



# IMPACT REPORT

2017 / 2018



## ELECTRICAL & COMPUTER ENGINEERING



**FOLLOW  
OUR FACULTY**

**READ UP ON  
OUR RESEARCH**



**LEARN ABOUT  
OUR ACADEMICS**



# Department Highlights



## ECE CHAIR PROFESSOR W. CLEM KARL

2017/2018 was another year of compelling advancement for the Department of Electrical and Computer Engineering at Boston University. We continued our growth with the successful hiring of three new, dynamic faculty members (introduced on page two). These hires span the critical areas of data science, low-power Internet-of-Things electronics, and cybersecurity. Our growth in data science builds on our Institutional Data Science Initiative (DSI)—a multi-year, interdisciplinary, BU-wide effort to positively impact this domain, and will eventually include a dedicated building on our campus. We were awarded a new, \$20 million, NSF-funded Engineering Research Center aimed at transforming cardiovascular care through nanotech-engineered tissue. ECE faculty impacts continued to be recognized by their peers with a variety of awards and fellowships. Our academic offerings also continued their expansion, with our undergraduate and graduate programs continuing to exhibit double-digit growth even when our selectivity increased. Have a look at our faculty, our research, and our programs!

### FACULTY

#### FACULTY GROWTH

**↑10**

New Faculty  
In 3 Years

#### FACULTY IN NUMBERS

**54**

Total  
Faculty

### RESEARCH

#### FUNDING GROWTH

**↑14%**

Average Annual Growth  
Rate Over 10 Years

#### GRANT FUNDING

**\$27M**

Total Over  
Twelve Months

### ACADEMICS

#### ELECTRICAL ENGINEERING

**#17** **↑9**

Graduate  
Rank\*

Rank Up 9  
Spots in 6  
Years\*\*

#### COMPUTER ENGINEERING

**#16** **↑11**

Graduate  
Rank\*

Rank Up 11  
Spots in 6  
Years\*\*

#### STUDENT POPULATION

**778** **↑13%**

Total  
Student  
Enrollment

Average Annual  
Growth Rate  
Over 7 Years

#### PHD

**126** **↑20%**

PhD  
Enrollment

Average Annual  
Growth Rate  
Over 7 Years

Source: USNWR | Private Institutions\* | Public and Private Institutions\*\*



# NEW FACES



## DATA SCIENCE

Assistant Professor Francesco Orabona was selected from a variety of candidates for our Junior Data Science Fellow. His current research aims to reduce and ultimately eliminate the constant need for a person to "hand-tune" the myriad of "knobs" in complex machine learning algorithms that are widely used today. His work has shown deep connections between

optimal sequential investment and high-dimensional machine learning problems, which led to the development of autonomous online learning algorithms requiring minimal human supervision. It is the first of its kind, and has already had a significant impact in theory and practice. It is even part of Microsoft's current Machine Learning Toolkit, which is emerging as the de facto standard in the industry.



## FAKE NEWS & CYBERSECURITY

Assistant Professor Gianluca Stringhini marries software security with data-driven approaches, revealing novel insights into malicious behavior on the Internet. His research identifies and analyzes fake news, hate speech, and cyberbullying, leading to new results that show strong correlation and synchronization of malicious behavior

across Reddit, YouTube, and other social media networks. Gianluca's work on identifying malware propagation behaviors, along with his research on defenses against the severe threat of ransomware, and his novel analyses to identify malicious mobile applications, give him a well-rounded and strongly interdisciplinary research agenda.



## INTERNET OF THINGS (IOT)

Assistant Professor Rabia Yazicigil's research focuses on wireless integrated systems and extreme circuits. She creatively combines analog and RF circuit designs with system-level solutions, particularly in digital signal processing and in security for energy-constrained IoT applications. Because of her novel RF architecture designs, Professor

Yazicigil recently enabled secure wireless communications for connectivity-in-everything and addressed the wireless spectrum crunch. Her research is strongly interdisciplinary and develops unique application-driven system solutions that are realized in integrated hardware implementations.

