

Institute for Data, Systems, and Society

The [Institute for Data, Systems, and Society \(IDSS\)](#) advances education in analytical methods in statistics and data science, information and decision systems, and the social sciences. Researchers at IDSS then apply these methods to research that addresses complex societal challenges in a diverse set of areas such as finance, energy systems, urbanization, social networks, and health. The IDSS academic programs and research laboratories and centers are interdisciplinary and draw faculty from all five MIT schools.

Academic year 2018 was one of continued growth for this relatively new unit. Major initiatives and accomplishments included the addition of new academic and professional education programs, developing a new fellowship thanks to a significant gift, and enlarging and adding major events.

Leadership

The director of IDSS is Munther Dahleh, the William A. Coolidge Professor in the Department of Electrical Engineering and Computer Science (EECS).

For the 2017–2018 academic year, IDSS leadership included:

- Alberto Abadie, professor of economics, associate director of IDSS
- John Tsitsiklis, Clarence J. Lebel Professor of Electrical Engineering and Computer Science, director of the [Laboratory for Information and Decision Systems \(LIDS\)](#) and associate director of IDSS
- Ali Jadbabaie, J. R. East Professor of Engineering, director of the [Sociotechnical Systems Research Center \(SSRC\)](#) and associate director of IDSS
- Devavrat Shah, professor of Electrical Engineering and Computer Science, director of the MIT Statistics and Data Science Center (SDSC).
- Munther Dahleh, acting director of the Technology and Policy Program
- Elizabeth Sikorovsky, executive director of IDSS
- Asu Ozdaglar, Joseph F. and Nancy P. Keithley Professor of Electrical Engineering and Computer Science and IDSS core faculty, head of the MIT Department of Electrical Engineering and Computer Science, effective January 1, 2018

Academic leadership for the 2017–2018 year included:

- Stephen Graves, Abraham J. Siegel Professor of Management Science and professor of Mechanical Engineering and Engineering Systems, IDSS graduate officer
- Ali Jadbabaie, program chair and admissions chair of the doctoral program in Social and Engineering Systems (SES)
- Jessika Trancik, SES student support and progress
- Alexander “Sasha” Rakhlin, program chair for the new interdisciplinary doctoral program in statistics, which will be launched in fall 2018
- Devavrat Shah and David Gamarnik, co-chairs of the curriculum committee for the minor in Statistics and Data Science

Faculty

The 84 IDSS core and affiliate faculty members are cross-listed with 13 MIT departments. IDSS also had four visiting faculty members in AY2018.

The following faculty members joined IDSS in 2017–2018:

- Alexander “Sasha” Rakhlin, associate professor in Brain and Cognitive Sciences and IDSS
- Suvrit Sra, assistant professor in EECS
- Luca Carlone, assistant professor in the Department of Aeronautics and Astronautics

Promotions

Yury Polyanskiy, associate professor of EECS and LIDS and SDSC affiliate faculty member, was granted tenure. Caroline Uhler was promoted to associate professor of EECS without tenure.

Awards

Faculty awards, grants, and recognition for 2017–2018 included:

- Noelle Selin and Ken Oye were given the Joseph A. Martore Award for Excellence in Teaching in IDSS for their updates to the Technology and Policy Program (TPP) curriculum.
- The Joseph A. Martore Award for Excellence in Teaching in IDSS was retroactively awarded for the past three years. For 2017, the award was given to Professors Caroline Uhler and Stefanie Jegelka for creating a capstone subject for the new IDSS minor in Statistics and Data Science, IDS.012 Computation and Applications. For 2016, it went to Devavrat Shah and Phillippe Rigollet for creating the Data Science and Big Data Analytics: Making Data-Driven Decisions online subject offered by IDSS and MIT Professional Education. For 2015, the award was given to Jessika Trancik for her highly rated courses, ESD.124 Energy Systems and Climate Change Mitigation and ESD.125 Mapping and Evaluating New Energy Technologies.
- Sertac Karaman and Eytan Modiano, along with LIDS student Rajat Talak, received the 2018 Association for Computing Machinery MobiHoc Best Paper Award for their paper “Optimizing Information Freshness in Wireless Networks under General Interference Constraints.”
- Luca Carlone won the Institute of Electrical and Electronics Engineers (IEEE) Transactions on Robotics King-Sun Fu Memorial Best Paper Award for “On-Manifold Preintegration for Real-Time Visual-Inertial Odometry.”
- Robert Berwick, Devavrat Shah, and John Tsitsiklis were recognized by EECS. Berwick received the Jerome Saltzer Award and Tsitsiklis received the Ruth and Joel Spira Teaching Award, both given for excellence in teaching. Shah was recognized as a Frank Quick Faculty Research Innovation Fellowship winner.

- Caroline Uhler was awarded an Abdul Latif Jameel World Water and Food Security Lab seed grant for research on climate impacts on agriculture.
- Philippe Rigollet received a grant from the Chan Zuckerberg Initiative for the Human Cell Atlas project.
- Pablo Parrilo was named to the Society of Industrial and Applied Mathematics Fellows Class of 2018.
- Noelle Selin was awarded a Hans Fischer Senior Fellowship at the Technische Universität München Institute for Advanced Study
- Tamara Broderick received a National Science Foundation CAREER award for her research on robust, scalable, reliable machine learning.
- Tamara Broderick and Stefanie Jegelka were named 2018 Sloan Research Fellows.
- Stephen Graves was elected to the National Academy of Engineering.
- Tamara Broderick received an Army Research Office Young Investigator Program award.
- Richard Larson received the first-ever Daniel Berg Lifetime Achievement Medal from the International Academy of Information Technology and Quantitative Management.
- Jonathan How was named a 2018 Control Systems Society IEEE Fellow.
- David Simchi-Levi was appointed editor-in-chief of *Management Science*, a flagship journal of the Institute for Operations Research and the Management Sciences.
- Stefanie Jegelka and Suvrit Sra were awarded a Critical Techniques, Technologies, and Methodologies for Advancing Foundations and Applications of Big Data Sciences and Engineering grant from the National Science Foundation.
- Daron Acemoglu was awarded a doctorate *honoris causa* from École Normale Supérieure Paris-Saclay.
- Alex “Sandy” Pentland was named a founding member of the board of directors for the United Nations Global Partnership for Sustainable Development Data.

