by a number of internal committees that also engaged with our co-funders. Based on this review, recommendations were made to the Institute Steering Committee which upon final review selected 17 projects (totaling \$505K as well as an additional \$200K of SAIL support) for funding. In addition to incubated funding, the Institute has also been the administrative home to over 40 extramural proposals in FY19, each of which is either collaborative, leverages the Institute's resources, or a combination of the two. Over the past year, the Institute has attracted significant external Sponsored Research funding, which totaled \$10.9M. The breakdown of the sponsors of this funding is as follows: NSF (\$3.9M), IARPA (\$3.2M), DOE (\$1.56M), Red Hat (\$1.0M), Honda (\$874K), and DARPA (\$251K). This is in addition to a much larger set of extramural proposals that were enabled and would not have been possible without material or programmatic support from the Institute.

### Supporting BU Students

Across all of our initiatives, the Institute spent \$798K on fellowships for graduate and undergraduate students in FY19. The funds were spent in support of a combination of BU Spark! Fellows, SAIL Internship program, the Institute's Graduate Student Fellowships which helps attract competitive graduate students, as well as the many graduate students supported through our Research Incubation Awards, which are selected after rigorous review and selection by our Steering Committee.

### Growing Data Science at BU

With an interdisciplinary research culture, state-of-the-art infrastructures, and professional, technical and administrative support, the Hariri Institute continues to thrive. Our affiliate community, comprised of 300 researchers from across the University are utilizing data science in exciting ways to enhance the study of all fields of inquiry including: politics, healthcare, smart cities, biology and much more. The announcement of the university's plans to set up a Faculty of Computing & Data Sciences (CDS) will go a long way in building on the Institute's achievements so far, by enabling the university to hire faculty associated with areas of scholarship that the Institute cares deeply about, and by allowing the university to develop much-needed academic programs that expand existing ones that the Institute is engaged with. We are looking forward to fully participating in the expected changes in the Boston University landscape with the inception of the new Faculty of CDS.

Quoting President Robert Brown in his communication about the establishment of the new CDS Faculty, "The creation of the Faculty of Computing & Data Science, together with the growing success of the Hariri Institute, and the construction of the Center for Computing & Data Sciences gives Boston University the ingredients to be a leader in the applications of computing and data science across the University and to educate generations of students with this competency." We echo the President's viewpoint and look forward to playing a central and active role in this new initiative.

A handwritten signature in blue ink, reading "Robert Brown".

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## PEOPLE

The Hariri Institute for Computing is comprised of scholars who represent both faculty and students from across the university and beyond with diverse backgrounds and areas of interest. This diversity creates an ecosystem of varied interests that contribute to a rich texture that is interwoven in a dynamic community. The Institute's community consists of institute leadership, steering committee, advisory board, fellows, faculty affiliates, students and staff.

### LEADERSHIP

The leadership team at the Institute is made up of our Founding Director, Azer Bestavros, university faculty, and other noted leadership. Each director oversees the research conducted in their specific areas.

### DIRECTORS

Directors at the Hariri Institute consist of university faculty, distinguished leaders and industry professionals. They oversee and guide research in their particular area of focus. Directors at the Institute are also ex-officio members of the Institute's Steering Committee.

### STEERING COMMITTEE

The Steering Committee at the Institute is comprised of members of the BU community and are appointed to support the director of the Institute with strategic planning and operational guidance. Additionally, the committee serves as a "think tank" to assist in creating a vision for how the Institute can enhance

BU's position in the data science ecosystem. Another important aspect of the Steering Committee is identifying opportunities for investment and awarding such things as the Research Incubation Awards. ***This past year we were honored to have 9 new members appointed to the committee. This new cohort represents 6 different colleges and schools from across the university.***

### Advisory Board

The Advisory Board at the Institute is made up of members appointed by the Institute Director. In contrast to the Steering Committee, the members of the Advisory Board represent external industry leaders as well as researchers from other academic institutions. Their responsibilities include strategic advice with regards to the institute's overall mission and positioning within the university. ***This past year we added 8 new members to the board.***

### FELLOWS

At the intellectual core of the Hariri Institute for Computing are the Fellows. This talented group of university faculty, students and external scholars make up the ecosystem of research at the institute. Each fellow brings their expertise and research to the Institute where they are funded and supported through administrative support, SAIL or other myriad benefits of being a fellow. The different levels of fellow can be described as:

### Institute Fellows

Institute Fellows are outstanding researchers at the core of the Institute. Their backgrounds cover a wide range of disciplines including computer science, political science, engineering, and many others.

### Data Science Faculty Fellows

Data Science Faculty Fellows are talented faculty from across the University whose expertise transcends traditional boundaries, leveraging computer science, statistics and electrical and computing engineering. Data Science Faculty Fellows take an active role in the evolution of the Data Science Initiative. ***This past year we added 4 new fellows.***

### Junior Faculty Fellows

Junior Faculty Fellows are early career BU faculty researchers. Their areas of focus span across multiple university schools and colleges. They are chosen by the Hariri Institute Steering Committee where they are awarded funding. ***This past year we added 6 new fellows.***

### Research Fellows

Research Fellows are made up of university faculty whose projects are funded by the Institute through incubated research and other researchers who have made significant contributions to the research being performed at the Institute in general.