## THE DATA SCIENCE INITIATIVE

Everywhere we look, from the way we deliver healthcare to our strategies for sustaining cities, managing supply chains and assessing how students learn, Big Data is transforming our ability like never before to think critically, plan effectively, and quickly make informed decisions on millions of everyday challenges. Data Science ties together hundreds of existing disciplines to help scientists, engineers, physicians, professionals, and researchers of virtually every background create new efficiencies and design smart solutions in real time. BU's Data Science Initiative (DSI) seeks to exploit ECE's existing strengths and further expand its capacity to compete and lead in the Big Data revolution as a globally recognized leader in interdisciplinary research. DSI supports the hiring of faculty members who will complement and expand BU's footprint in data science research. Orabona was chosen because his work in Data Science is extremely broad, from mathematical foundations of learning theory and data science, to its applications in contemporary scientific, societal and real-world engineering problems. His work spans a wide-variety of areas including online, active, and deep learning, computer vision, and robotics.





# Faculty Recognition



## NEW NAI FELLOW

**Professor David Bishop**, Director of the CELL-MET Engineering Research Center and Head of the Boston University Division of Materials Science & Engineering, is now a National Academy of Inventors (NAI) Fellow. The NAI Fellows Selection Committee inducted Bishop because he has “demonstrated a highly prolific spirit of innovation in creating or facilitating outstanding inventions that [have] made a tangible impact on quality of life, economic development, and the welfare of society.”



## IEEE SIGNAL PROCESSING SOCIETY BEST PAPER AWARD

**Associate Professor Vivek Goyal** was a co-recipient of a 2017 IEEE Signal Processing Society Best Paper award for an article entitled “Message-Passing De-Quantization with Applications to Compressed Sensing” published in IEEE Transactions on Signal Processing. The article develops a novel framework for the estimation of a random vector from quantized linear measurements. This could lead to next-generation sensor systems with greatly reduced memory, communication, and power requirements, and significantly impact smart cities, medical diagnostics, ecological monitoring and more.



## EARLY CAREER AWARD WINNER

**Associate Professor Ayse Coskun** won the 2017 IEEE CEDA Ernest S. Kuh Early Career Award for her sustained and outstanding contributions to energy-efficient system-level design. This award honors an individual in the early stages of his or her career who has made innovative and substantial technical contributions to the area of Electronic Design Automation. Professor Coskun’s work includes temperature-aware design and management, 3D-stacked system design, and management of large-scale computing systems.



## OSA

## FELLOWS

**David Boas, Luca Dal Negro, and Selim Ünlü Elected Fellows of The Optical Society (OSA)**

“Fellows are members who have served with distinction in the advancement of optics and photonics. No more than 10 percent of the total OSA membership may be chosen as Fellows, making the process both highly selective and competitive.” -OSA

# FACULTY IN NUMBERS



## FACULTY ON THE RISE:

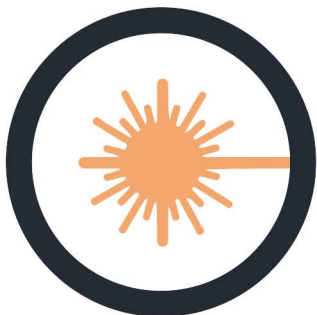


### NEW: AIMBE Fellow

Professor and Chair W. Clem Karl was elected to the American Institute for Medical and Biological Engineering (AIMBE) College of Fellows, comprised of the top 2% of medical and biological engineers in the country. This election marks Karl with one of the highest professional distinctions accorded to a medical and biological engineer. "I'm honored to be chosen as an AIMBE Fellow and thrilled to join the growing group of Fellows at Boston University," says Professor Karl. "The collaborative environment provided by BU College of Engineering has allowed me to thrive in the interdisciplinary world of Biomedical Engineering. It's an exciting and impactful discipline."



# Research Focuses



## PHOTONICS, ELECTRONICS AND NANOTECHNOLOGY

Photons, the fleeting particles of light, are the communicators of the universe. They let us still see the remnants of the Big Bang, and are instrumental in carrying the information load of the internet at blazing speeds. They are also our most sensitive fine-toothed probes in both space and time into the world around us, from radio astronomy to microscopic biological imaging and semiconductor chip fabrication.