Major Events

NSF Workshop on Low Latency-Wireless Random Access, November 2–3, 2017. This workshop, hosted by the Laboratory for Information and Decision Systems, brought together experts from industry and academia to discuss the challenges and solutions for the problem of multiple access in wireless communication and the so-called Internet of things.

Women in Data Science Conference, March 5, 2018. IDSS co-hosted this event with the Harvard University Institute for Applied Computational Science and Microsoft Research New England. A total of 194 people attended.

Policy Hackathon, April 6–8, 2018. Run by IDSS students, the first annual Policy Hackathon put 100 students and researchers on interdisciplinary teams to work on solutions to real societal challenges presented by sponsors who shared relevant large data sets.

SDSCon 2018, April 20, 2018. The Statistics and Data Science Center hosted this event, bringing together the statistics community and showcasing data science projects. Discussions covered applications of statistics and data science across a wide range of fields and approaches for the 166 people who attended.

In addition to these major events, IDSS continued to present the following ongoing seminar series:

- IDSS Distinguished Seminar Series
- IDSS Special Seminars
- Stochastics and Statistics Seminar Series
- LIDS Seminar Series

Distinguished Seminar Series

- September 2017: Fast and Slow Learning from Reviews, Daron Acemoglu (MIT)
- October 2017: How Technology Design will Dictate Our Civic Future, Latanya Sweeney (Harvard University)
- November 2017: Social Network Experiments, Nicholas Christakis (Yale University)
- December 2017: Essential Concepts of Causal Inference: A Remarkable History, Donald Rubin (Harvard University)
- February 2018: Machine Learning and Causal Inference, Susan Athey (Stanford University)
- April 2018: Computational Social Science: Exciting Progress and Future Challenges, Duncan Watts (Microsoft Research, New York City)
- May 2018: Conflict in Networks: The Rise and Fall of Empires, Sanjeev Goyal (University of Cambridge)

Special Seminars

February 2018: Provably Secure Machine Learning, Jacob Steinhardt (Stanford University)

Industry Connections

IDSS receives corporate support through its Industry Partner program. Current industry partners are Thomson Reuters, Booz Allen Hamilton, and WorldQuant. Their funding supports fellowships and some programming costs (conferences, workshops, and so on). Partners are invited to join the External Advisory Board.

In the summer of 2018, IDSS launched the Industry Alliance program, designed for companies that would like to begin engagement with IDSS but are not ready to engage at the partnership level. Those firms are invited to attend conferences and interact with faculty at a series of events and are also given access to a portal of IDSS research.

Resource Development and Fundraising

IDSS had its best fundraising year since its formation in 2015. In fiscal year 2018, IDSS raised \$10,553,666, as compared to \$317,641 in FY2017, \$4,374,674 in FY2016, and \$297,869 in FY2015.

Resource development activity in 2017–2018 focused on research, identification, cultivation, solicitation, and stewardship. With the help of many partners in MIT's Office of Resource Development and the Alumni Association, IDSS was able to engage new prospects, hold faculty speaking events, fund travel for visits, host visitors, engage the External Advisory Board, and expand its effort to increase new philanthropic support.

Michael Hammer Fellowship

IDSS has taken a major step forward this year thanks to a generous endowment gift from Phyllis Thurm Hammer and the Hammer family, establishing the Michael Hammer Fellowship Fund. The Hammer Fellowships remember Michael M. Hammer '68, SM '70, PhD '73, a much-lauded educator, visionary engineer, and pioneering business leader and author. They will be awarded annually to IDSS doctoral students in the Social and Engineering Systems program and to IDSS postdoctoral scholars.

The first Hammer Fellowship recipients were chosen this summer. They are Manxi Wu SM '17, a second-year PhD student in SES; Cate Heine and Leon Yao, who will join SES in September; and Kiran Garimella, a postdoctoral fellow starting in February 2019.

Postdoctoral Associates

In AY2018, SDSC hired Andrej Risteski to fill its first annual postdoctoral Norbert Wiener Fellowship in Statistics. Amin Rahimian received the IDSS postdoctoral associate research position.

Seed Grants

The IDSS Seed Fund Program supports innovative, early-stage research projects that focus on societal challenges. Through the grants, IDSS seeks to encourage researchers from across MIT to collaborate and to open up new avenues for interdisciplinary research that bring together the full range of Institute capabilities. Grants support the projects of SES doctoral students or postdoctoral associates working with two IDSS faculty.

Funded Projects and Recipients

The Seed Fund grants supported four projects in AY2018.

Financial Networks and Bank Failures; Sectoral Shocks and Aggregate Fluctuation

Student: Mert Demirer

Faculty: Munther Dahleh, Michael Scahub, Daron Acemoglu

Scalable Probabilistic Inference for the Analysis International Product Trade Profiles
 Student: Lorenzo Masoero
 Faculty: Tamara Broderick, In Song Kim

Repurposing Drugs for Alzheimer’s Disease using Electronic Health Records and Modern Data Analytics
 Student: Marie-Laure Charpignon
 Faculty: Stan Finkelstein, Roy Welsch

Predicting the Popularity of Online Jihadist Writing
 Postdoc: Santiago Segarra
 Faculty: Ali Jadbabaie, Rich Nielsen

MIT Institute for Foundations of Data Science

Professors Philippe Rigollet and Devavrat Shah were co–principal investigators on a multi-year NSF project designed to foster breakthrough discoveries in data science. As the first phase of this project, they, together with their collaborators, founded the MIT Institute for Foundations of Data Science—an interdisciplinary effort to develop the theoretical foundations of data science through integrated research and training activities.

