MIT
Schwarzman
College of
Computing

Update on the College

Dan Huttenlocher, Dean
Fall, 2021

Vision for the College

Computing – from hardware, to software, to algorithms, to AI – is becoming part of the *intellectual fabric* of every field

But the pace and scale of change are overwhelming conventional research and education pathways

Skyrocketing demand for CS programs and classes

Relevant advances often not accessible to those in other fields

Broad and rapid applicability calls for better understanding of implications

The College is transforming computing at MIT to address these limitations and better serve the nation and the world

Achieving the Vision

Skyrocketing demand

- 25 new core faculty positions
- 25 new shared faculty positions
- Blended majors
- New AI+D major
- Broadening of computing: ORC, CCSE, SDSC

Often not accessible to other fields

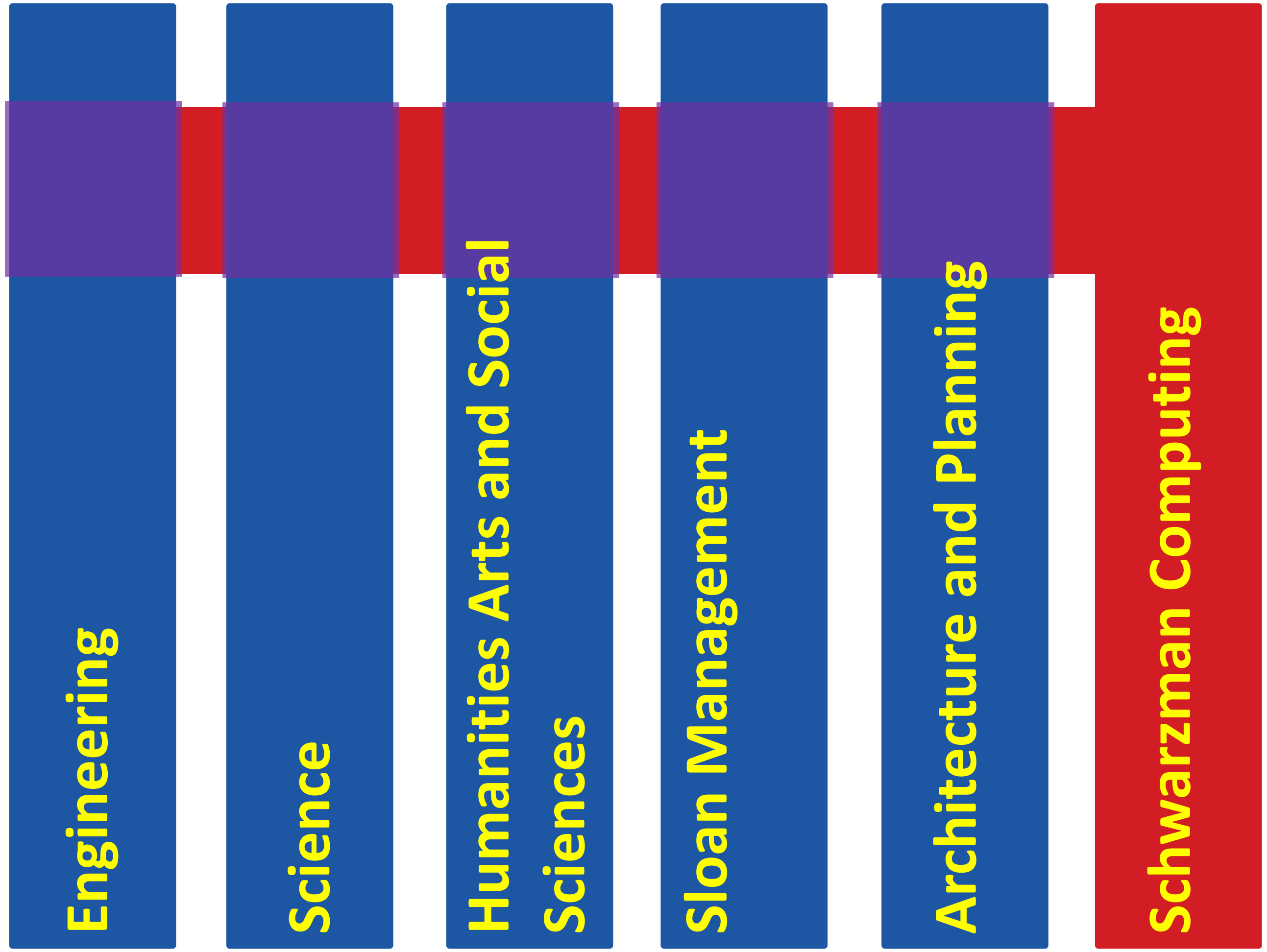
- Common Ground
- Blended majors
- Online education
- AI Policy Forum
- Broadening: ORC, CSE, SDSC
- Synergies such as Life Sciences

