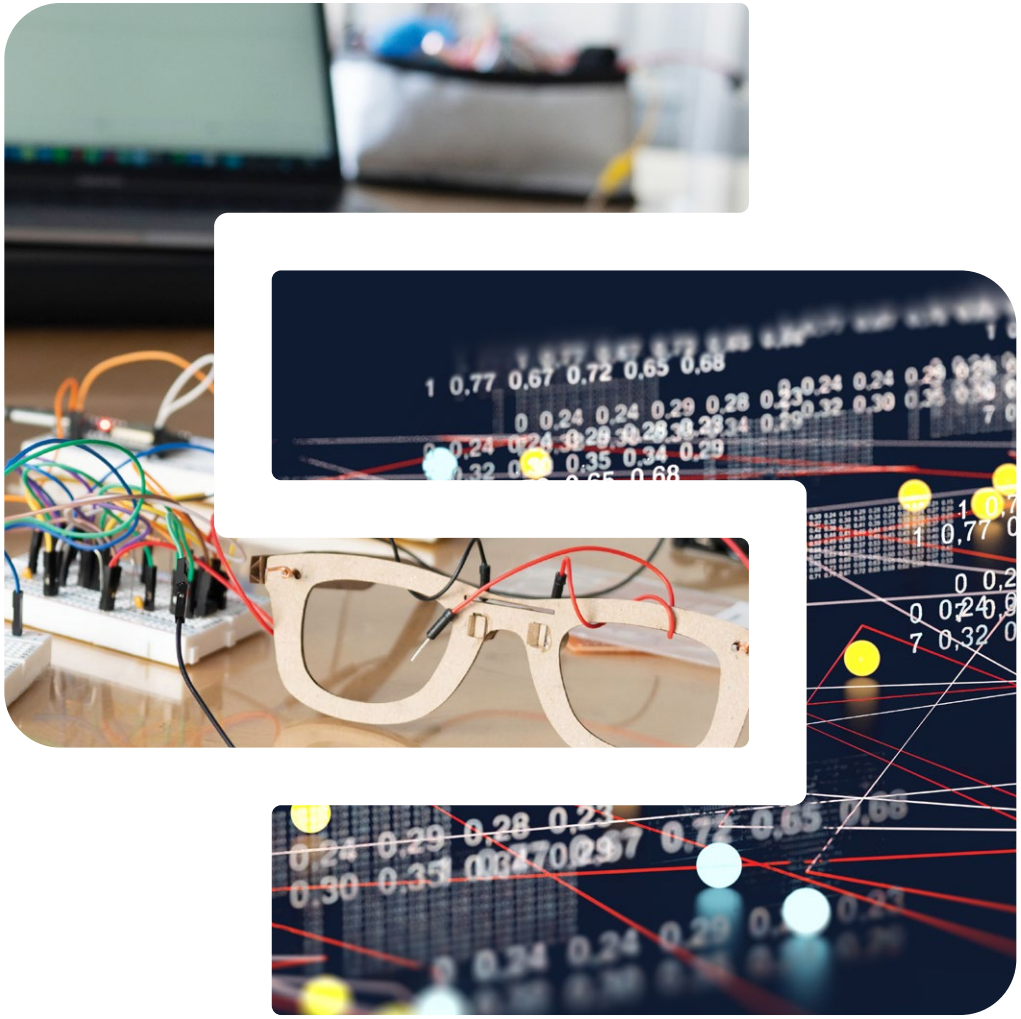
Impact Report
2020–2021



MIT Schwarzman College of Computing


MIT Schwarzman
College of Computing

The college aims to educate students who are fluent both in the "language" of computing and that of their disciplines.

When the MIT Stephen A. Schwarzman College of Computing was launched in 2019, the largest change at the Institute in three-quarters of a century, nobody could have predicted that the new college would be getting off the ground in the throes of the worst pandemic in the last hundred years. Yet amid all the societal, individual, and academic challenges, MIT's problem-solving spirit prevailed. It has been truly amazing to see what we have been able to accomplish together, from facilitating groundbreaking new research, to developing cross-cutting classes and curricula, to creating frameworks for understanding the social and ethical issues in computing technologies, to hiring outstanding new faculty.

While this is just the beginning, the scale and scope of change that we are already realizing with the Schwarzman College of Computing is only made possible by the talent and dedication of so many in the MIT community. I continue to be thankful to the faculty, students, staff, researchers, and friends who are so central to this exciting progress. I am particularly grateful to Anantha Chandrakasan, dean of the School of Engineering, who laid the groundwork for the college and continues to be critical to its achievements.

This impact report represents a synthesis of the college's activities over the course of the 2020–2021 academic year and how through its pedagogy, collaborations, and community, the college is leading the transformation of education and research in computing and artificial intelligence. It was a year in which we saw significant milestones, including powerful new pilot courses to educate students who are fluent both in the "language" of computing and that of their disciplines, as well as the launch of a case study series on social and ethical responsibilities of computing to spark discussion in the classroom and beyond.

We also welcomed a number of extraordinary new faculty members to the Institute—some of whom are shared between the college and an academic department or school. The shared faculty positions present an unprecedented opportunity to develop crucial areas at MIT that connect computing with other disciplines and will help to form and strengthen cross-departmental ties. There is much more to share as you will see in the following pages.

A look back at what we have accomplished is a reminder of our potential for future endeavors. I hope it inspires you to join us and engage with the MIT Schwarzman College of Computing in the coming year.

Sincerely,

Daniel P. Huttenlocher SM '84, PhD '88

Dean, MIT Schwarzman College of Computing
Henry Ellis Warren (1894) Professor of Electrical Engineering and Computer Science

Organizational Structure

The MIT Stephen A. Schwarzman College of Computing is propelling a rapid evolution of computing education and research programs, improving collaboration between computing and other disciplines, and advancing the study and practice of social and ethical responsibilities of computing. The college's structure is both cross-cutting across all of MIT and a focused home for computer science and artificial intelligence (AI) education and research.

The College Mission

Supporting rapid growth and evolution of computing fields, notably computer science and AI, through coordination and collaboration of efforts such as curriculum development

Facilitating computing collaborations, including cross-cutting research activities and educating computing "bilinguals," across all five schools at MIT and beyond

Focusing on social and ethical responsibilities of computing, blending humanist, social science, policy, and technical perspectives into its teaching, research, and implementation

The college is structured around three key focus areas that, together, are meeting the opportunities and challenges posed by today's and tomorrow's computing technologies. The college is facilitating the coordination and alignment of existing computing education and research at MIT, providing opportunities for improvement, and introducing programs and units to address emerging and cross-cutting areas. The college's structure will be assessed and revised regularly to address the rapidly changing landscape of the field.

Units of the College

ACADEMIC

- Department of Electrical Engineering and Computer Science, joint with the School of Engineering

  Faculties: Electrical Engineering, Computer Science, Artificial Intelligence and Decision-Making

- Institute for Data, Systems, and Society

  Technology and Policy Program

  Statistics and Data Science Center

- Operations Research Center, joint with the MIT Sloan School of Management
- Center for Computational Science and Engineering

RESEARCH

- Abdul Latif Jameel Clinic for Machine Learning in Health
- Computer Science and Artificial Intelligence Laboratory
- Laboratory for Information and Decision Systems
- MIT-IBM Watson AI Lab, joint with the School of Engineering
- MIT Quest for Intelligence
- Sociotechnical Systems Research Center

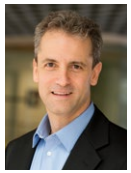
Leadership News

Dimitris Bertsimas SM ’87, PhD ’88
Co-lead, Abdul Latif Jameel Clinic for Machine Learning in Health

Dimitris Bertsimas SM ’87, PhD ’88, the Boeing Leaders for Global Operations Professor of Management at the MIT Sloan School of Management, is the new faculty lead for entrepreneurship in MIT’s Abdul Latif Jameel Clinic for Machine Learning in Health. Bertsimas led a team of MIT researchers who worked with Janssen on a machine-learning model that played a key role in the clinical trial process for the Johnson & Johnson Covid-19 vaccine. Scientists at Janssen Research & Development worked with MIT to apply AI and machine learning to help guide the company’s research efforts into a potential vaccine.