Additional investigators included the following core and affiliate faculty members from IDSS, SDSC, and LIDS: Guy Bresler, Tamara Broderick, Victor Chernozhukov, Costis Daskalakis, David Gamarnik, Tommi Jaakkola, Stefanie Jegelka, Jonathan Kelner, Aleksander Madry, Ankur Moitra, Elchanan Mossel, Pablo Parillo, Suvrit Sra, and Caroline Uhler.

In the spring of 2018, the MIT Institute for Foundations of Data Science hosted a workshop and bootcamp called “Sublinear Algorithms, Local Algorithms and Robust Statistics.” The event invited speakers from MIT and 13 other universities, as well as two industry speakers.

Academic Programs

IDSS comprises the doctoral program in Social and Engineering Systems and the Technology and Policy Program.

During AY2018, the Statistics and Data Science Center launched an undergraduate minor in statistics and data science and the interdisciplinary doctoral program in statistics. The SDSC also offered professional education via the online course Data Science and Big Data Analytics: Making Data-Driven Decisions—a collaboration with MIT xPro. SDSC also launched a MicroMaster’s in statistics and data science.

The Doctoral Program in Social and Engineering Systems

The [doctoral program in Social and Engineering Systems \(SES\)](#) is a unique research program focused on addressing concrete and societally significant problems by combining the analytical tools and methods of engineering and information sciences with social science tools and methods.

Program Milestones

- September 2017: SES's second class of nine students started the program. One additional student started in February 2018.
- January/February 2018: SES written qualifying exams were administered for the first time.
- June 2018: First Hammer Fellowships were awarded.

Admissions for September 2018

- Applied: 242
- Admitted: 10
- Deferrals from 2017: 1
- Students starting in AY2019: 4

Student Support

Incoming students will be supported through fellowships, including the new Hammer Fellowship. Continuing students are primarily covered by graduate assistantships and also by fellowships.

Awards and Honors

In addition to being the first Hammer Fellow, Manxi Wu was awarded the 2017 Milton Pikarsky Memorial Award from the Council of University Transportation Centers for her master's thesis.

Incoming SES students Cate Heine and Leon Yao were named Hammer Fellows.

Ian Schneider won the Senior Paper award from the Technology, Management, and Policy Consortium.

Marco Miotti was among 16 MIT students named to the Siebel Scholars Class of 2018.

Graduates

The legacy Engineering Systems Division doctoral program graduated nine students in academic year 2018. The program is expected to graduate its final student in 2020.

Technology and Policy Program

Formed in 1975, the [Technology and Policy Program \(TPP\)](#) is an interdisciplinary graduate program that educates students focusing on issues at the interface of technology, society, and the sociotechnical aspects of complex systems.

Students

TPP offers a two-year master's of science program and encourages its students to pursue doctoral research in the areas of technology, management, and policy. The program's applicant cohort is diverse, with applications coming from graduates of undergraduate programs around the world, many of whom have additional practical work experience. Additionally, approximately one-third of TPP students concurrently pursue a second master's degree or a doctoral degree in another department. The annual program student intake averages 35 to 40 students, comprising more than 40% women and approximately 40% international students.

Graduation and Employment

In AY2018, 26 students graduated with an SM in technology and policy; six of them earned a second MIT SM. This year, six of these graduating students will enter PhD programs, largely at MIT. Other graduates took jobs in industry, government service, start-ups, or consulting. Of the roughly 1,300 graduates of TPP over its 40-plus year history, about 40% currently work in industry, 20% in consulting, 15% in academia, and 12% in government. The rest work in other industries (law, nonprofit organizations, and so on).

Technology and Policy Program Research

TPP student research spans the Institute—in both institutional and intellectual scope—covering the core challenges of modern society: sustainability, health, and security. For example, many TPP students are affiliated with the MIT Energy Initiative, where they learn about energy choices, sustainability policy, and environmental responsibility. TPP students hold research appointments at programs and centers across the campus, including other sustainability-centered programs (including the Tata Center, the Joint Program on the Science and Policy of Global Change, and the Center for Energy and Environmental Policy Research), engineering and engineering systems programs (the Center for Complex Engineering Systems, the Computer Science and Artificial Intelligence Laboratory, the Lean Advancement Initiative, and the Sociotechnical Systems Research Center) and the Humanitarian Response Laboratory. Students also hold research positions with the Charles Stark Draper Laboratory and Lincoln Laboratory research programs, and can be found working with other MIT initiatives, including the Internet Policy Initiative, Environmental Solutions Initiative, and Initiative on the Digital Economy.

Fellowships

In the past year, TPP students received a number of MIT fellowships, including from the Legatum Center, the MIT Energy Initiative, the Tata Center, Lincoln Laboratory, and the Office of the Dean for Graduate Education Diversity Fellowships. Within TPP, the de Neufville and Bernard Rabinowitz Fellowships were awarded to TPP students. Additionally, TPP students have been awarded external fellowships from the National Science Foundation, the Fulbright Chile program, and the Thailand government.

Policy Internship Program

Seventeen TPP students representing six countries traveled to Washington, DC, in March 2018. This annual trip gives students an opportunity to build professional networks with others who are working at the intersection of science, technology, and policy.