### Graduate Student Fellows

Graduate Student Fellows are outstanding PhD students who pursue computational and data-driven research at Boston University.

### Postdoctoral Research Associates

Postdoctoral Research Associates have recently earned a PhD and are currently working on a research project of the Institute.

### FACULTY AFFILIATES

The Hariri Institute for Computing Faculty Affiliates consists of Boston University faculty members who are engaged in research projects from various backgrounds and experiences. Once a member, they can tap into resources available to them through the Institute, such as facilities, funding programs, administrative support and event planning. ***This past year we added 32 members, bringing our total to 297.***

### ADMINISTRATIVE STAFF

The Institute's administrative staff is a team of dedicated professionals assembled to provide program and project management, grant administration, financial management, event planning, and communications support to Institute faculty researchers and affiliates. ***This past year we added 1 new staff member.***

### STUDENT INTERNS

#### SAIL Interns

The Software & Application Innovation Lab (SAIL) at the Hariri Institute, provides graduate and undergraduate students the opportunity to work alongside experienced and professional software engineers, software developers and architects as software engineer interns, UI/UX design interns, and graphic design interns. Although the program operates throughout the year, the summer internship program has the largest number of students participating.

#### BU Spark! Interns & Consultants

BU Spark! engages undergraduate students in a variety of different ways. First and foremost it provides a supportive community for student-centered innovation and entrepreneurship that fosters informal, flexible networks and enables student access to a wide range of university-supported and student-led resources on the BU campus and beyond. Also, BU Spark! cultivates connections between student projects produced within the context of academic courses, independent research, and other programs to facilitate next-stage development for student-led concepts. ***This past year we worked with 375 student interns, 92 different projects, representing 17 BU schools and colleges.***



## REFLECTING ON OUR NUMBERS

In FY19 we saw substantial growth in several different areas of the Institute. The most important numbers represented here are the ones that reflect the growth in our ability to fund projects. Additionally, we focused on activities and initiatives that have allowed us to expand our connections across the university and beyond through events and marketing of the Institute.



Operating Budget



Blog Post Articles



Group Meetings



Six Junior Faculty Fellows  
Awarded (\$60K Total)



Departments Represented  
by Faculty Affiliates



Institute-led Proposals



Social Media Mentions



Public Events



Depts. Represented by  
Incubation Awards



Institute-enabled Proposals



Social Media Posts



Research Expenditures



Faculty Affiliates  
(across 91 depts., 16 schools)



Incubation Awards Given



Extramural Funding



Colleges & Schools Represented  
by Incubation Awards



Incubation Award  
PIs & Co-PIs



Institute Enabled Funding  
(43 fellows thru 3 Inst. seed funding programs)



Institute-led Funding



Community Research  
Expenditures



Hariri External Funding  
(since inception, based on expenditures)



Social Media Followers



# CENTERS AND INITIATIVES



ARTIFICIAL INTELLIGENCE  
RESEARCH



BOSTON WOMEN'S  
WORKFORCE COUNCIL



BU SPARK!



CENTER FOR  
COMPUTATIONAL SCIENCE



DATA SCIENCE  
INITIATIVE



DIGITAL HEALTH  
INITIATIVE



RED HAT  
COLLABORATORY



RELIABLE INFO SYSTEMS,  
CYBER SECURITY  
& CYBER ALLIANCE



SOFTWARE APPLICATION  
& INNOVATION LAB

# Data Science Initiative (DSI)



## ON A MISSION TO ATTRACT DEDICATED FACULTY

The Data Science Initiative (DSI) is an initiative of the Hariri Institute. It is connected to the Hariri ecosystem predominantly as a recruitment platform to attract cross-disciplinary faculty whose dedication and expertise in the data sciences is second to none. Therefore the initiative exists in the BU ecosystem and beyond as it brings together faculty from different schools, colleges and universities. DSI was originally launched by BU Provost Jean Morrison in 2014 to leverage BU's existing strengths and further expand its capacity to compete and lead in the Big Data revolution.

## THE INITIATIVE CONTINUES TO GROW

This past year we were excited to once again add four outstanding BU faculty members. They were chosen for exceptional contributions to their areas of study and for the versatility, multidisciplinary scope, and tremendous potential of their research to yield new innovations and breakthroughs.

## BU Data Science (BUDS) Day 2019

Another achievement from the past year was a successful BU Data Science (BUDS) Day. This event, in its 4th year, brought together BU researchers and external data scientists for a day-long symposium. Close to 200 attendees listened to panelists, roundtables and lightning talks on topics such as "Impactful Collaborations" and "Research Enablers." BUDS Day aims to provide an environment for cross-disciplinary connections and drive future research collaborations.

## CONTINUED ALIGNMENT AND GROWTH

As interest in the data sciences at BU and beyond continues to grow with new technologies, research, and discoveries, so too will the DSI. We aim to continue to recruit the brightest faculty from across the country and beyond. Additionally, the Hariri Institute will continue to provide a unique environment and a common space that encourages DSI faculty to connect, cross-disciplinary lines, and pursue game-changing research outside traditional silos.