## DATA SCIENCE AND INTELLIGENT SYSTEMS

The abundance of sensors around us, from traffic cameras to Fitbits, open unprecedented opportunities for smart cities, smart homes, and smart healthcare. By integrating intelligent computation, data science and machine learning, this wealth of sensor data can help us mitigate highway congestion, reduce HVAC energy use, develop visible-light communication, study the human brain, and deliver personalized medicine.



## MOBILE/CLOUD COMPUTING AND CYBERSECURITY

Computational and network sciences play a central role in tackling the challenges arising from pervasive computing across different scales such as cloud and mobile computing. Compared to the stationary, local computing of the past, this new computing diversity has created new challenges in terms of reliability and energy efficiency, but also in terms of security and privacy.



## IMAGING AND OPTICAL SCIENCE

Today, novel light-sensing modalities help us discover new biological phenomena, empower vision for driverless cars, and facilitate recognition of human activities without violating individuals' privacy. Tomorrow's technology will allow us to "see" through walls and measure heart-rate without contact. These advances are made possible by integrating novel sensing materials, optoelectronic devices and computational algorithms.



## BIO-ECE AND DIGITAL HEALTH

While a deep understanding of and interaction with biological systems has evaded humanity for centuries, the modern tools and methods of Electrical and Computer Engineering (ECE) seem to be on the cusp of a breakthrough. Today's Bio-ECE techniques strive to gain better insight into the human brain, design artificial neural systems inspired by modern neuroscience, develop new biomaterials and biosensors, and deliver smart healthcare.

# RESEARCH THAT CHANGES THE WORLD



When we succeed, that's going to be an awful lot of people alive for their grandchildren's weddings.

– David Bishop, ECE



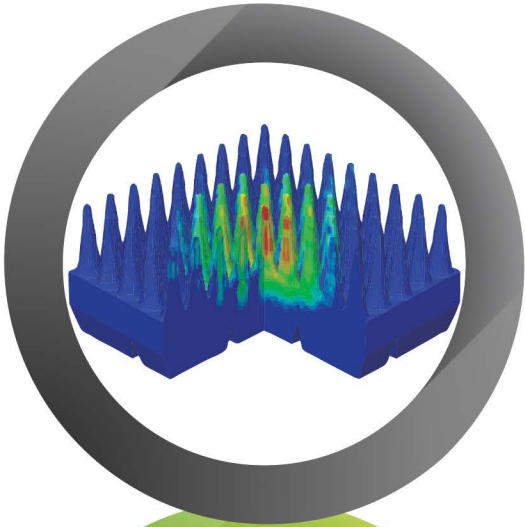
Research

## NEW NSF ENGINEERING RESEARCH CENTER FOCUSES ON FIXING FAILING HEARTS

BU ECE won a \$20 million award from the National Science Foundation (NSF) to host a new multi-institution Engineering Research Center (ERC) tasked with synthesizing personalized heart tissue for clinical use. The grant is renewable for a total of 10 years and \$40 million. “We’re trying to create cardiac patches,” says the center’s Director, David Bishop. “Thousands of people around the world die from heart attacks every day. We’re trying to create a solution for that. That’s solving a world-class, big-time problem.” The project aims to transform cardiovascular care by combining breakthroughs in nanotechnology and manufacturing with tissue engineering and regenerative medicine. By using the latest multiscale 3D printing technologies to engineer scaffolds, cells can be guided to assemble into complex tissues that exhibit desired behaviors.



# Research Snapshot



## CENTER FOR SEMICONDUCTOR MODELING OF MATERIALS & DEVICES

Today, semiconductor-based electronic devices play a pivotal role in various defense, security and commercial applications. While computer simulation tools are extensively employed to design and optimize such devices, these tools are decidedly immature for non-silicon semiconductors. This often leads to excessive manufacturing costs due to a flawed design and development process. To address this, a new Center for Semiconductor Modeling of Materials and Devices funded by the U.S. Army Research Laboratory and headed by Professor Enrico Bellotti is developing new methodologies that will allow for a faster and more effective device development process.



## GENETIC CIRCUIT DESIGN AUTOMATION

The Living Computing Project, which was awarded a \$10 million grant from the National Science Foundation, will develop technology for systems that can harness evolution, adaptation, replication, self-repair, and more. According to Professor Douglas Densmore, the Lead Principal Investigator on the project, "when you think about it, cells are kind of computers themselves, [and] by turning them into circuits, we've figured out a way to make cells that respond the way we want them to. What we are looking at with this study is how to describe those circuits using a programming language and to transform that programming language into DNA that carries out that function."