Program alumni arranged and hosted presentations at NASA, the Brookings Institution, Senator Tammy Duckworth's office, the Office of Management and Budget, the Federal Emergency Management Agency, the Association of Public and Land-grant Universities, the Department of Energy, the Department of Defense, and the World Bank. During the trip, TPP hosted a networking reception for students and alumni.

During the summer of 2018, TPP funding provided stipend support for a few students with unpaid internships. TPP students interned at the Center for Strategic and International Studies in Washington, DC; the National Institute for Health and Care Excellence in England; Enel X in Chile; Iberdrola in Spain; Revelator in Israel; and the Regional Agency of Energy and Climate in France. Other TPP students are participating in paid internships at various agencies and corporations, including the XPRIZE Foundation, Rio Tinto, Code for Humanity, the World Bank, NASA's Ames Research Center, and Vanasse Hangen Brustlin Inc.

Conferences and Workshops

TPP is a founding member of the Technology Management and Policy (TMP) Graduate Consortium, which includes programs in North America, Europe, and Asia. The annual meetings of this consortium afford TPP students and doctoral students in the IDSS-SES program the opportunity to share their research and network with students across the globe. More than 50 students and faculty from 11 universities typically participate in the event. This year's TMP consortium meeting was hosted from June 17–19 by Delft University of Technology. Through the generosity of a private donor, TPP was able to provide travel funds for six TPP and IDSS-SES PhD students and the TPP director of education. Doctoral candidate Ian Schneider (TPP '16) was given an award for the best senior paper for "Forward Contracts for Electricity and Generator Market Power: How Externalities Reduce Benefits in Equilibrium." Current TPP student Nathaniel Fruchter was given an award for the best junior paper for "Security, Bots, and Governance: Civic Infrastructure for Public Participation in the Age of the Social Botnet."

Over the past year, TPP students presented papers and posters at conferences and workshops around the world. The annual MIT Energy Conference, MIT India Conference, MIT Global Start-up Workshop, and MIT Energy Night leadership teams featured several TPP students. The program's students are involved in the leadership of a number of organizations and initiatives across the Institute, including the MIT Energy Club, the MIT Clean Energy Prize, the Science Policy Initiative, the Sustainability Initiative, the Mining, Oil, and Gas Club, Graduate Women at MIT, Le4Dev, the Graduate Student Council, LGBT Grad @ MIT, PN2K, the Global Poverty Initiative at MIT, MIT Hacking Medicine, MIT house committees, English as a Second Language tutors, the Graduate Student Leadership Institute, and the Transportation Club.

The MIT Policy Hackathon: Data to Decisions was held on campus during the weekend of April 6–8. TPP students and their counterparts within IDSS conceived and executed the event. Approximately 100 researchers and students from MIT and six other universities gathered for this weekend event, which teamed data science with engineering and policy students to explore solutions to real societal challenges submitted by sponsor organizations.

Student Honors and Awards

TPP students received honors and awards from MIT and beyond. This year, students received prizes as members of the winning teams for the MIT Policy Hackathon (Grand Prize), the MIT Energy Hackathon Challenge, the MD5 Hacking Emergency Response Hackathon, and the Innovation, Development, Enterprise, Action, and Service Global Challenge.

Student Society

In March, the Technology and Policy Student Society organized an on-campus TPP alumni-student reception and dinner. The event was held for the first time in 2017. Other highlighted events include the Culture Nights and the iAmbassador series, which give international students an opportunity to give presentations about their culture and technology policy issues in their home countries. The student society's Coffee Talks—which gave students an opportunity to talk to each other about subjects of personal interest to them—returned for its third year. The annual InterYear Retreat and winter ski trip continue to be two of the biggest events of the year.

Alumni Engagement

With more than 1,300 alumni, TPP continues to foster a strong community. The program's alumni host students at their organizations during annual visits to Washington, DC. During the academic year, local and visiting alumni are encouraged to visit TPP to give presentations or have informal meetings with the current TPP students. Alumni have offered ongoing support to student and program initiatives, including funding for summer internships, recruitment and outreach, and support for women in technology and policy.

Leadership

Munther Dahleh, director of MIT's Institute for Data, Systems, and Society, is serving as interim director of TPP; Noelle Selin, associate professor in IDSS and Earth, Atmospheric, and Planetary Sciences, served as associate director until the start of her sabbatical in January 2018. Frank Field is TPP's director of education.

IDSS Student Council

The IDSS Student Council was convened in academic year 2017 for the purposes of community building and event planning, and to serve as an advisory body for IDSS leadership on student issues. In the council's second year, the student councilors were:

- Joshua Mueller (SES doctoral program)
- Julia Romanski (Laboratory for Information and Decision Systems)
- Amy Umaretiya (TPP)
- Mengying "Mandy" Wu (SES doctoral program)

The faculty advisor was Professor Ali Jadbabaie. The IDSS Student Council coordinated and participated in a number of activities in AY2018. Its major activity was the MIT Policy Hackathon.

IDSS Research

The following research labs and centers within IDSS were active in AY2018.

Laboratory for Information and Decision Systems

The major research lab within IDSS, the [Laboratory for Information and Decision Systems \(LIDS\)](#) is an interdepartmental research center committed to advancing research and education in the analytical information and decision sciences. It is reporting separately from IDSS this year.

Sociotechnical Systems Research Center

The [Sociotechnical Systems Research Center \(SSRC\)](#) is an interdisciplinary research center that seeks collaborative, multidisciplinary, systems-theoretic approaches to complex societal challenges. The center administers research that brings together faculty, researchers, students, and staff from across MIT to study complex enterprises that span government, industry, the service sector, and health care. Its annual report appears below.