## 2019 DATA SCIENCE FACULTY FELLOW COHORT



**Mark Crovella**  
Professor  
Computer Science, CAS



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



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



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

# Software & Application Innovation Lab (SAIL)



## AN IN-HOUSE CATALYST FOR SOFTWARE-DRIVEN INNOVATION AND SCHOLARSHIP

Since its inception in 2014, the Software & Application Innovation Lab (SAIL) has operated within the Hariri Institute ecosystem as a resource to the different Hariri centers and initiatives by providing in-house software and engineering support. We employ eight full-time software engineers and project managers, maintains an internship program of 7-12 interns each semester (at the undergraduate and graduate levels), and has undertaken about 70 distinct software engineering projects. Specifically, this specialized lab develops high-grade software applications and assists with budgeting, project management, and other aspects of a project. The areas supported are language processing, public health, economics, and medical. The SAIL team consists of software engineers, developers, managers, and internal faculty.

## Supporting Communities Both Internally and Externally

Externally, we work with the Red Hat Collaboratory (RHC) and other various industry projects. Courtesy of BU Spark!, SAIL is invited to X-lab information sessions, which matches BU students with external industry projects at little-to-no-cost to industry partners. Similarly, the RHC invites SAIL to their colloquium series, which gives SAIL members a chance to network with external industry and in turn, SAIL assists in RHC projects by answering inquiries concerning software design or software platforms.

## AN INTERNSHIP PROGRAM TO BE PROUD OF

This past year we worked with over 40 clients across 12 schools and colleges at BU. We continue to be a part of the Hariri Institute and larger BU community. We're also proud of our internship program which has offered internship opportunities to over 40 BU students to grow their software engineering expertise and solve research challenges across disciplines. SAIL interns and fellows work directly with software engineers and researchers in the space where academia meets application, learning and experimenting with new technologies on projects in data science, security and privacy, synthetic biology, digital health, and more. Many of these interns go on to work as professional programmers when they graduate.



## EMISSION TRACKING AND ANALYTICS USING VEHICULAR TRAFFIC FLOWS

This SAIL project developed a first-of-its-kind roadway-scale model of vehicle emissions of both CO<sub>2</sub> and five additional air pollutant species in collaboration with the Boston Metropolitan Planning Organizations.

## Software & Application Innovation Lab (SAIL)



### EXPANSION OF OUR NETWORK AND PROJECT OWNERSHIP

This upcoming year, we are looking to expand our internship program to offer more summer internship positions to a larger community to grow the pool of student expertise and knowledge. A closer collaboration with BU Spark! is also one of our goals in order to expand projects and provide expertise and mentoring to X-lab students. SAIL also wants to expand its digital health and natural sciences involvement. In terms of project management, we are going to try a different approach, dividing themes amongst programmers according to their passions and interests. The same programmer will oversee a project to create a better sense of ownership and project continuity. Having the same project manager will also help with team collaboration dynamic, project development, and recruitment of SAIL by external companies.

## BU Spark!

### AN ECOSYSTEM OF STUDENT RESEARCHERS

BU Spark! has been an initiative of the Hariri Institute since January 2017. Its central focus is giving experiential learning opportunity for students seeking opportunities to gain real world experience; where knowledge acquired in a classroom setting could be put into practice. It's this ecosystem with student researchers that sets it apart from other Hariri centers. It's own ecosystem of cross-disciplinary students from colleges and schools across the university mimics perfectly with the mission of the Hariri Institute for Computing to initiate, catalyze, and propel collaborative, interdisciplinary research and training initiatives for a better society.



Also as an initiative of the Hariri Institute, BU Spark! is well connected to the larger Boston University ecosystem. BU Spark! is an active member of Innovate@BU and increasingly aligning our learning outcomes with the university-wide Innovation Pathway, where course credit enables student participation, in partnership with the computer science department, which enables student participation is made possible by collaborating with the Computer Science department. BU Spark! also utilizes the BU HUB, with one Cross-College Challenge course approved, and several other Hub Unit approvals in the works.

### A Network Beyond BU

Also, Spark! extends its reach into the outside university ecosystem by working with external partners through outreach, well thought out client engagement strategies, student ambassadors, and a strong marketing and branding campaign. External partners represent a vast number of industries, cities, towns, and nonprofits.