Fotini Christia
Director, Sociotechnical Systems Research Center

Fotini Christia, the Ford International Professor in the Social Sciences, is the new director of the Sociotechnical Systems Research Center, which studies high-impact, complex societal challenges. Christia’s research into the political economy of conflict and development in the Muslim world has entailed extensive fieldwork in Afghanistan, Bosnia-Herzegovina, Iraq, and Yemen. She currently is using cellphone and social media data to research refugee return in Syria and gender-based violence in Egypt during Covid-19.



James DiCarlo
Director, MIT Quest for Intelligence

James DiCarlo, the Peter de Florez Professor of Neuroscience, has been appointed director of the MIT Quest for Intelligence as it seeks to discover the basis of natural intelligence, create new foundations for machine intelligence, and deliver new tools and technologies for humanity. As director, DiCarlo will forge new collaborations with researchers within MIT and beyond to accelerate progress in understanding intelligence and developing the next generation of intelligence tools.

Sertac Karaman SM ’09, PhD ’12
Director, Laboratory for Information and Decision Systems

Sertac Karaman SM ’09, PhD ’12, associate professor of aeronautics and astronautics, is the new director of the Laboratory for Information and Decision Systems, an interdepartmental research center committed to advancing education and research in the analytical information and decision sciences. Karaman’s research interests lie in the broad areas of robotics and control theory, with applications in driverless cars, unmanned aerial vehicles, distributed aerial surveillance systems, and air traffic control.

Ankur Moitra SM ’09, PhD ’11
Director, Statistics and Data Science Center

Ankur Moitra SM ’09, PhD ’11, the Norbert Wiener Professor of Mathematics, is the new director of the Statistics and Data Science Center. Moitra works at the interface between theoretical computer science and machine learning by developing algorithms with provable guarantees and foundations for reasoning about their behavior. His research spans a diverse range of topics, including spectral and tensor methods, optimization, high-dimensional statistics, sampling, inference, and combinatorics.

Unit Highlights

A New Center Established to Advance Predictive Simulation Research

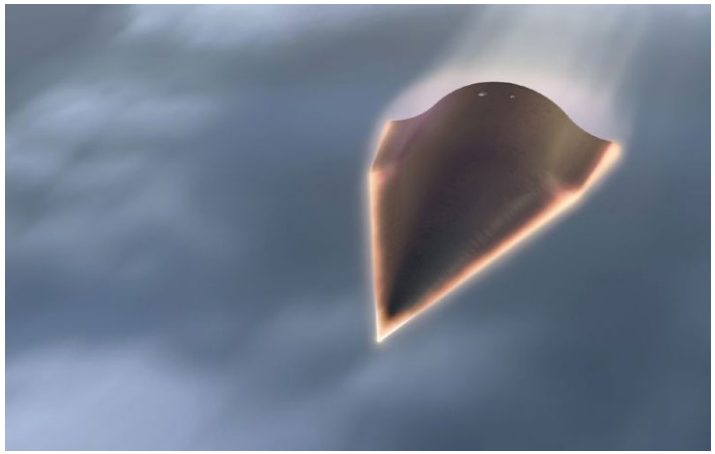
Predicting how materials will hold up under the most strenuous conditions is a scientific problem with major technological applications ranging from spaceflight to industrial and nuclear safety. Computational modeling and simulation are indispensable tools. The new Center for the Exascale Simulation of Materials in Extreme Environments in the college brings researchers together to connect quantum and molecular simulations of materials with advanced programming languages, compiler technologies, and software performance engineering tools. Leading the project as principal investigator is Youssef Marzouk ’97, SM ’99, PhD ’04, professor of aeronautics and astronautics and co-director of the Center for Computational Science and Engineering. There is participation from faculty and researchers spanning five MIT departments and the college, with eight individuals serving as co-principal investigators from the Center for Computational Science and Engineering, the Computer Science and Artificial Intelligence Laboratory (CSAIL), and the Statistics and Data Science Center.

CSAIL Launches Future of Data, Trust, and Privacy Consortium

Strategic use of data is vital for progress in science, commerce, and even politics, but at the same time, citizens are demanding more responsible, respectful use of personal data. The Future of Data, Trust, and Privacy is a lab effort that brings state-of-the-art MIT computer science research together with world-leading public policy expertise and engagement. Led by MIT principal investigators Daniel J. Weitzner and Srini Devadas, the initiative will promote collaboration between experts in five distinct technical areas: database systems, applied cryptography, AI and machine learning, data portability and new information architectures, and human-computer interaction.

EECS Readies New Major in AI+D

A new major in Artifical Intelligence and Decision-Making (AI+D) is being developed by the Department of Electrical Engineering and Computer Science (EECS) for introduction in fall 2022.

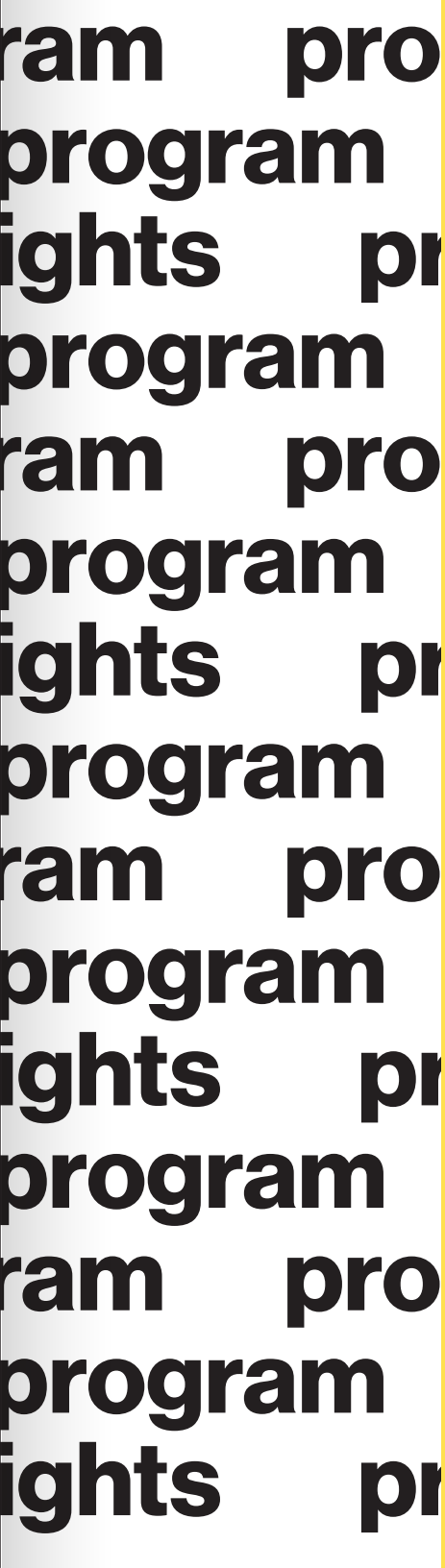


The new Center for the Exascale Simulation of Materials in Extreme Environments applies computational modeling and simulation to predict how materials will hold up under strenuous conditions such as flight.

Key objectives of the curriculum committee, chaired by Leslie Kaelbling, the Panasonic Professor of Computer Science and Engineering, include defining the new discipline of AI+D and designing the major from the ground up to incorporate mathematical and computational foundations through advanced methodological, empirical, and application-oriented subjects.

The discipline of AI+D develops techniques for the analysis and synthesis of systems that not only interact with an external world via perception, communication, and action, but that learn, make decisions, and adapt in a changing environment. AI+D integrates disciplines including electrical engineering, computer science, statistics, operations research, and brain and cognitive sciences. A successful AI+D curriculum is seen as training students in the mathematical and theoretical foundations and cutting-edge techniques and approaches of modern AI+D systems.

The college is coordinating computing education and engagement across MIT.



Program Highlights

The Schwarzman College of Computing has initiated an unprecedented push to coordinate computing education and engagement across MIT through more flexible, interconnected academic structures than conventional departments and schools. The college is building collaborations across MIT schools and departments as well as beyond campus through a variety of new programs and efforts, including Social and Ethical Responsibilities of Computing, Common Ground for Computing Education, and the AI Policy Forum.