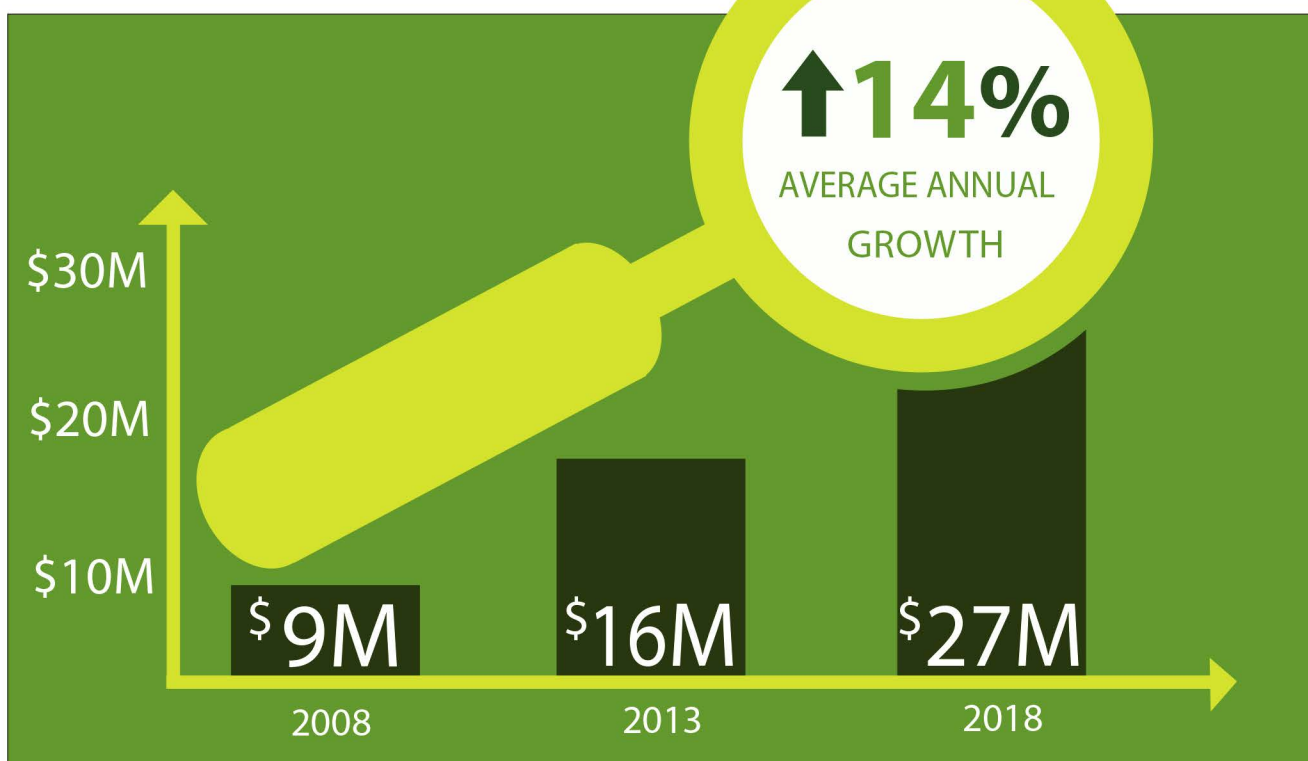
## "IT'S THE HITS TO THE HEAD, NOT CONCUSSIONS, THAT TRIGGER CTE"

A new study that suggests chronic traumatic encephalopathy (CTE) is caused by head injuries and not by concussions, explains why 20% of athletes in early stages of the illness, and whose brains were examined post-mortem, never had a concussion. Professor Janusz Konrad and PhD graduate Amanda Gaudreau-Balderrama (ENG '17) contributed to the study. It asserts that any head injury can cause blood vessels to leak proteins into adjacent brain tissues, inflaming them. CTE is commonly found in athletes, soldiers, and others with a history of repeated concussions and brain trauma. It is associated with dementia, mood changes, and aggression. According to this finding, efforts that center on protecting athletes from concussions should focus more on preventing repeated hits to the head.