## BU Spark!

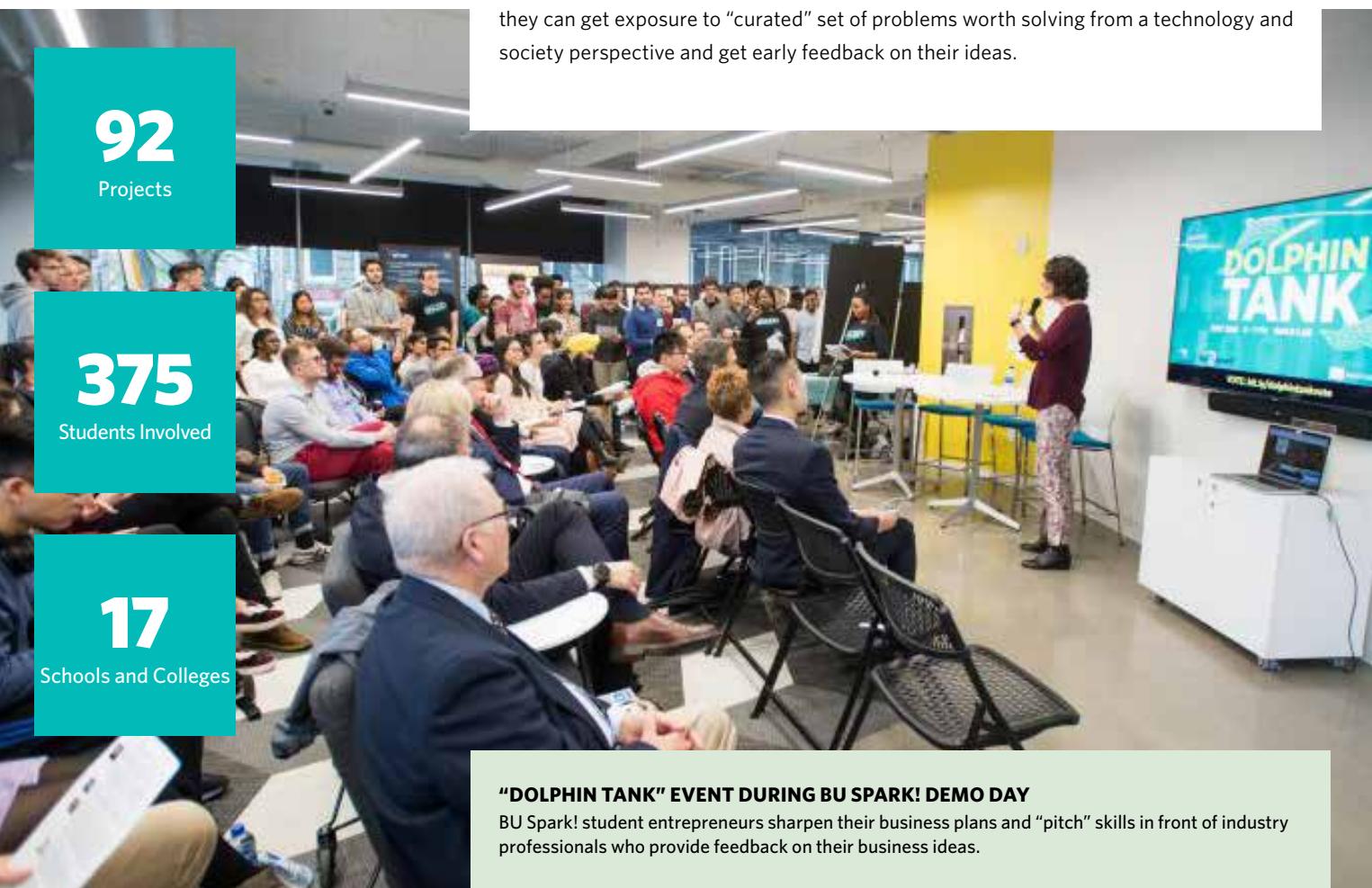
Additionally, we're proud of our Hackathon 101 workshop, a Women in Computer Science Panel, and a BU Admissions presentation where high school students from all over the nation were introduced to eye-opening concepts and practices. After the event a survey of PreHacks participants found that 96% of students who attended during 2019 would attend the event in 2020. Additionally, 69% of students who attended PreHacks are interested in applying to Boston University and 77% would recommend Boston University to a friend. We look forward to growing and evolving our programs to cater to an even larger group of PreHacks attendees in 2020.

### THREE PROGRAMS TO LOOK FORWARD TO

In the upcoming year BU Spark! has several programs that we will introduce to the Boston University community.

The Freshman Hackathon is an effort to include some of our youngest students in BU Spark! To promote our internal goals for greater diversity and inclusion we invite all freshman students, regardless of their discipline or level of experience in tech, to join us to learn about the computing leadership council at Spark!

Another project we are looking forward to is the BU Spark! Ideathon. The Ideathon will be an experience for students to partake in before they apply to the program where they can get exposure to "curated" set of problems worth solving from a technology and society perspective and get early feedback on their ideas.



## Center for Reliable Information Systems and Cyber Security/Cyber Alliance (RISCS)



### AT THE CENTER OF THE CYBER SECURITY ECOSYSTEM

Center for Reliable Information Systems and Cyber Security/Cyber Alliance (RISCS) is a center of the Hariri Institute of Computing. It is a participant in the Hariri ecosystem in that it utilizes the faculty researchers of other Hariri initiatives and centers as well as taking advantage of the facilities and hosting of events at the Institute. It operates in a cross-disciplinary manner that draws on the expertise of 22 faculty and over 100 graduate students from the College of Arts and Sciences, the College of Engineering, Questrom School of Business, and Metropolitan College, and provides opportunities for faculty and students from diverse fields to collaborate on interdisciplinary research problems, create new knowledge, and develop innovative multidisciplinary curricula.