A case study series from the Social and Ethical Responsibilities of Computing delves into a range of topics, from social and ethical implications of computing technologies and the racial disparities that can arise from deploying facial recognition technology in unregulated, real-world settings to the biases of risk prediction algorithms in the criminal justice system and the politicizing of data collection.

Social and Ethical Responsibilities of Computing

A cross-cutting area in the college, the Social and Ethical Responsibilities of Computing (SERC) advances responsible "habits of mind and action" for those who develop and deploy computing technologies while fostering the creation of technologies in the public interest.

Case Studies

A new SERC case study series, launched in February 2021, delves into a range of pertinent topics on the social and ethical implications of computing technologies, including the racial disparities that can arise from deploying facial recognition technology, the biases of risk-prediction algorithms in the criminal justice system, and the politicizing of data collection. The specially commissioned and peer-reviewed cases are brief and intended for undergraduate instruction across a range of classes and fields. They may also be of interest for computing professionals, policy specialists, and general readers.

An example in the inaugural series is the "Case of the Nosy Neighbors," which asks students to assume the role of a high-ranking, ethics-focused employee at a fictional, neighborhood-based social media company. It involves challenging ethical questions around how social media services and surveillance tools are built and used and the complicated relationships between companies, their users, and law enforcement.

“This is a time when we need to be exploring all possible avenues for how to teach MIT students to build technologies ethically. Being a part of SERC enabled me to help do just that: work with professors and students across the Institute to develop new models for ethical engineering pedagogy.”

Milo Phillips-Brown PhD ’19

Former Distinguished Postdoctoral Scholar in Ethics and Technology at MIT
Inaugural Recipient of the MAC3 Society and Ethics in Computing Research Award

“I’ve found there is a real desire among my peers to learn about, and think through, the ethical, social, and cultural implications of technology. I am incredibly excited that SERC is providing opportunities to have these conversations in the classroom setting, and I personally look forward to pulling from what I have learned working with SERC as I go forward in my career.”

Katherine “Katie” Collins ’21

Former undergraduate member of the Dean’s Action Groups on Social and Ethical Computing, which organizes cohorts of researchers from a variety of departments and fields of study to work together, discuss common research interests, and help create frameworks for incorporating ethics into computing and, more broadly, education at MIT.

SERC Scholars

A new SERC Scholars program is open to outstanding undergraduates, graduate students, and postdocs from across the Institute.

These SERC Scholars will represent the next generation of leadership in social and ethical issues in computing and will build a new community of expertise and scholarship across disciplines in this area. This multidisciplinary community will accelerate the impact of SERC, facilitating new collaborations for classroom, research, and engagement activities in social and ethical responsibility. SERC Scholars work on key activities that both expand on SERC's current work and launch new efforts.

In the coming year, the SERC Scholars' trajectory will be refined by considering the emerging models of the current students' participation to design undergraduate pathways, graduate-student pathways, and an expanded postdoc program. For each group, the goal is to craft sustainable-level effort over a semester that can build over time.

Cultivating the Next Generation of Leadership

Milo Phillips-Brown PhD '19, a participant in SERC, was named the inaugural recipient of the MAC3 Society and Ethics in Computing Research Award, which provides support to promising PhD candidates or postdocs conducting interdisciplinary research on the societal and ethical dimensions of computing. Phillips-Brown, who is now associate professor of philosophy in the Faculty of Philosophy and Department of Computer Science at the University of Oxford, was recognized for his work teaching responsible engineering practices to computer scientists.

AI Policy Forum

The rapidly increasing applicability of AI has prompted a number of organizations to develop high-level principles on social and ethical issues such as privacy, fairness, bias, transparency, and accountability. Building on those broader principles, the AI Policy Forum, a global effort convened by the MIT Schwarzman College of Computing, aims to provide tools and an overarching policy framework to help governments and companies.

In May 2021, the college hosted the first AI Policy Forum Symposium, which was devoted to equipping high-level decision makers to produce better public policy around AI and better AI systems with concern for public policy.

Over the course of two half-day virtual sessions, the symposium explored pressing policy issues regarding AI in our economies and societies, while examining three key focus areas in AI policy: mobility, finance, and health care. The symposium brought together leading AI and public-policy scholars; government officials and regulators from cities, states, countries, and international organizations; and civil society leaders and advocates.

Pablo Parrilo, the Joseph F. and Nancy P. Keithley Professor of Electrical Engineering and Computer Science, instructs students during a class in the Common Ground course Linear Algebra and Optimization.

Common Ground for Computing Education

Class enrollments in the Department of Electrical Engineering and Computer Science (EECS) are approaching an all-time high. However, not all enrollees are degree students of EECS majors. Students studying everything from life sciences to urban studies and planning know that programming skills and harnessing the power of machine learning are key components to a successful career.

The Common Ground for Computing Education, created through the MIT Schwarzman College of Computing, provides a mechanism for undergraduate and graduate students to pursue that valuable computational knowledge within the context of their fields of interest. It brings to the forefront rapidly changing computer science and AI fields together with the problems and methods of other disciplines. Facilitating multi-department collaboration, the Common Ground's main objective is to educate computing bilinguals, students who are fluent in both computing methodology and the fundamentals of their disciplines—a core component of the college mission.

The Common Ground Standing Committee is chaired by Jeffrey C. Grossman, head of the Department of Materials Science and Engineering and the Morton and Claire Goulder and Family Professor of Environmental Systems, and Asu Ozdaglar, SM '98, PhD '03, the Schwarzman College of Computing's deputy dean of academics, EECS department head, and MathWorks Professor of Electrical Engineering and Computer Science. It has 29 members from across campus, reflecting the interest and engagement in these efforts.

The committee worked together to develop mechanisms for engaging faculty across the Institute, laying the groundwork for a call for proposals. It is centered on three primary focus areas: Fundamentals of Computational Science and Engineering; Fundamentals of Programming/Computational Thinking; and Machine Learning, Data Science, and Algorithms.

“Modeling with Machine Learning is one of the few classes able to teach theory with immediate application in practice. The six-unit, paired-course format gave flexibility and allowed me to focus on exactly what I was interested in, showing how fundamental ML principles are used in research and industry.”

Jake Yasonik ’24

Course 6-7 Computer Science and Molecular Biology

Co-chairs across the three focus areas are Eran Egozy ’93, MNG ’95, professor of the practice in music technology; Rob Miller ’95, MNG ’95, Distinguished Professor of Computer Science; Ankur Moitra SM ’09, PhD ’11, the Norbert Wiener Professor of Mathematics; David Sontag SM ’07, PhD ’10, the Hermann Von Helmholtz Associate Professor of Health Sciences and Technology; David Darmofal SM ’91, PhD ’94, the Jerome C. Hunsaker Professor of Aeronautics and Astronautics; and Troy Van Voorhis, the Robert T. Haslam and Bradley Dewey Professor of Chemistry and head of the Department of Chemistry.

Many faculty members are eager to be involved in developing a new computing curriculum, and several courses have been piloted since the Common Ground was launched in January 2020:

- **Introduction to Computational Science and Engineering**
  Provides an introduction to computational algorithms for understanding scientific phenomena and designing engineering systems, drawing from diverse applications including mechanics, robotics, climate science, biology, aerospace, and others. Topics include computational algorithms to simulate time-dependent processes, optimization and control of physical systems, and quantification of uncertainty in problems involving randomness using probability and statistics.