Statistics and Data Science Center

The [MIT Statistics and Data Science Center \(SDSC\)](#) serves as an MIT-wide focal point for advancing research related to statistics and data science. Its annual report appears below that of the MIT Sociotechnical Systems Research Center.

Munther Dahleh

Director, MIT Institute for Data, Systems, and Society

William A. Coolidge Professor of Electrical Engineering and Computer Science

MIT Sociotechnical Systems Research Center

The MIT Sociotechnical Systems Research Center is an interdisciplinary research center that seeks collaborative, multidisciplinary, systems-theoretic approaches to complex societal challenges. The center administers research that brings together faculty, researchers, students, and staff from across MIT to study complex enterprises that span government, industry, the service sector, and health care.

SSRC supports IDSS faculty research and comprises several ongoing research programs. Its total research volume in FY2018 was approximately \$9.9 million. The center's research partners include the Center for Biomedical Innovation (CBI), the Center for Complex Engineering Systems (CCES), the Consortium for Engineering Program Excellence (CEPE), the Ford-MIT Alliance, MIT Connection Science, and the Systems Engineering Advancement Research Initiative. The following sections highlight the key activities of the year for each of these centers.

Vannevar Bush Fellowship

SSRC supports and manages Ali Jadbabaie's fellowship award from the Office of the Secretary of Defense. This five-year fellowship (totaling \$3 million) supports Professor Jadbabaie's basic research effort at the interface of complex networks as well as

quantitative and computational social science. During the past year, his research has funded several ongoing collaborations between Professor Jadbabaie and several political science faculty members at MIT who are IDSS affiliates.

Together with IDSS faculty member Fotini Christia from the Department of Political Science, Professor Jadbabaie studied the effect of exogenous violent shocks on patterns of communication in Yemen. They analyzed call detail records from more than nine billion cellphone calls spanning 2010–2012, as al-Qaeda increased the amount of Yemeni territory under its control and the US responded with drone strikes targeting militants. Using panel fixed effects models, the researchers showed that the average effect of drone strikes on call volume is significant, but highly localized, with an increase in call volume in areas within 25 miles of a drone strike that tapers off at further distances. Drone strikes were also found to have a larger effect for high-casualty events that target militants. To quantify the individual effects of drone strikes, Professor Jadbabaie and colleagues employed anomaly detection methods that detect a significant effect in close to 60% of the drone strikes in the data set and attain good classification performance between strikes and non-strikes. Their analysis allowed comparison of the effect of drone strikes on aggregate communications with the effects of other exogenous shocks, such as bombings or important religious and social events. These findings offer a new angle on how big data can be used to understand the causal effects of conflict and violence on people's everyday lives.

Together with Political Science and IDSS faculty member Richard Nielsen and IDSS postdoctoral associate Santiago Segarra, Jadbabaie investigated a repository of jihadist writings. Using data from 50 million page views on a jihadist website, researchers investigated what makes some jihadist writings more popular than others and whether killing and capturing jihadist thinkers is an effective policy tool for reducing the popularity of their ideas. They found that the identity of the author is the strongest predictor of baseline popularity among jihadist readers. When authors are killed, the popularity of their documents temporarily increases, but there is no long-term effect. Fears that counterterrorism efforts will inadvertently re-popularize jihadists' ideas are overblown, but counterterrorism efforts do not appear to make jihadists' ideas less popular either. The consumption patterns of jihadist texts open a window into the jihadist psyche, which may lead to the understanding of how their thinking is shaped.

Together with Political Science and IDSS faculty member Adam Berinsky, and IDSS and Sloan School of Management faculty member Dean Eckles, as well as Professor Munzer Dahleh and TPP student Manon Revel, Professor Jadbabaie has embarked on an empirical research program to look at the spread of misinformation online. Specifically, the group is investigating the role of content recommendation networks—advertising widgets placed on news websites that look like legitimate articles but instead are clickbait—in spreading misinformation during the past election.

Center for Biomedical Innovation

The MIT Center for Biomedical Innovation (CBI) integrates the Institute's technical, scientific, and management expertise to solve complex biopharmaceutical challenges and improve the impact of biomedical innovation on society. The center advances cross-

stakeholder collaboration and practice through a range of multidisciplinary real-world initiatives. These activities bring parties together for mutual advantage and create system-scale effects on healthcare.

Center for Biomedical Innovation Initiatives

The NEW Drug Development ParaDIGmS (NEWDIGS) program is a collaborative “think and do” tank with a mission to enhance the capacity of the global biomedical innovation system to reliably, efficiently, and sustainably deliver new, better, and affordable therapeutics to the right patients. Major NEWDIGS projects were Financing and Reimbursement of Cures in the US (FoCUS) and Learning Ecosystems Accelerator for Patient-centered Sustainable innovation (LEAPS).

FoCUS addresses the pressing need for innovative financing and reimbursement models for curative therapies that ensure timely access for patients in need, affordability for payers, and incentives for sustainable innovation by manufacturers. Launched in May 2016, the FoCUS Project has 14 sponsoring bodies, had more than 150 participants and was advanced through Design Labs in October 2017 and April 2018. It is now preparing to launch the first pilot project on the use of performance-based annuities for gene therapy with Massachusetts commercial insurers in early 2019.

LEAPS was announced during the Next Wave Forum, held on December 12–13, which had more than 250 senior healthcare leaders from all stakeholder groups (regulatory, patient, provider, payer, industry) in attendance. It will feature the piloting of a healthcare learning system for a target disease in Massachusetts with input from senior advisors, including Mary Lou Sudders (Health and Human Services of Massachusetts), Janet Woodcock (US Food and Drug Administration), Michael Sherman (Harvard Pilgrim Health Care), and Sandy Pentland (MIT Media Lab).