### The Perfect Partnership of Cyber Security and Law

Additionally, RISCS inspired the creation of the Cyber Security, Law & Society Alliance, with growing participation and engagement from researchers from computer science, law and related disciplines at Boston University. It's another example of engagement with the BU community and partnerships with diverse schools from across the university ecosystem.

External to the BU community, RISCS leadership interfaced with scientists from the Honda Research Institutes (HRI) to develop a new research partnership. In addition to sponsoring research, the partnership will provide BU researchers with the opportunity to learn about HRI's emerging technology and envisioned applications.

### RECOGNITION LOCALLY AND NATIONALLY

Over this past year we're particularly proud of several activities and projects. First, the Cyber Security, Law & Society Alliance held monthly lunch meetings to establish a common language and shared understanding of priorities and concerns between RISCS and the BU Law School. In addition to presentations by both RISCS researchers and BU Law professors, the group brought in several external speakers. Additionally we were excited by both Azer Bestavros and Mayank Varia taking part in several briefings with Congressional staffers and directors of several executive branch organizations to discuss issues of privacy and security pertaining to data collection and analysis systems that exist within government workflows in the present or (if pending legislation is adopted) the future.

The BU Security Group, which pursues research in cryptography and network security, hosted 11 seminars throughout the year and held the summer Seminar on Practical Security series. Series talks discussed the latest topics in cybersecurity attacks and defenses.

## Center for Reliable Information Systems and Cyber Security/Cyber Alliance

**RAN CANETTI**

Director, Center for Reliable Information Systems & Cyber Security (RISCS)  
Professor, Computer Science, CAS

**\$462K**

DARPA/IARPA  
Funding

**\$3M**

Money Proposed

**18**

Cyber Alliance  
Seminars

### A Collaborative Teaching Approach

Also, within the university's teaching mission, we have developed a "law for algorithms" class co-taught with BU Law, Berkeley CS and Berkeley Law. This course was taught in Fall 2018 and Fall 2019; the first iteration was conducted jointly with Harvard CS and Law. This project-based course pairs students in computer science and the law to explore a prominent topic at the intersection of these fields in a cross-cutting fashion.

Also, Ran Canetti and Mayank Varia provided a composable security analysis of OpenStack, a popular open-source software package used by the MOC and others to manage cloud computing services.

### EXCITED ABOUT AUTOMATION AND COLLABORATION

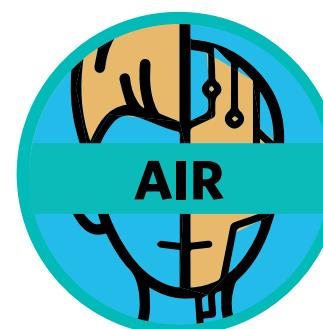
In the next year we are looking forward to developing automated tools for performing compositional security analysis for security-sensitive systems. This is a promising and exciting new direction with potentially significant scientific and real-world impact. We also have been collaborating on large project with NEU and MIT towards practical secure computation, which is funded by IARPA and continues to see positive results now and in the future.

We're also excited about the Cyber Alliance and how it continues to grow by attracting new speakers from outside of BU and expanding its audience across university schools and colleges.

## Artificial Intelligence Research (AIR)

### CROSSING BOUNDARIES WITH AI RESEARCH

The Artificial Intelligence Research (AIR) initiative operates within the Hariri Institute for Computing's ecosystem as an initiative that engages with different communities within the Institute and around Boston University. Our primary research focus is on new computational models aimed at general artificial intelligence, i.e. agents that exhibit the skills and learning capacity close to those of biological intelligence (human or animal). We cross the boundaries of computer vision, natural language processing, machine learning, robotics, and human-computer interaction research and promotes AI education at Boston University. Within the Hariri Institute for Computing, AIR has two research labs associated with it. The first is the Artificial Intelligence and Emerging Media (AIEM) Lab. The purpose of this lab is to explore and create techniques from machine learning, natural language processing, and computer vision to interpret emerging media. The second lab is called the Image and Video Computing (IVC) Lab. The IVC researches many aspects of computer vision, machine learning, and human-computer interaction.



### SHARING RESEARCH STORIES AND BROADENING OUR REACH

The past year we are most proud of our flagship event called the AIR Open House held in October 2018. This event occurs annually and brings together AI researchers at BU with industry groups interested in AI research. Its main goal was to showcase AI research at Boston University, increase interaction between the AIR community and industry labs such as SRI International, Microsoft, Google, Amazon, Red Hat, and Facebook amongst many others, with the possibility of leading to future collaborations and/or internship opportunities.



### 2018 AIR OPEN HOUSE

Brian Kulis, Assistant Professor, Electrical & Computer Engineering, ENG, speaks on a panel at AIR Open House.

## Artificial Intelligence Research

This past year saw several projects highlighted by Ph.D. and graduate students alike. Notably, Xiaoting Zhang, a postdoctoral researcher focusing on 3D fabrication, computer-aided design, and computational geometry worked with Emily Whiting, Assistant Professor of Computer Science, CAS. Her recent interests revolve around shape modeling and optimization for additive manufacturing. Her specific project includes developing an algorithm that calculates how to cheaply and easily craft sculptural objects using fabric, plaster, and a sewing machine.