# GRANTS OVERVIEW

## RESEARCH FUNDING



Research

## DIVERSE FUNDING PROFILE



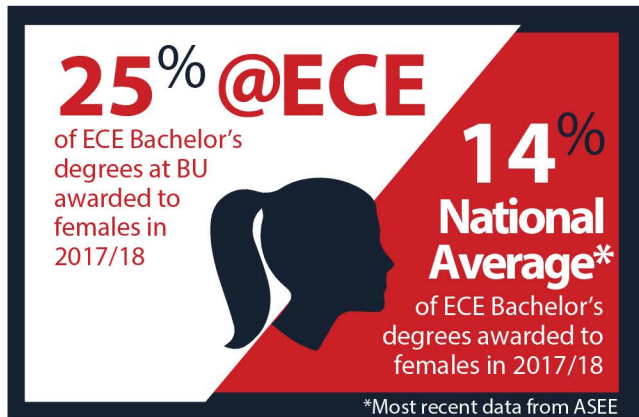
# Academic Excellence

## ENROLLMENT PER DEGREE

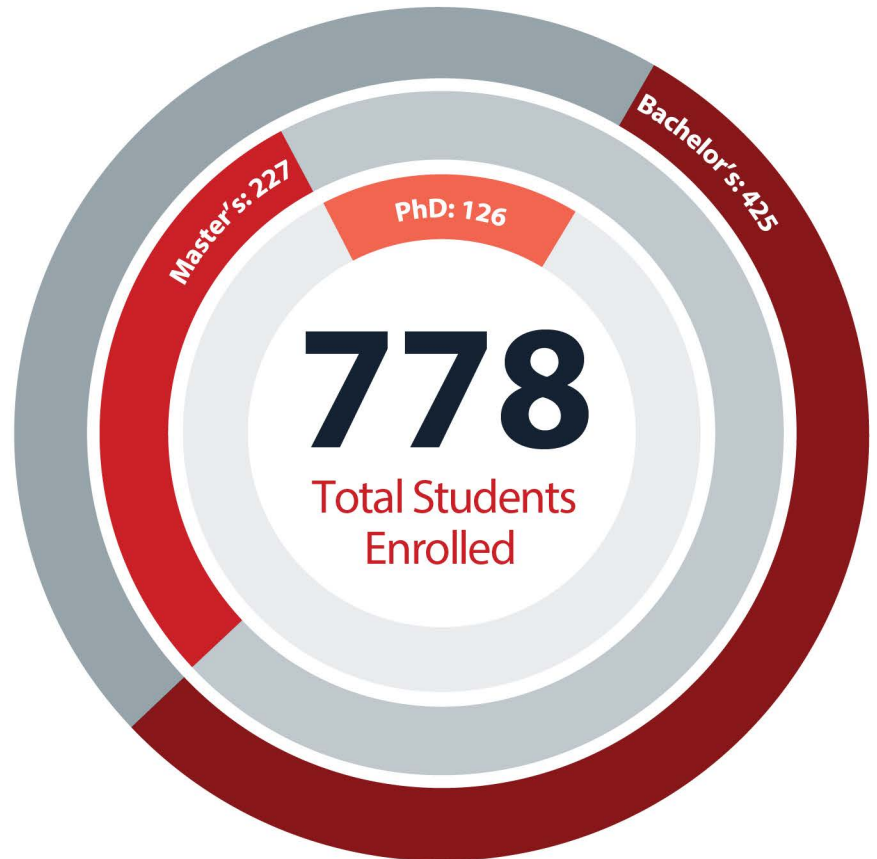


average annual enrollment growth over 7 years

## More BU Women Earn ECE Bachelor's Degrees than the National Average



## CURRENT STUDENT POPULATION



## CREATING THE SOCIETAL ENGINEER®

Societal Engineers are problem solvers with the skills necessary to make a life-long impact and move society forward.

Seniors in ECE offer their skills to solve various engineering problems both around Boston and across the world. They work with a customer to research, design and prototype a solution to some specific challenge.

### Best ECE Senior Design Award:



#### TEAM COMPOS:

Created an adaptive, indoor localization system, using a network of beacons, a server, webpage, and wearable devices for Alzheimer patients in order to alert caregivers about abnormal behavior and movement patterns.