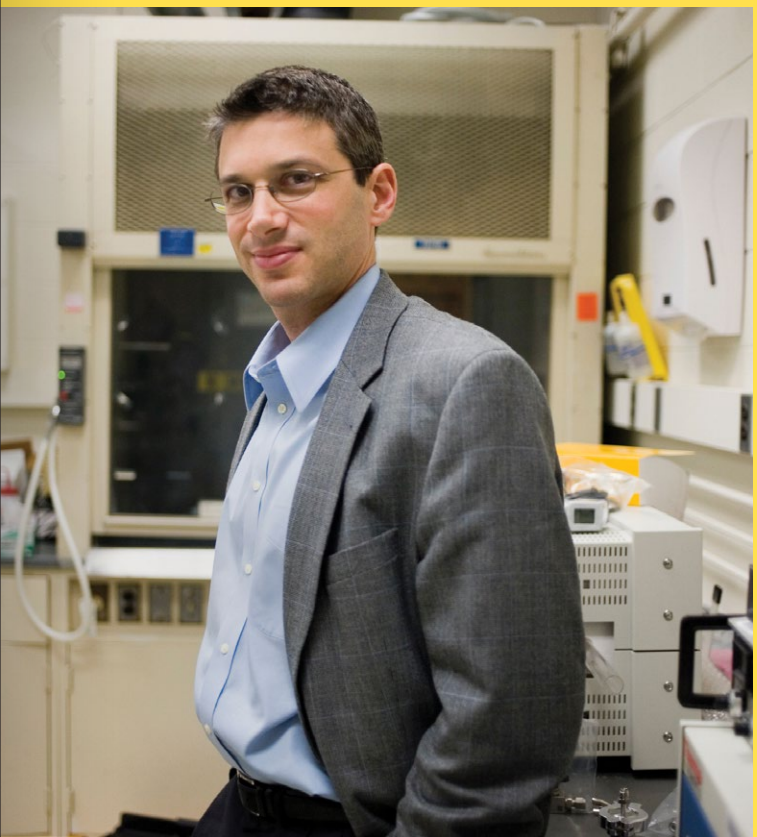
- **Linear Algebra and Optimization**
  A unified introduction to linear algebra and optimization and their interconnections, with a view towards modeling, computation, and applications. The subject integrates computational, geometric, and algebraic viewpoints. Topics include vectors, matrices, eigenvalues, singular value decomposition, principal component analysis, least squares, linear/quadratic programming, and convex optimization.

- **Modeling with Machine Learning: From Algorithms to Applications**
  Teaches students from a range of majors to translate a problem into a machine-learning formulation and find appropriate tools for solving it. Students enroll in two modules: the common core, which covers machine-learning fundamentals, and one of several different discipline-specific modules that build on the core material.

“The composition of the committee aligns with the mission of the Common Ground in that it draws from all parts of the Institute. Our work is enabling students to frame disciplinary problems using a rich computational framework and it has been wonderful to work with colleagues in different departments to pilot computing classes that are useful across a range of areas and support the educational mission of individual departments.”

Asu Ozdaglar SM ’98, PhD ’03

Deputy Dean of Academics, Schwarzman College of Computing
Head, Department of Electrical Engineering and Computer Science
MathWorks Professor of Electrical Engineering and Computer Science



“It has been great to work with colleagues from across campus on the Common Ground standing committee. I share their enthusiasm for pursuing the opportunities in computing education, and it is exciting to see MIT students having access to these new courses.”

Jeffrey C. Grossman

Head, Department of Materials Science and Engineering
Morton and Claire Goulder and Family Professor
in Environmental Systems

MIT researchers developed a hardware and software system that could reduce the computing power, energy, and time required for text analysis and generation.

Research Impact

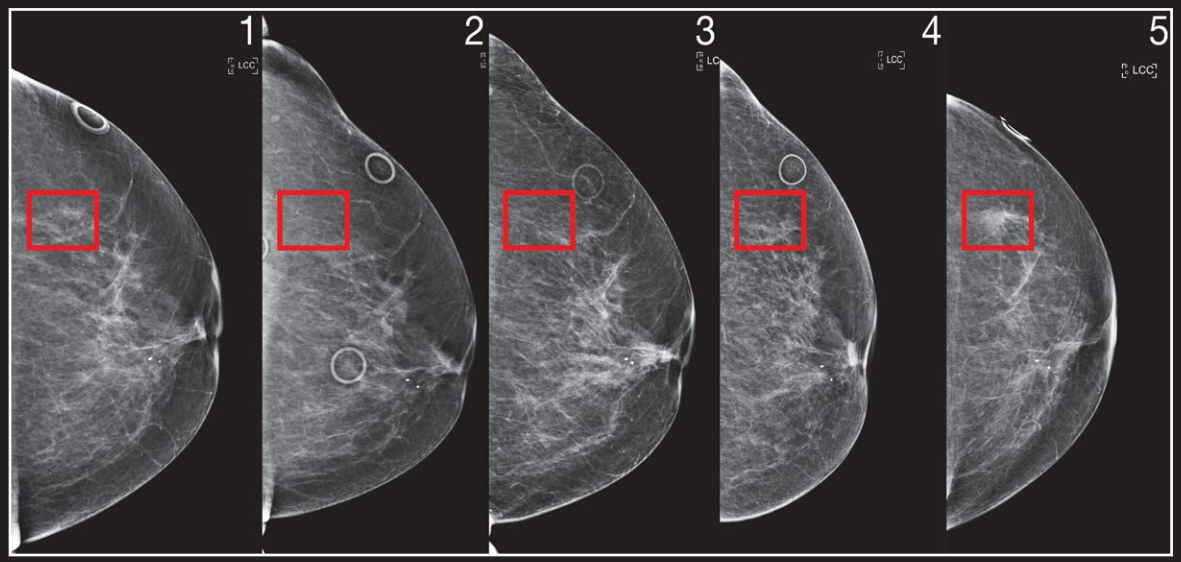
As humanity endeavors to meet global challenges ranging from climate change to Covid-19 to systemic inequality, computing is forging a path to novel solutions. The following research examples demonstrate the scope and impact of computing research undertaken by the labs, units, and centers in the MIT Schwarzman College of Computing, which is engaging faculty, students, and collaborators from across a vast array of disciplines.

Behind Covid-19 vaccine development

A machine-learning model developed jointly by Janssen and MIT data scientists played a key role in the clinical trial process for the Johnson & Johnson Covid-19 vaccine. Scientists at Janssen Research & Development worked with MIT researchers to apply AI and machine learning to help guide the company's research efforts into a potential vaccine. Dimitris Bertsimas SM '87, PhD '88, the Boeing Leaders for Global Operations Professor of Management at the MIT Sloan School of Management, who had developed a machine-learning model that tracks Covid-19 spread in communities, served as primary technical partner on the project.

Robust AI tools to predict future cancer

MIT researchers have improved their machine-learning system developed to predict cancer risk from mammogram images and validated its effectiveness with studies from several hospitals. Two years ago, scientists from MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) and the Abdul Latif Jameel Clinic for Machine Learning in Health demonstrated a deep-learning system that predicts cancer risk using just a patient's mammogram. The researchers hope improvements they have made to the "Mirai" algorithm will hasten the image-based risk model's wider adoption in clinical care.



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One-stop machine-learning platform turns health care data into insights

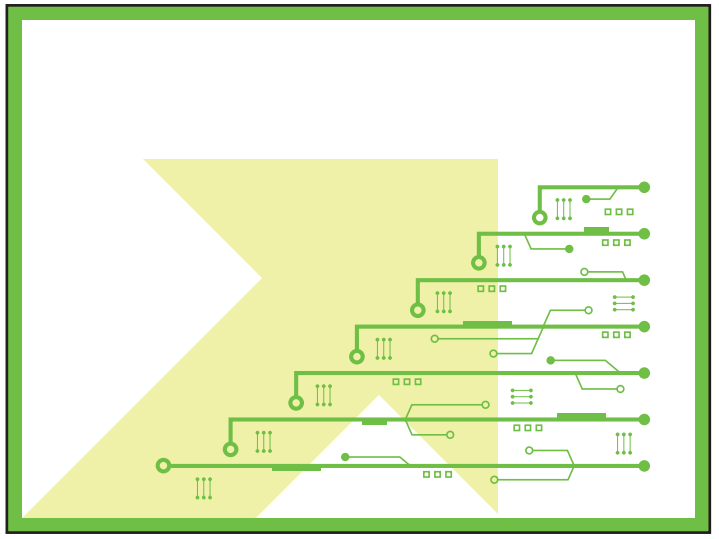
Cardea, a software system built by researchers and software engineers at MIT's Data to AI Lab in the Laboratory for Information and Decision Systems (LIDS) aims to bring the power of prediction to hospitals by streamlining complex machine-learning processes. By shepherding hospital data through an ever-increasing set of machine-learning models, the system could assist hospitals in planning for events as large as global pandemics and as small as no-show appointments.