### BREAKING DOWN SILOS ONE TALK AT A TIME

Down the road, AIR is working to expand its visibility within the Hariri Institute, Boston University, and external industry partners. This will be accomplished through high-quality, content-rich seminars and talks given by some of the biggest names in AI across the country. AIR also aims to continue its support of AI research projects that cross the typical boundaries of academia and promote student and faculty involvement at all levels.



## Red Hat Collaboratory (RHC)

### A NETWORK ACROSS BU AND BEYOND

The Red Hat Collaboratory (RHC) is an initiative of the Hariri Institute. It connects BU faculty and students within the BU ecosystem with Red Hat, an external industry partner of the Institute. Established in 2017, our mission is to advance research focused on emerging technologies in many areas including operating systems, cloud computing services, machine learning and automation, and big data platforms.



The RHC also operates within the BU ecosystem as a connector across the university with the successful implementation of the Red Hat Colloquium Series. This has, in turn, increased our engagement with BU faculty and has provided a stage for speakers to share their projects and other topics on emerging technologies.

### PAST ACHIEVEMENTS INCLUDING NATIONAL SEMINARS AND TEACHING

This past year we were proud to the ChRIS Project initiative which showcases medical image processing on an open cloud, using MPC tools developed by SAIL. An instance of ChRIS is already deployed over Boston Children's Hospital (BCH) and Massachusetts Open Cloud (MOC).

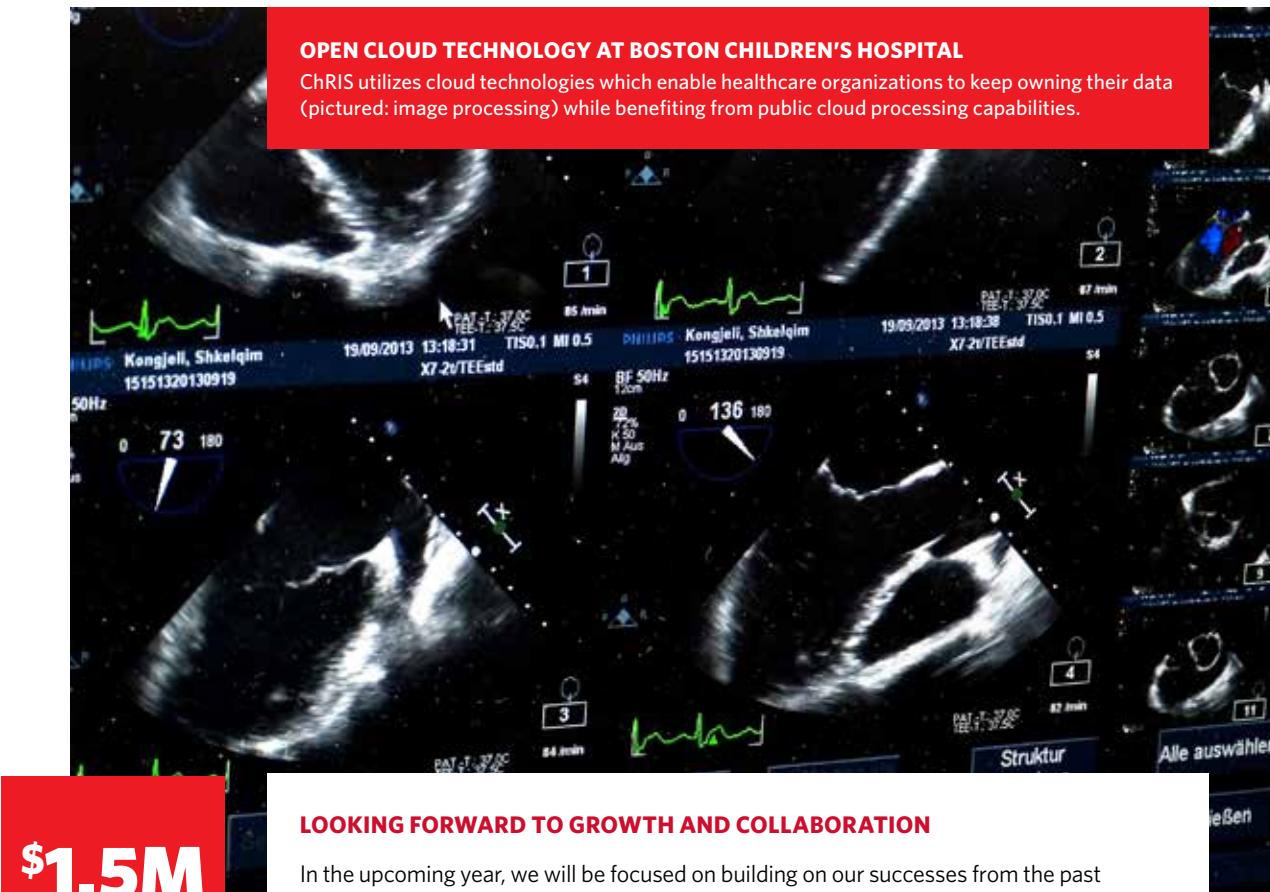
We also were excited to have seven PhD students working at Red Hat on Collaboratory projects this Summer 2019. Also, we increased our presence within the Hariri Institute for Computing ecosystem and the rest of BU, with an Engineer In Residence program.