Biomanufacturing Program

The Biomanufacturing Program (BioMAN) hosted two workshops, one in September 2017, “Setting Specifications for Biotherapeutic Products,” and one in May 2018, “Opportunities for Data Analytics in Biomanufacturing,” that were attended by 128 consortium members, MIT faculty, and invited guests. In November 2017, BioMAN hosted its ninth annual BioMAN Summit, on “Commercialization of Cell and Gene Therapy Products: The Impact of Critical Choices.” The two-day event, with 171 attendees representing academia, industry, and government, explored the challenges faced by manufacturers as emerging cell and gene therapy products advance through the clinical-trial stages into commercial-scale production.

BioMAN also co-organized a “Vaccines Bioprocess and Commercialization Workshop” with University College London, which explored critical issues at the various stages of vaccine development. Finally, BioMAN continued to incubate its global health initiative, BioACCESS, whose aim is to overcome knowledge gaps and technical barriers to accessing biologic medicines in resource-limited settings across the entire value chain (manufacturing, supply, diagnosis, adherence, and so on).

Educational Activities

CBI offered Advances in Biomanufacturing (7.458/7.548/10.03/10.53) on campus in spring 2018. The subject was taught in blended format with students learning the principles of biomanufacturing online in 10.03r; during class time, guest lecturers, including regulators and subject-matter experts from industry, offered a deeper exploration of a focused topic. The online material was moved from edX to MIT Professional Education and offered on the MITx Pro platform under the title Principles of Biomanufacturing.

The Consortium on Adventitious Agent Contamination in Biomanufacturing is a collaborative research project with 25 biopharmaceutical manufacturers and technology and service providers. The consortium hosted two workshops at MIT: “Experiences in the Control of Adventitious Agents through Testing” in October 2017, and “Adventitious Agent Control for Raw Materials” in April 2018. The outcomes of the research projects were presented at eight different conferences over the past year. A book chapter, “Quality Risk Management in the Context of Viral Contamination,” was published and a manuscript on the topic of facility segregation was accepted by the *PDA Journal of Pharmaceutical Science and Technology* for publication in July 2018.

The National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL), established in March 2017 as a member of the Manufacturing USA network of public-private partnerships, focuses on innovation in biopharmaceutical manufacturing and the associated US workforce. Through January 2018, CBI personnel continued to play key roles in NIIMBL’s development and growth, providing significant support to all structural efforts, including proposal writing, local and national team building, fundraising and partner negotiations, and the launch of the first two project calls. CBI was part of a team, led by Professor Krystyn Van Vliet, that was awarded a \$1.3 million project from NIIMBL’s Project Call 1.0 for a workforce development project called Blended Learning for Training of Cell Therapy Manufacturing Personnel.

Research Highlights

The NEWDIGS group was awarded a grant from the National Institutes of Health through the Johns Hopkins and Tufts University Trial Innovation Center to develop and host design laboratories for exploring efficacy to effectiveness clinical trial strategy and implementation. Pathways for repurposing off-patent drugs were explored for two products in development by members of the NIH Clinical and Transitional Science Awards Network in a May Design Lab.

CBI and Sanofi Pasteur continued their collaboration on the Continuous Viral Vaccine Manufacturing research project. The project allows Sanofi Pasteur to work with professors in MIT’s Chemical Engineering and Biology departments, and with CBI scientists and postdocs, to create a process model that will allow the continuous platform process to be used across a variety of cell and virus types to make vaccines faster, better, and more affordable.

Faculty members from CBI, Chemical Engineering, and Sloan continue to work on the Food Supply Chain Analytics and Sensing Initiative. In coordination with an extensive on-the-ground network in China, the initiative is creating visibility into the risk

drivers induced by upstream supply chains and strategies. The idea is to mitigate risks through a range of newly developed interventions that include predictive risk analytics, testing and tracing capabilities, real-time monitoring of corresponding socioeconomic environments, and modification and redesign of the respective supply chains.

Paula (Gigi) Hirsch, MD, is the executive director of CBI, and Stacy Springs, PhD, is the senior director of programs.

Center for Complex Engineering Systems

The Center for Complex Engineering Systems is based jointly at MIT and the King Abdulaziz City for Science and Technology (KACST), Saudi Arabia's national science agency. Since its inception in 2011, CCES has been part of KACST's Joint Centers of Excellence Program. The program's core mission is to foster the necessary research environment to improve competitiveness and capacity for innovation through scientific inquiry, and to participate in a rigorous training program for the most promising young scholars, who are selected from the top 0.5% of applicants from across the Kingdom. CCES has notably high research outputs as well as high acceptance rates of its students to top-tiered schools of engineering. To date, 15 researchers (six women and nine men) from CCES-KACST have been admitted to MS and PhD programs in departments across the Institute, including the Computer Science and Artificial Intelligence Laboratory, the Department of Civil and Environmental Engineering, and the Media Lab, among others.

The impact of CCES research is not only in its volume but also in its rigor—and it has been a particularly important resource for policy makers focused on the modernization of Saudi Arabia's infrastructure and its transition to a knowledge-based economy. The center continues to deepen and expand its relationships with key stakeholders in the Kingdom, partnering directly with entities such as the ministries of labor, economy and planning, and water and electricity, as well as the Arriyadh Development Authority. In March 2018, CCES students from Saudi Arabia showcased some of the center's work in an interactive exposition that accompanied the Innovation to Impact forum for business and government leaders from Saudi Arabia that took place at MIT.