Monitoring sleep positions for a healthy rest

A wireless device that captures sleep data without using cameras or body sensors could aid patients with Parkinson's disease, epilepsy, or bedsores. BodyCompass is the first home-ready, radio-frequency-based system to provide accurate sleep data without cameras or sensors attached to the body. It was developed by MIT researchers led by Dina Katabi SM '99, PhD '03, the Thuan and Nicole Pham Professor, and Shichao Yue SM '18, PhD '21.

Shrinking deep learning's carbon footprint

Deep learning has driven much of the recent progress in AI, but as demand for computation and energy to train ever-larger models increases, many are raising concerns about the financial and environmental costs. To address the problem, researchers at MIT and the MIT-IBM Watson AI Lab are experimenting with ways to make software and hardware more energy efficient, and in some cases, more like the human brain.



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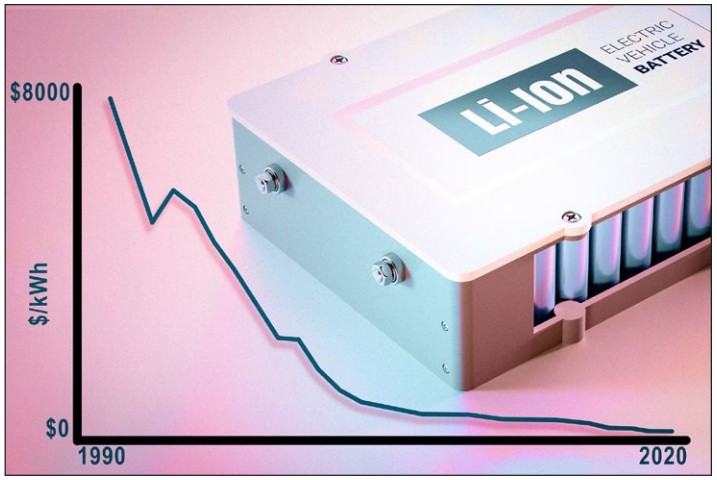


The price of lithium-ion batteries has declined 97% since 1991.

Study reveals plunge in lithium-ion battery costs

Attempting to quantify the dramatic cost decline of rechargeable lithium-ion batteries—the dominant rechargeable technology in today's world—has produced ambiguous and conflicting results that have hampered attempts to project the technology's future or devise policies and research priorities. Researchers in MIT's Institute for Data, Systems, and Society (IDSS) have conducted an exhaustive analysis of these studies to arrive at a clear picture of the technology's trajectory.

A language learning system that pays attention—more efficiently than ever before

The importance of key words underlies a popular new tool for natural language processing (NLP) by computers: the attention mechanism. When coded into a broader NLP algorithm, the attention mechanism homes in on key words rather than treating every word with equal importance. The attention mechanism's accuracy often comes at the expense of speed and computing power, however. It runs slowly on general-purpose processors. MIT researchers have designed a combined software-hardware system, dubbed SpAtten, specialized to run the attention mechanism. SpAtten enables more streamlined NLP with less computing power.

Toward a machine-learning model that can reason about everyday actions

Researchers have trained a model to reach human-level performance at recognizing abstract concepts in video. "We show that you can build abstraction into an AI system to perform ordinary visual-reasoning tasks close to a human level," says the study's senior author, Aude Oliva, a senior research scientist at MIT and MIT director of the MIT-IBM Watson AI Lab.

Making smart thermostats more efficient

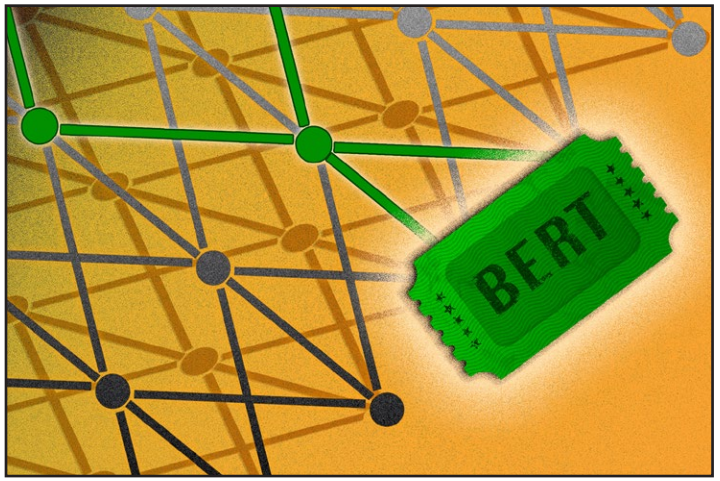
Researchers from LIDS, in collaboration with Skolkovo Institute of Science and Technology scientists, have designed a new smart thermostat that uses data-efficient algorithms that can learn optimal temperature thresholds within a week. The thermostat quickly learns to optimize building microclimates for both energy consumption and user preference. The algorithms developed for the thermostat employ a methodology called reinforcement learning, a data-driven sequential decision-making and control approach that has gained much attention in recent years for mastering games like Backgammon and Go.

Computational tools to combat systemic racism

The Initiative on Combatting Systemic Racism at MIT, led by Fotini Cristia, the Ford International Professor in the Social Sciences, is seeding and coordinating cross-disciplinary research on how to identify and overcome racially discriminatory processes and outcomes across a range of American institutions and policy domains. Building off the extensive social science literature on systemic racism, the focus is to use big data to develop and harness computational tools that can help effect structural and normative change towards racial equity.

Shrinking massive neural networks used to model language

As a branch of AI, natural language processing (NLP) aims to decipher and analyze human language with applications such as predictive text generation or online chatbots. The state-of-the-art neural network approach to NLP demands supercomputing power unavailable to most users. Jonathan Frankle, a PhD student in CSAIL, and colleagues report that hidden within that massive neural network are leaner subnetworks that can complete tasks efficiently, potentially lowering computing costs and increasing accessibility to NLP.



CSAIL researchers are working toward potentially lowering computing costs and increasing accessibility to natural language processing.

Researchers from the Imagination, Computation, and Expression Laboratory created a video game featuring a discriminatory racial encounter to guide clinicians toward a better understanding of adolescent behavior.

Examining racial attitudes in virtual spaces through gaming

Video games or virtual reality experiences that address racial issues are increasingly popular for educational or training purposes. Researchers from the Imagination, Computation, and Expression Laboratory, part of CSAIL and the MIT Center for Advanced Virtuality, have created a video game simulation of a discriminatory racial encounter between a Black student and her white teacher. The game, called Passage Home, is intended as an innovative tool for clinicians to better understand the behavioral choices adolescents make when encountering racial injustice.

Understanding how people make sense of information in the information age

Manon Revel SM ’19, a PhD student in LIDS and in IDSS, has been investigating the effect that “clickbait” ads in online news sites have on reader trust. Revel hopes the project will demonstrate the risk of losing readership in the long term to reap the short-term financial rewards of native ads that are designed to blend in with news stories but more often than not are clickbait.

Inequality across networks

As a child in Iran, Eaman Jahani witnessed a constant struggle for social equity and progress. He’s now a PhD student in the Social and Engineering Systems program in IDSS. Working with Alex “Sandy” Pentland PhD ’82, the Toshiba Professor of Media Arts and Science in the MIT Media Lab and in IDSS, and Dean Eckles, an MIT Sloan School of Management professor and an IDSS affiliate, Jahani explores how the structure of social networks can perpetuate inequality, especially the unequal distribution of resources. “Networks play an important role in access to opportunities,” he says. “I study how networks reinforce and even widen existing inequalities.”

Algorithm finds hidden connections between paintings at the Met

Researchers from CSAIL and Microsoft created an algorithm to discover hidden connections between paintings at the Metropolitan Museum of Art in New York and Amsterdam's Rijksmuseum. Inspired by a Rijksmuseum exhibit, *Rembrandt and Velazquez*, the MosAIc system finds paired or analogous works from different cultures, artists, and media by using deep networks to understand how "close" two images are. The researchers hope the project inspires others to think about how information-retrieval tools can be applied to other fields like the humanities, social science, and medicine.

CSAIL and Microsoft researchers created an algorithm to discover hidden connections between paintings at the Metropolitan Museum of Art in New York and the Rijksmuseum in Amsterdam.