We also played a role in the Red Hat Summit, a premier open source technology event for thousands of IT professionals to innovate and focus on high-performing Linux, cloud, automation and management, container, and Kubernetes technologies.

Our involvement with teaching included a co-taught basic operating systems course with Red Hat Senior Engineer Larry Woodman. We were major participants in cloud computing courses with five RHC-led projects including guest lectures and mentoring teams of students giving experiential learning

## Red Hat Collaboratory



**\$1.5M**  
Funding

### LOOKING FORWARD TO GROWTH AND COLLABORATION

In the upcoming year, we will be focused on building on our successes from the past year. We will continue to knit together RHC's different research efforts and the projects supporting them. Additionally, our primary project covers how secure Multi-Party Computation (MPC) would run on the MOC and ChRIS, and would be the workflow engine to drive the process, and the feeder for image processing that would depend on MPC. Also, using OpenShift, ChRIS, and the Open Data Hub project led by RHC's AI Center of Excellence will support a service on the MOC that will allow cooperating institutions to grant permission to researchers to execute real-world queries on private data.

**150**  
Attendees at RHC Colloquium Series

**15**  
Papers Published

**4**  
Visiting Professors

## Center for Computational Science (CCS)



### HOSTING VISITORS AND CONNECTING COMPUTATIONAL SCIENTISTS

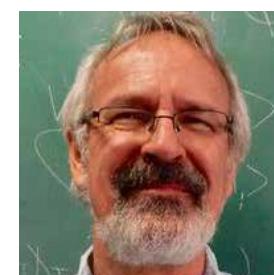
The Center for Computational Science (CSS) is a center within the Hariri Institute for Computing. It was founded in 1990 and supports collaborations across departments and colleges by connecting computational scientists from different areas. BU Professor of Chemistry, David Coker has been the center's director for several years. Furthermore, we expand our ecosystem by hosting several faculty members from around the world with our visitor's program. These faculty members visit BU for a week to 2 months to develop collaborations with BU researchers, who nominate visitors for the program.

Promoting scientific curiosity among high-school students and providing early-stage exposure to cutting-edge research is the primary goal of the computational chemistry workshop developed by Prof. Bravaya. During the workshop, the students learn about state-of-the-art research and visualize important physical chemistry concepts.

### SHARING OUR IDEAS WITH A GROUP OR INDIVIDUAL

This year we spearheaded the development of a large institutional proposal for a National Science Foundation (NSF) Materials Research Science and Engineering Center (MRSEC) grant. The NSF MRSEC competition occurs every three years and the program supports 20 Centers nationwide at between \$2M and \$4M for each Center per year.

We also welcomed a new faculty member, Prof. Qiang Cui from the University of Wisconsin, Madison in January 2018. Prof. Cui is a world leader in Computational Science, with a research focus in the fields of theoretical and computational chemistry of biomolecular systems. Also, Prof. Sahar Sharifzadeh's research was highlighted on the national stage this year when she was named one of the 11 Rising Stars of Science.



**David Coker**  
Director, Center for Computational Science  
BU Professor, Chemistry, CAS



**Qiang Cui**  
BU Professor, Chemistry, CAS

**3**  
Visiting Professors

**\$1.5M**  
D.O.E. Initiative

**4**  
Lunch Seminars

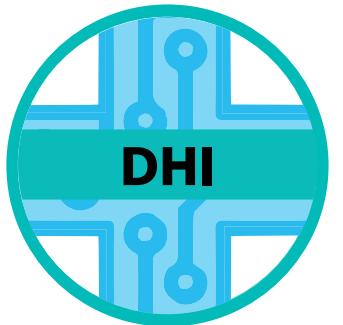
**160**  
Lunch Seminar Attendees

This year we held several CCS special lunch seminars to highlight the activities of our visiting researchers. We supply lunch for participants of these meetings and they are run in a highly interactive 2-hour format. They are very well attended with typically 30-40 participants from the broad CCS community.

### FOCUSING ON CONTINUED SUPPORT

In the upcoming year, we're looking forward to continuing on the successes of the previous year. We will be taking the lead partnering with our MRSEC IRG groups to explore new funding opportunities and project development. Additionally, our first CCS visitor in the new year will be Professor Markus Elstner from the Karlsruhe Institute of Technology. Our talks are well attended and we hope to grow this aspect of the CCS to give our speakers an expanded audience to speak to.