### Entrepreneurial Award:



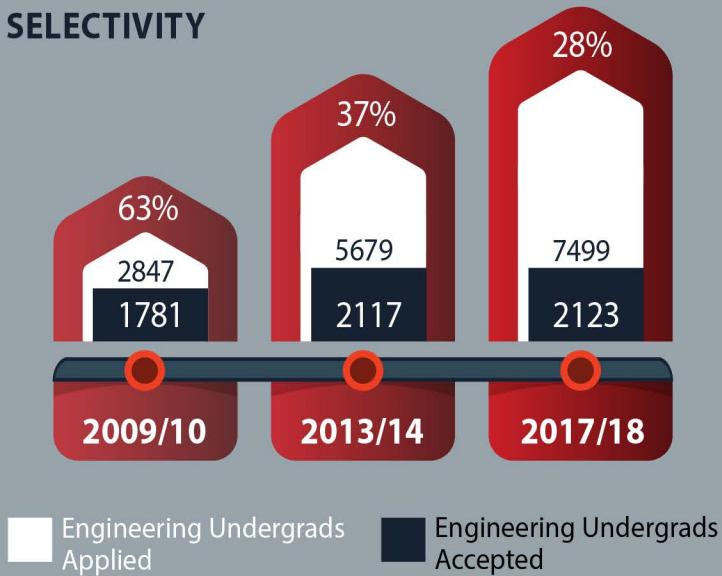
#### TEAM UBRU:

Developed a prototype of a fully-automated, networked espresso machine, able to create and store user profiles in the cloud to provide coffee drinkers with their personalized, favorite shot of espresso from any Barista device.

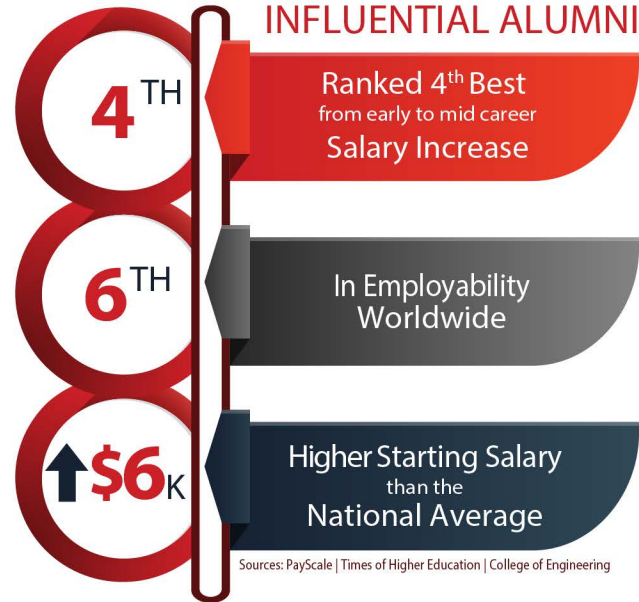


# ADVANCED COLLEGE STANDING

## INCREASING UNDERGRADUATE SELECTIVITY



## INFLUENTIAL ALUMNI



## GLOBAL CAMPUS:

**89 Students Studied Abroad in 2017/18**



## ECE Senior Design Project Excellence Awards:



### Team LaserTrac:

Developed a method of optical tracking for unmanned aerial vehicles to maintain bidirectional optical communication between moving targets, potentially useful for providing internet access to disaster areas.



### Team Smart Loo:

Developed sensors that monitor real-time supply levels of restroom inventory in order to reduce waste and scheduling inefficiency by predicting maintenance needs for specific locations.



### Team Smart Lending Locker:

Created a device and method to automatically lend laptops to students; the locker status and logs were made accessible through a smartphone app.



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## **\$1M ARPA-E Contract: 3-Year Project to Develop COSSY**

BU ECE is developing a Computational Occupancy Sensing SYstem (COSSY). This system of sensors can estimate the number of people in a room and adjust air flow in heating, ventilation and air conditioning (HVAC) appropriately, with the goal of saving energy. The project is funded by a \$1 million grant from the Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) in order to reduce HVAC energy usage, which accounts for 37% of energy consumed in commercial buildings in the United States.

# get the whole story...

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