Transforming quantum computing's promise into practice

William D. Oliver SM '97, professor of electrical engineering and computer science, is building a new class of computer—the quantum computer—with the potential to radically improve how we process information and simulate complex systems. Quantum computers can process information far faster than legacy computers, in some cases completing tasks in minutes where a classical computer would, in theory, take millennia. Oliver founded the Engineering Quantum Systems Group at MIT to focus on superconducting qubit technology. "Our mission is to build the fundamental technologies that are necessary to scale up quantum computing," he says.

Job connectivity improves resilience in US cities, study finds

Members of MIT's Connection Science Group in the Sociotechnical Systems Research Center have mapped the job landscapes in cities across the United States and showed that job "connectedness" is a key determinant of the resilience of local economies. The findings indicate job connectivity results in lower unemployment and contributes to a rise in overall wages and suggest that policy makers should consider this factor when planning for the future of work in their regions.

From robust research opportunities and programming to chances to engage with world-class new faculty, the college is offering students a broad array of experiences.

Community Highlights

The MIT Schwarzman College of Computing connects world-class researchers who are at the forefront of computing innovation and students who are channeling their passion for computer science and AI into solving the world's biggest challenges. Together, they are advancing the role of computing in progress toward a more equitable society.

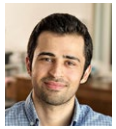
Students in the college are tapping into the knowledge of world-class educators who are working to redefine the state of the art in computing and applying their expertise at the intersection of computing and other fields of study.

Faculty

Faculty within the college are working at the forefront of computing research and at the nexus of computing and other disciplines. They are delivering the latest advances in computing and AI through groundbreaking research and educating our students to lead in the algorithmic future. From health care and economics to design and humanities, the work of our faculty in teaching and research crosses disciplinary boundaries to address critical challenges and opportunities facing the world today.

New Faculty

Four new faculty in the Department of Electrical Engineering and Computer Science (EECS), which jointly reports into the MIT Schwarzman College of Computing and the School of Engineering, have either recently started or have accepted a position at MIT.



Mohsen Ghaffari SM '13, PhD '17 joins MIT in EECS's Faculty of Computer Science in April 2022, arriving from ETH Zurich. Noted for his work on distributed and parallel algorithms, he received the 2017 Association for Computing Machinery (ACM)-European Association for Theoretical Computer Science Principles of Distributed Computing Doctoral Dissertation Award and earned honorable mention for the 2017 ACM Doctoral Dissertation Award. He received a 2019 starting grant from the European Research Council.

Mina Konakovic Lukovic joins MIT as an assistant professor in EECS's Faculty of Artificial Intelligence and Decision-Making (AI+D) in July 2022. She has been a Schmidt Science Postdoctoral Fellow at MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL), mentored by Professor Wojciech Matusik SM '01, PhD '03. Her research focuses on computer graphics, computational fabrication, 3-D geometry processing, and machine learning, including architectural geometry and the design of programmable materials.

Vincent Sitzmann joins MIT as an assistant professor in EECS's Faculty of AI+D in July 2022. He has been a postdoctoral associate with MIT professors Joshua Tenenbaum PhD '99; William T. Freeman PhD '92; and Frédo Durand, the Amar Bose Professor of Computing, at CSAIL. His research interests lie in the self-supervised learning of neural representations of 3-D scenes and their applications in computer graphics, computer vision, and robotics. His goal is to allow independent agents to reason about our world given visual observations, such as inferring a complete model of a scene with information on geometry, material, and lighting from only a few observations, a task that is simple for humans but currently impossible for AI.

Tess Smidt '12 joined as an assistant professor in EECS's Faculty of Electrical Engineering in August 2021. She was the 2018 Alvarez Fellow in Computing Sciences at Lawrence Berkeley National Laboratory, where she designed neural networks from first principles for rich data types such as geometry and scientific data. As an undergraduate at MIT majoring in physics and minoring in architecture, she engineered giant neutrino detectors in physics professor Janet Conrad's group and created a permanent science-art installation on MIT's campus called the *Cosmic Ray Chandeliers*.

New Faculty in Shared Positions

Searches are underway to fill 25 new faculty positions to be shared between the college and an academic unit in one of the five schools. Hires in 2020–2021 include:

Connor Coley SM '16, PhD '19, the Henri Slezynger Career Development Assistant Professor, joined the Department of Chemical Engineering (ChemE) in July 2020 and was formally appointed to a shared position between the college — in EECS's Faculty of AI+D — and ChemE in July 2021. Prior to his MIT arrival, he was a postdoctoral researcher at the Broad Institute of MIT and Harvard. His research interests are in how data science and laboratory automation can be used to streamline discovery in the chemical sciences.

Manish Raghavan joins as an assistant professor in a shared position between the college — in EECS's Faculty of Computer Science — and the MIT Sloan School of Management in September 2022. In fall 2021, he became a postdoctoral researcher at Harvard University's Center for Research on Computation and Society. His primary interests lie in the application of computational techniques to domains of social concern, including algorithmic fairness and behavioral economics, with a focus on the use of algorithmic tools in the hiring pipeline.

Nidhi Seethapathi joins as an assistant professor in January 2022 in a shared position between the college — in EECS's Faculty of AI+D — and the Department of Brain and Cognitive Sciences. She has been a postdoctoral researcher at the University of Pennsylvania. Her research goal is to build computational predictive models of human movement with applications in autonomous and robot-aided neuromotor rehabilitation. She will lead a research group at MIT to realize this goal through modeling and experiments.

Two Faculty Named to Endowed Chairs

The Schwarzman College of Computing has awarded named professorships to two faculty members in EECS. Dina Katabi and Aleksander Mądry are the holders of inaugural chaired appointments in the college in recognition for their work in computer science, electrical engineering, AI, and machine learning.

Dina Katabi SM '99, PhD '03 has been named the inaugural Thuan and Nicole Pham Professor. Katabi's work spans computer networks, wireless sensing, applied machine learning, and digital health. She is especially known for her work on a wireless system that can track human movement even through walls — a technology that has great potential for medical use. She is a member of the EECS faculty and is a principal investigator in CSAIL, as well as director of the Networks at MIT research group and co-director of the MIT Center for Wireless Networks and Mobile Computing.

Aleksander Mądry SM '09, PhD '11 has been named the inaugural Cadence Design Systems Professor. Established by Cadence Design Systems, Inc., the purpose of the position is to support outstanding faculty with research and teaching interests in the fields of AI, machine learning, or data analytics. Mądry's research spans algorithmic graph theory, optimization, and machine learning. In particular, he has a strong interest in building on existing machine-learning techniques to forge a decision-making toolkit that is reliable and well-understood enough to be safely and responsibly deployed in the real world. Mądry is a member of CSAIL and the Theory of Computation Group and is the director of MIT's Center for Deployable Machine Learning.

Faculty Spotlights

Regina Barzilay Honored by World's Largest AI Society

Regina Barzilay, the School of Engineering Distinguished Professor for AI and Health, received the Squirrel AI Award for Artificial Intelligence for the Benefit of Humanity, a $1 million award presented by the Association for the Advancement of Artificial Intelligence for individuals whose work in the field has had a transformative impact on society. Barzilay, who is also the faculty lead of AI for the Abdul Latif Jameel Clinic for Machine Learning in Health, was recognized for her work developing machine-learning models to develop antibiotics and other drugs and to detect and diagnose breast cancer at early stages.

Stefanie Mueller Changes Everything: A Hands-On Class Responds to Covid-19

Stefanie Mueller's hands-on building and fabrication class, 6.810 Engineering Interactive Technologies, is dedicated to interacting with technology in the physical world. The pandemic provided an "opportunity to rethink our teaching," says the EECS assistant professor. Students were sent bags of electronic components, carried out class discussions via Slack, and booked times in the International Design Center lab, which was deep-cleaned between visits. The faculty of 6.810 say rising to the challenges posed by the pandemic enhanced their own problem-solving skills, too, improving their pedagogy and leaving them with a lasting respect for their students.

The pandemic provided an opportunity to "rethink our teaching," says EECS professor Stefanie Mueller, who teaches the hands-on class 6.810 Engineering Interactive Technologies.

Devavrat Shah on Curbing Online Misinformation

The specter of fake news looms over many facets of modern society. Waves of online misinformation have rocked societal events from the Covid-19 pandemic to US elections. But it doesn't have to be that way, according to Devavrat Shah, a professor in EECS and the Institute for Data, Systems, and Society (IDSS). Shah researches the recommendation algorithms that generate social media news feeds. He has proposed a new approach that could limit the spread of misinformation by emphasizing content generated by a user's own contacts rather than whatever happens to be trending globally.