## Digital Health Initiative (DHI)



### BRINGING TOGETHER HEALTHCARE RESEARCHERS

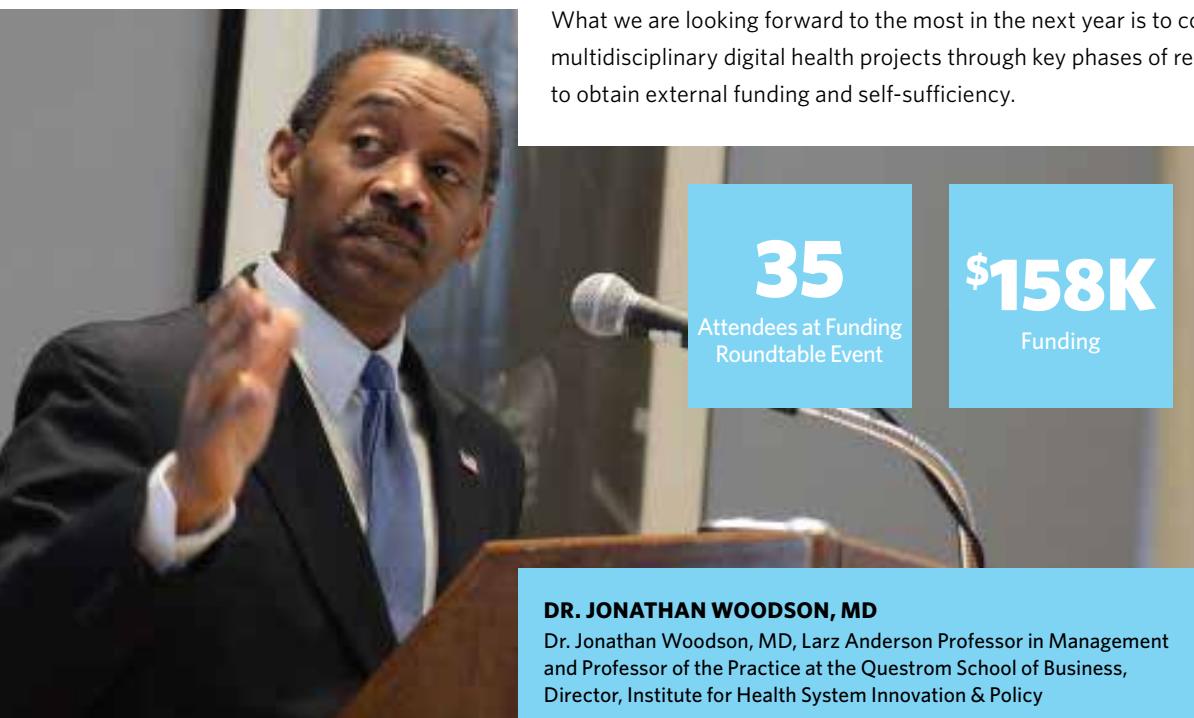
The Digital Health Initiative is an initiative of the Hariri Institute. It plays a role in the Hariri ecosystem as a collaborative effort with the Institute for Health System Innovation & Policy (IHSIP). This relationship allows both groups to leverage their distinct strengths of collaborative and expansive networks to cultivate sustainable development of digital health research and invention at BU. These cross-discipline experts are a part of the university ecosystem as well as the external healthcare community in Boston and beyond.

### FUNDING RESEARCH FOR FUTURE SOLUTIONS

This past Spring 2019 the Digital Health Initiative participated in a call for proposals for the Hariri Institute's Research Incubation Awards. Held every spring, DHI was one of several different tracks where submitters could choose which area made most sense for their proposals. Additionally, DHI hosted a roundtable event that was well attended. The purpose of this roundtable was to provide faculty researchers the chance to hear from other past submitters their experiences with the proposal process, if their project was ready for submission and what to expect if awarded with funding.

### KEEPING THE MOMENTUM GOING

What we are looking forward to the most in the next year is to continue to support multidisciplinary digital health projects through key phases of research, shoring them up to obtain external funding and self-sufficiency.



## Boston Women's Workforce Council (BWWC)



### A PUBLIC-PRIVATE PARTNERSHIP WITH THE CITY OF BOSTON

The Boston Women's Workforce Council (BWWC) is an initiative of the Hariri Institute. It is connected within the Hariri ecosystem and can utilize the Institute's data science expertise in the form of faculty researcher expertise, facilities, and administrative support. It also has an extended network in an external ecosystem as a public-private partnership between Mayor Martin J. Walsh and the Boston business community and conducts biennial reports on the wage gap in the greater Boston area.

### RECOGNIZING COMPANIES WHO DEMONSTRATE EFFECTIVE PRACTICES TO CLOSE THE GENDER PAY GAP

This past year we were most proud of launching an annual application process in April 2018 to recognize companies that demonstrate outstanding contributions and achievements for effective practices and innovative initiatives to either closing the gender pay gap and/or creating new opportunities for women within the company.

Additionally, the BWWC kicked the year off by hosting an Ideathon - at the Questrom School for Business at Boston University. The event's purpose was for employers who were seeking to gain a deeper understanding of tech solutions advancing women in the workplace.

### BUILDING ON A SOLID FOUNDATION

In the upcoming year, we are looking forward to embarking on another Biennial Wage Gap Measurement to produce their 4th wage gap analysis report. In late fall 2019, they will also be introducing an industry breakdown through which signers in heavily-represented industries will be able to measure themselves against their industry average. In partnership with State Street's Professional Women's Network, the BWWC is also taking the winning initiatives from the Innovative Initiatives application process and creating a blueprint/playbook that presents best practices applicable to industry and size of companies. Borne out of the blueprint/playbook, the BWWC will develop a series of workshops for members.





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