In FY2018, MIT and KACST signed a contract extension that will ensure research funding for principal investigators at MIT through 2028. CCES launched a new series of 11 two-year research projects, each with an annual volume of \$165,000. These projects focused on energy management at the urban, national, and regional scales; the integration and optimization of transportation networks; the expansion of the innovation space within Saudi Arabia's economy and its technology policy; and developing platforms for integrating decision support systems that leverage interconnected aspects of findings across CCES's portfolio.

To date, CCES-funded affiliates have authored or co-authored more than 100 publications, including works in progress for peer-reviewed journals and leading conference venues. A large percentage of these publications have been jointly authored by CCES researchers based both at KACST and MIT, demonstrating the successes of the collaboration.

Professor Kamal Youcef-Toumi is the MIT co-director of CCES.

Consortium for Engineering Program Excellence

The Consortium for Engineering Program Excellence's research efforts focus on improving program performance by examining the relationships and interactions between diverse functions and stakeholders involved in complex engineering programs. The research is framed through the lenses of program management, systems engineering and product development, lean management, and organizational change fields. Its strategic partners in this work are the Project Management Institute and the Brightline Initiative coalition. Five conference papers were accepted and presented. Additionally, three professional publications, two professional conference presentations, two panel presentations, and a global webinar were delivered. During this period, six students advised by CEPE faculty completed master's theses and another two students began work on their master's theses. Professor Warren Seering was CEPE principal investigator and Eric Rebentisch was research lead.

Ford-MIT Alliance

The Ford-MIT Alliance, an Institute-wide initiative, was established in 1998. The alliance is the Institute's longest running, large-scale collaboration with industry. Since 1998, the alliance has funded more than 150 projects across the Institute, with a total investment to date by Ford of more than \$50 million. The Ford-MIT Alliance research portfolio is managed by an operating committee that includes two co-directors: Professor Jonathan How and Ed Krause, Ford's global manager of external alliances in the Division of Research and Advanced Engineering. This group reports to an executive committee that includes Karen K. Gleason, Alexander and I. Michael Kasser Professor of Chemical Engineering and associate provost, and Ken Washington, vice president of research and advanced engineering, Ford Motor Company. The alliance holds executive committee meetings on campus at least once a year. This year, the alliance had a record number of participants from the MIT faculty.

MIT Connection Science

Professor Alex "Sandy" Pentland's MIT Connection Science research initiative continued to receive additional major funding from IBM, Intuit, MasterCard, NEC, Airbus, and Ernst & Young. This funding supports research that uses artificial intelligence and machine learning to understand and change real-world human behavior. So-called living labs have been established in Israel, Senegal, China, and Columbia using an MIT-developed system called "OPAL" that shares public and private data by using encrypted queries, decentralized identities, trusted computation, and attribute exchanges that represents a breakthrough in trusted computation on the internet. This work supports the emerging personal data ecosystem in which people, organizations, and computers can manage access to their data more efficiently and equitably.

Systems Engineering Advancement Research Initiative

Several Systems Engineering Advancement Research Initiative (SEArI) research projects continued with government agencies in the US Department of Defense, Naval Postgraduate School, and the Norwegian University of Science and Technology. SEArI leads MIT's continuing participation in the Systems Engineering Research Center (SERC), a US Department of Defense university affiliated research center. SEArI is

actively engaged in collaboration with other universities involved in the SERC research program, including Purdue University, Georgia Institute of Technology, and the University of Southern California. Nine graduate students (both master's and doctoral level) from several degree programs performed research with the group. SEArI also hosted two visiting international students as part of a continuing research collaboration with the Technical University of Munich.

SEArI published one book chapter, two journal papers, three government research reports, and four refereed conference papers. SEArI researchers gave three invited talks at government-sponsored forums and served on two invited panel sessions at research conferences. SEArI researchers continued as instructors in the MITx Pro certificate program on Architecture and Systems Engineering: Models and Methods to Manage Complex Systems.

Dr. Donna Rhodes, principal research scientist, is SEArI's principal investigator. Dr. Adam Ross is a collaborating research scientist.

Ali Jadbabaie

Director, Sociotechnical Systems Research Center

Associate Director, Institute for Data, Systems, and Society

JR East Professor of Engineering

Statistics and Data Science Center

The mission of the MIT Statistics and Data Science Center (SDSC), working within the Institute for Data, Systems, and Society, is to serve as an MIT-wide focal point for advancing research and education programs related to statistics and data science by developing new academic programs in this field.

Leadership

Professor Devavrat Shah of EECS is director of the SDSC. Additional leadership comes from members of the center who partially represent the diversity of research foci embraced by the center. These include Emery Brown (Brain and Cognitive Sciences), Victor Chernozhukov (Economics), David Gamarnik (Management), and Philippe Rigollet (Mathematics).

In academic year 2018, Professor Alexander "Sasha" Rakhlin accepted the role of program chair of the new Interdisciplinary Doctoral Program in Statistics. Professors Devavrat Shah and David Gamarnik co-chaired the curriculum committee for the Minor in Statistics and Data Science.

Education

Minor in Statistics and Data Science

In AY2018, 12 MIT undergraduates applied to the Minor in Statistics and Data Science. Seven students graduated with the minor.

Interdisciplinary Doctoral Program in Statistics

The Interdisciplinary Doctoral Program in Statistics was launched in the late spring of 2018. The program was designed for students currently enrolled in a participating MIT doctoral program who wish to develop their understanding of 21st-century statistics within their chosen field of study. Participating MIT doctoral programs include programs in the departments of Aeronautics and Astronautics, Economics, Mathematics, Political Science, and IDSS's own Social and Engineering Systems program. SDSC graduated two interdisciplinary doctoral students immediately upon launch: Tetsuya Kaji (Economics) and Cheng Mao (Mathematics).