The college is educating students to be conversant in the language of AI and computing and other diverse disciplines.

Students

Many MIT students have passions beyond computer science but recognize the need to be adept in computing techniques and methodologies to pursue other interests, whether they be political science, economics, or urban science. The college is both strengthening the computing fields at MIT and more effectively and creatively connecting AI and computing to every discipline on campus.

Graduate Student Spotlights

- **Hammaad Adam**, a recipient of the Vanu Bose Fellowship and PhD student in IDSS, focuses his research on questions at the intersection of AI, health care, and systemic racism. His work has two broad goals: first, to highlight and investigate race-, gender-, and religion-based disparities in clinical care, and second, to use AI and machine learning to address the identified inequities. He has been working on these questions in the context of mental health, critical care, and organ allocation.

- **Alexander Amini '17, SM '18** and **Andrew Spielberg**, both PhD students in CSAIL, helped develop an algorithm to aid engineers in designing soft robots that collect more useful information about their surroundings. The deep-learning algorithm suggests an optimized placement of sensors within the robot's body, allowing it to better interact with its environment and complete assigned tasks.

- **R'mani Haulcy SM '19**, a MathWorks Fellow and PhD student in EECS, focuses her research on Alzheimer's disease. In the Spoken Language Systems Group within CSAIL, Haulcy uses machine learning to identify speech differences in people with cognitive impairments. "There are themes in speech that we're not able to hear, but models can pick up on them," she explains, noting machine learning can be used to distinguish one cognitive impairment from another, useful information for both clinicians and drug developers. Spotting Alzheimer's at earlier stages may help researchers find methods to slow the disease's progression or someday prevent it.

- **Ji Lin SM '21**, a PhD student in EECS, helped develop a system that could bring deep-learning neural networks to new—and much smaller—places, like the tiny computer chips in wearable medical devices, household appliances, and the 250 billion other objects that constitute the internet of things. Deep learning is the branch of AI that curates your social media and serves your Google search results, and soon could check your vitals or set your thermostat.

- **Tan Zhi Xuan**, a PhD student in EECS, helped create an algorithm capable of inferring goals and plans, even when those plans might fail. Part of the quest to capture social intelligence in machines, this type of research could eventually be used to improve a range of assistive technologies, collaborative or caretaking robots, and digital assistants like Siri and Alexa.

Undergraduate Advisory Group

Student input plays a vital part in helping the Schwarzman College execute its disciplinary mission in computer science and AI as well as its cross-cutting vision for facilitating computing collaborations in education and research across MIT. The college's Undergraduate Advisory Group provides ongoing feedback to leadership, including helping guide decisions about the undergraduate experience. The group, which meets monthly during the fall and spring terms, is composed of a cross-section of students from a range of backgrounds in traditional and blended EECS majors and other computing-related programs.

Undergraduate Student Research Spotlights

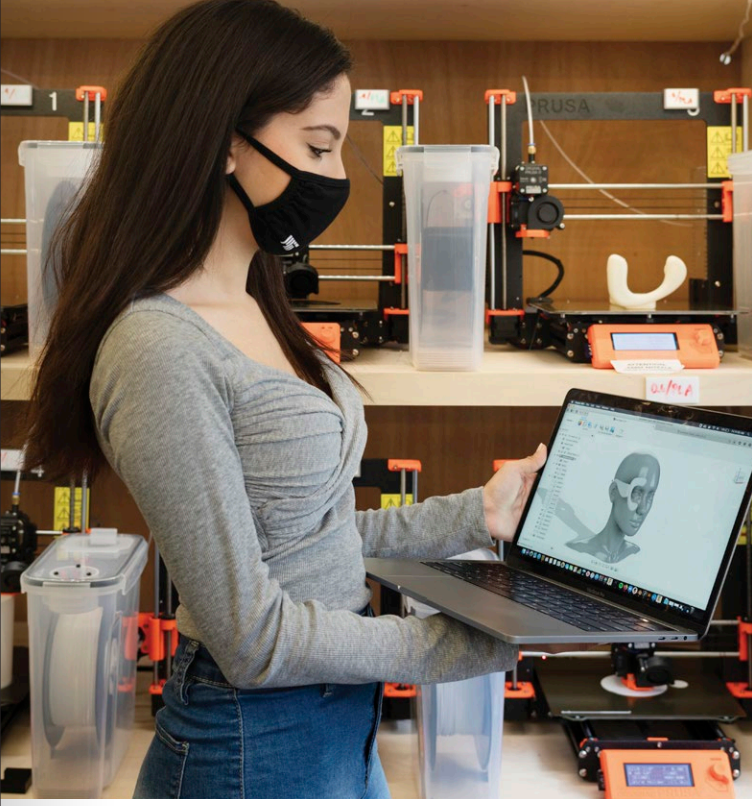
In two years, the MIT Quest for Intelligence has placed 329 students in research projects aimed at pushing the frontiers of computing and AI, and using these tools to revolutionize how we study the brain, diagnose and treat disease, and search for new materials.

- **Squeezing More Energy from the Sun**

  The price of solar energy is dropping as technology for converting sunlight into energy steadily improves. Solar cells are now close to hitting 50% efficiency in lab experiments, but there's no reason to stop there, says **Sean Mann '23**, a sophomore majoring in computer science. In an Undergraduate Research Opportunities Program (UROP) project with Giuseppe Romano, a researcher at MIT's Institute for Soldier Nanotechnologies, Mann is developing a solar cell simulator that would allow deep-learning algorithms to systematically find better solar cell designs.

- **Teaching Neural Networks Physics to Identify Stress Fractures**

  Sensors deep within the modern jet engine sound an alarm when something goes wrong, but diagnosing the precise failure is often impossible without tinkering with the engine. To get a clearer picture faster, engineers are experimenting with physics-informed deep-learning algorithms to translate these sensor distress signals. **Julia Gaubatz '21**, who majored in aerospace engineering, programmed physical constraints into a deep-learning model in a UROP project with Raul Radovitzky, a professor in the Department of Aeronautics and Astronautics (AeroAstro), recent AeroAstro graduate **Grégoire Chomette SM '21**, and student **Parker Mayhew '22**. Their goal is to analyze the high-frequency signals coming from, say, a jet engine shaft, to pinpoint where a part may be stressed and about to crack.



Students take part in 6.810 Engineering Interactive Technologies.

■ **Putting language comprehension under a microscope**

In a UROP project in the lab of Roger Levy, professor in the Department of Brain and Cognitive Sciences, sophomore **Pranali Vani '23** ran a set of sentence-processing experiments online. In each sentence, one word was placed in such a way that it created an impression of ambiguity. The weirder the sentence, the longer it took a human subject to decipher its meaning. In three sets of experiments, Vani found that the biggest slowdowns came when a verb was positioned in a way that sounded ungrammatical. Vani got similar results when she ran the experiment on a deep-learning model. Though the model wasn't trained on English grammar, the results suggest that a neural network trained on reams of text effectively learns the rules anyway.

Diversity, Equity, and Inclusion

Developing leaders who offer the world new technological possibilities grounded in human values starts with a community of learning and research that values and supports all of its members, regardless of race, gender, or identity. Units across the college are engaging in activities aimed at improving the climate for underrepresented groups. These actions, aligned with those of the larger MIT community, are important steps toward making the college an equitable and welcoming place where all members thrive.

New Assistant Dean for Diversity, Equity, and Inclusion

Alana Anderson joined the Schwarzman College of Computing as the assistant dean for diversity, equity, and inclusion (DEI). Anderson will be responsible for DEI programming activities in the college, working with college units, the schools, and DEI Institute leadership.

Most recently, Anderson served as the director of programs for diversity and inclusion in the Office of the Provost at Boston University. She has spent her career in higher education with roles focusing on student engagement, diversity, and inclusion at Babson College, Bentley University, and MIT's Student Activities Office. Anderson earned a bachelor's degree in politics at Brandeis University, a master's degree in higher education and student affairs from Indiana University, and a PhD in higher education from Boston College.

The college is working collaboratively with its academic units, labs, and centers to advance diversity, equity, and inclusion.

The MIT Abdul Latif Jameel Clinic for Machine Learning in Health hosted the virtual AI for Health Care Equity Conference.

Perspectives and Action in the College's Departments and Centers

The college, in partnership and collaboratively with its academic units, labs, and centers, is actively working to address racism and to advance DEI. Since its inception, the college has been focused on recruiting a more diverse faculty and is developing additional plans for graduate admissions and for improving the culture and climate in the college, in conjunction with the rest of MIT, which in April 2021, shared a five-year Strategic Action Plan for Diversity, Equity, and Inclusion, a comprehensive, Institute-wide action blueprint.

- The Graduate Application Assistance Program (GAAP) in the **Department of Electrical Engineering and Computer Science** (EECS) pairs student mentors in EECS with applicants from underrepresented backgrounds. The GAAP initiative is one of the largest student-run graduate mentorship programs in the United States, pairing nearly 100 committed mentors with as many as 200 applicants from underrepresented backgrounds. The aim is to boost the numbers of underrepresented students of color and of women in one of the largest research departments in the United States.

- The **MIT Abdul Latif Jameel Clinic for Machine Learning in Health** hosted the AI for Health Care Equity Conference to assess the state of the art in this space, including new machine-learning techniques that support fairness, personalization, and inclusiveness; identify key areas of impact in health care delivery; and discuss regulatory and policy implications. Nearly 1,400 people attended the virtual conference — co-chaired by Regina Barzilay, the School of Engineering Distinguished Professor for AI and Health; Collin Stultz, MD, the Nina T. and Robert H. Rubin Professor in Medical Engineering and Science; and Fotini Christia, the Ford International Professor in the Social Sciences — to hear from thought leaders in academia, industry, and government who are working to improve health care equity and further understand the technical challenges and paths forward.

- The opportunities that computation has opened up are vast, but they have been compromised by concerns over privacy, discrimination, misinformation, and cybersecurity. The **Institute for Data, Systems, and Society** and the **Sociotechnical Systems Research Center** worked with the dean's office in the School of Humanities, Arts, and Social Sciences on a workshop series, Systemic Racism and Computation, that examined what can be learned about race and how systemic racism operates in the United States by examining the role of big data and computation in the social sciences. Led by Christia, the focus on the US experience with systemic racism presented a way to scope the dynamic and voluminous line of inquiry in this field.

- MEnTorEd Opportunities in Research is a new postdoctoral fellowship program sponsored by the **Computer Science and Artificial Intelligence Laboratory** (CSAIL) to support exceptional researchers in computer science and AI. Fellows will conduct cutting-edge research as part of a vibrant community and will be hosted by research groups with synergistic scientific interests. The aim is to enable outstanding individuals to do research in the lab and prepare for careers in academia or industry. The program also features in-depth opportunities for mentorship from researchers in both CSAIL and industry. Postdoctoral researchers selected will be awarded a one-year funded appointment (renewable for a second year).

EECS Graduate Application Assistance Program

100 **mentors**

200 **applicants from underrepresented backgrounds**

The college's new building, designed by Skidmore, Owings & Merrill, is scheduled for completion in 2023 at the heart of campus.

A New Hub for Computing Excellence

The new headquarters building for the Schwarzman College of Computing is critical to supporting the growth in computing and AI education and research, the cross-cutting programs of the college, and engagement beyond MIT. Designed by Skidmore, Owings & Merrill, the building is scheduled for completion in 2023 and is located on Vassar Street near the central intersection of MIT's intellectual traffic and the Kendall Square innovation community. The building will bring together the college, disciplines across the Institute, and nearby companies. MIT neighbors include the Department of Electrical Engineering and Computer Science, the Department of Brain and Cognitive Sciences, and the MIT Computer Science and Artificial Intelligence Laboratory.

As a destination for a wide-ranging community of people working to shape computing, the building will attract not only computer scientists but also researchers across the spectrum of MIT disciplines, as well as thought leaders from the academic, business, government, and nonprofit sectors. With its signature event space and lecture hall alongside classrooms, labs, and communal areas for learning and connecting, the building will serve as a foundation for computing breakthroughs at MIT and impact around the world.

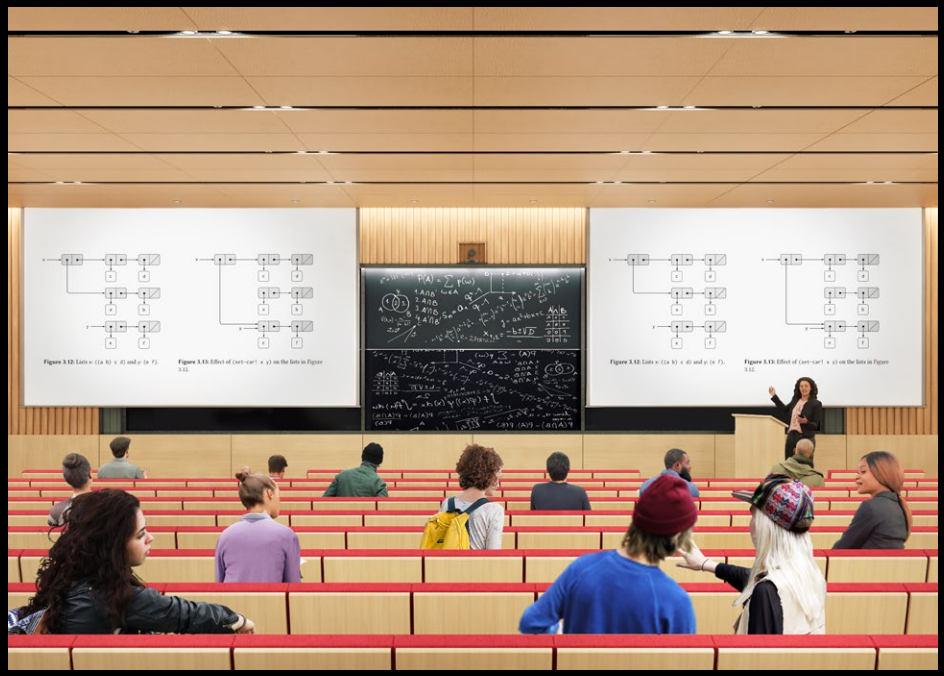
Building a Computing Community

The building will increase opportunities for collaboration, with offices and research labs for new and existing students, faculty, and visiting scholars; facilities for cross-cutting programs; tutoring rooms; and informal gathering spaces. A 250-seat lecture hall, 60-seat classroom, and Dean's Suite will welcome people from across the Institute and around the world. Two levels will feature laboratory spaces designed for multiple uses, including digital fabrication and robotics. The building will also support college units such as the MIT Quest for Intelligence as well as the Common Ground for Computing Education and the Social and Ethical Responsibilities of Computing.

A ground-level cafe and areas for studying and collaboration will be destinations for MIT students and visitors. The building will also include MIT's newest event space, eight stories high, drawing guests from the computing community on campus and beyond. Its central location with striking views across Cambridge and Boston will make it one of MIT's premier venues.

Right: A 250-seat lecture hall will play a role in educating the next generation of leaders in computing and AI. Below: A premier event space and an outdoor terrace are planned for the top floor, offering stunning views of the MIT campus and into Boston's Back Bay.

Opposite: Activating Vassar Street, which cuts through the MIT campus to vibrant Kendall Square, the building will increase opportunities for community interaction, inviting the public to learn more about the advances of the college.




ITS APPLICATION TO INDUSTRY THE ARTS
Passion
FOR A BETTER WORLD
#MITBetterWorld
Research
FOR A BETTER WORLD
#MITBetterWorld
Visitor
Information
Center

Thank You

With a commitment to collaboration embedded in its DNA, the MIT Schwarzman College of Computing is empowering our faculty, students, and staff to harness computing and AI to make a better world. It is helping us think carefully about the societal impact of the technologies we create and raise a generation of students for whom these considerations are instinctive. I am grateful to the faculty, students, and staff who are advancing the college's mission and to Mr. Stephen A. Schwarzman and our generous alumni and friends for their visionary support.

L. Rafael Reif
MIT President


MIT Schwarzman
College of Computing

Massachusetts
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Technology