Online MicroMasters Program in Statistics and Data Science

This year, SDSC developed a new online educational offering in collaboration with MIT Open Learning: the MicroMasters Program in Statistics and Data Science. Registration launched in the spring of 2018, with courses set to start in fall 2018. The program consists of four online courses and a virtually proctored examination. The courses are:

- Probability: The Science of Uncertainty and Data. The instructors are John Tsitsiklis (professor, EECS, SDSC affiliate faculty, and director of LIDS) and Patrick Jaillet (professor, EECS).
- Data Analysis in Social Science: Assessing Your Knowledge. The instructors are Esther Duflo (Abdul Latif Jameel Professor of Poverty Alleviation and Development Economics, and SDSC affiliate faculty) and Sara Fisher Ellison (senior lecturer in Economics).
- Fundamentals of Statistics. The instructor is Philippe Rigollet (associate professor, Mathematics, and SDSC core faculty).
- Machine Learning with Python: From Linear Models to Deep Learning. The instructors are Regina Barzilay (Delta Electronics Professor, EECS) and Tommi Jaakkola (Thomas Siebel Professor, EECS and IDSS).

Data Science and Big Data Analytics: Making Data-Driven Decisions

The six-week online professional education course Data Science and Big Data Analytics: Making Data-Driven Decisions was presented three times in the period between July 1, 2017, and June 30, 2018, with a fourth presentation ending on July 1, 2018. In total, the course had 3,328 registrants and issued 2,525 certificates.

Dates: May 30– July 1, 2017

Registrants: 844

Certificates issued: 683

Countries represented: 52

Dates: October 23–December 17, 2017

Registrants: 800

Certificates issued: 524

Countries Represented: 53

Dates: February 5–March 26, 2018

Registrants: 1,058

Certificates issued: 811

Countries represented: 84

Dates: May 7–June 26, 2018

Registrants: 626

Certificates issued: 507

Countries represented: 68

Workshops and Conferences

SDSCon 2018

This year featured the second annual SDSCon, a celebration of MIT’s statistics and data science community organized by SDSC, on April 20, 2018. The event featured short talks from leaders in the field of statistics and data science, and presentations from established academic leaders, industry innovators, and rising stars. Discussions covered a wide range of theory and application, representing the latest research and breakthroughs in statistics and data science. There were 166 attendees.

Stochastics and Statistics Seminar Series

This is a signature series of weekly seminars hosted by SDSC featuring leading statisticians and data scientists from around the world. For academic year 2018, the series included:

- New Provable Techniques for Learning and Inference in Probabilistic Graphical Models—Andrej Risteski (Princeton University)
- Sample Complexity of Population Recovery—Yury Polyanskiy (MIT)
- Walking Within Growing Domains: Recurrence Versus Transience—Amir Dembo (Stanford University)
- Optimal Lower Bounds for Universal Relation, and for Samplers and Finding Duplicates in Streams—Jelani Nelson (Harvard University)
- Transport Maps for Bayesian Computation—Youssef Marzouk (MIT)
- Additivity of Information in Deep Generative Networks: The I-MMSE Transform Method—Galen Reeves (Duke University)
- Structure in Multi-Index Tensor Data: A Trivial Byproduct of Simpler Phenomena?—John Cunningham (Columbia University)
- Inference in Dynamical Systems and the Geometry of Learning Group Actions—Sayan Mukherjee (Duke University)
- On Learning Theory and Neural Networks—Amit Daniely (Google)
- Unbiased Markov Chain Monte Carlo with Couplings—Pierre Jacob (Harvard University)

- Statistics, Computation, and Learning with Graph Neural Networks—Joan Bruna Estrach (New York University)
- Generative Models and Compressed Sensing—Alex Dimakis (University of Texas at Austin)
- Challenges in Developing Learning Algorithms to Personalize Treatment in Real Time—Susan Murphy (Harvard University)
- Alex Bloemendal (Broad Institute)
- Connections Between Structured Estimation and Weak Submodularity—Sahand Negahban (Yale University)
- Variable Selection Using Presence-Only Data with Applications to Biochemistry—Garvesh Raskutti (University of Wisconsin)
- User-Friendly Guarantees for the Langevin Monte Carlo—Arnak Dalalyan (CREST, École Nationale de la Statistique et de l'Administration Economique)
- Optimization's Implicit Gift to Learning: Understanding Optimization Bias as a Key to Generalization—Nathan Srebro-Bartom (Toyota Technological Institute, Chicago)
- One- and Two-Sided Composite-Composite Tests in Gaussian Mixture Models—Alexandra Carpentier (Otto von Guericke Universitaet)
- Statistical Estimation Under Group Actions: The Sample Complexity of Multi-Reference Alignment—Afonso Bandeira (New York University)
- When Inference Is Tractable—David Sontag (MIT)
- Statistical Theory for Deep Neural Networks with Relu Activation Function—Johannes Schmidt-Hieber (Leiden, the Netherlands)
- Optimality of Spectral Methods for Ranking, Community Detections, and Beyond—Jianqing Fan (Princeton University)
- Testing Degree Corrections in Stochastic Block Models—Subhabrata Sen (Microsoft)
- Inference, Computation, and Visualization for Convex Clustering and Biclustering—Genevera Allen (Rice University)
- Size-Independent Sample Complexity of Neural Networks—Ohad Shamir (Weizman Institute)
- Dynamic Incentive-Aware Learning: Robust Pricing in Contextual Auctions—Adel Javanmard (University of Southern California)
- Fitting a Putative Manifold to Noisy Data—Hariharan Narayanan (Tata Institute of Fundamental Research, Mumbai, India)

Devavrat Shah

Director, Statistics and Data Science Center

Professor, Electrical Engineering and Computer Science