Better understanding of implications

- SERC: Social/Ethical Responsibilities
- IDSS systemic racism initiative
- Jameel Clinic health equity
- New classes on impacts of AI
- Increased research

College Cuts Across the Five Schools at MIT

Intellectual Fabric, Forefront of Computing



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Academic and Research Units

Academic

- Electrical Engineering & Computer Science Dept. (EECS) *
  - Faculties of EE, CS, AI+D
- Operations Research Center (ORC) **
- Inst. Data, Systems & Society (IDSS)
  - Statistics & Data Science Center (SDSC)
  - Technology Policy Prog. (TPP)
- Center for Computational Science & Engineering (CCSE)

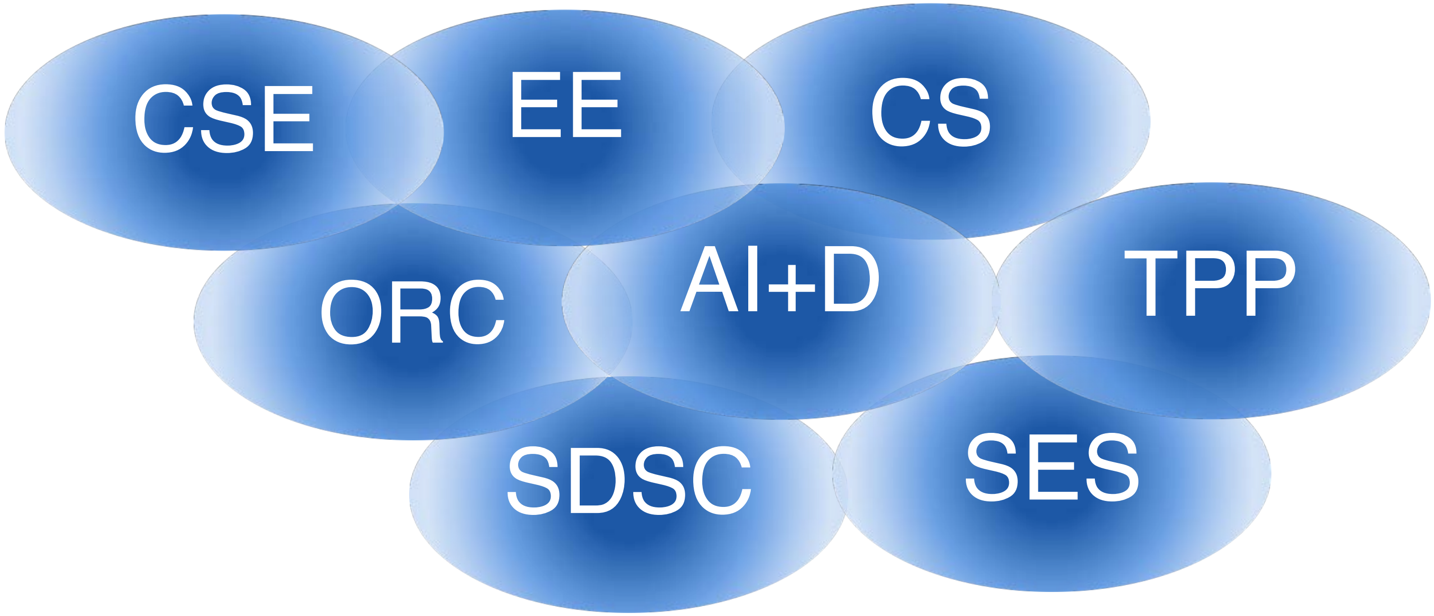
Research

- Computer Science and Artificial Intelligence Lab (CSAIL)
- Lab for Information and Decision Systems (LIDS)
- Quest for Intelligence
- MIT-IBM Watson AI Lab *
- Jameel Clinic: AI & Health

* Jointly part of School of Engineering and Schwarzman College of Computing
** Jointly part of Sloan School of Management and Schwarzman College of Computing

Academic Programs

- Computing programs are evolving rapidly
- “Attractors” rather than “sets”, no clear boundaries
  - Similar to EECS Faculties but across units



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New Cross-Cutting Program Areas

Across MIT departments, labs, and centers

Common Ground for Computing Education

- Multi-department collaborations to meet needs beyond single one
- Develop blended and integrated computing classes and curricula
- A key aspect of educating computing "bilinguals" – those in other fields

Social and Ethical Responsibilities of Computing (SERC)

- Build habits of mind and action regarding impacts of computing, incorporating multiple perspectives
- Approaches to teaching and research
- Responsible deployment

DEI Approach

- Focus on creating and supporting a culture of belonging – where people feel welcome and encouraged
  - Approaches to DEI work differ – seek to engage in respectful and sometimes challenging discussions to broaden our understanding and inclusivity
- Improving the diversity of graduate programs – warrants particular focus and innovative solutions, given the lower diversity relative to undergraduates at MIT
- Alana Anderson, newly hired Assistant Dean for DEI, is helping support us in these objectives

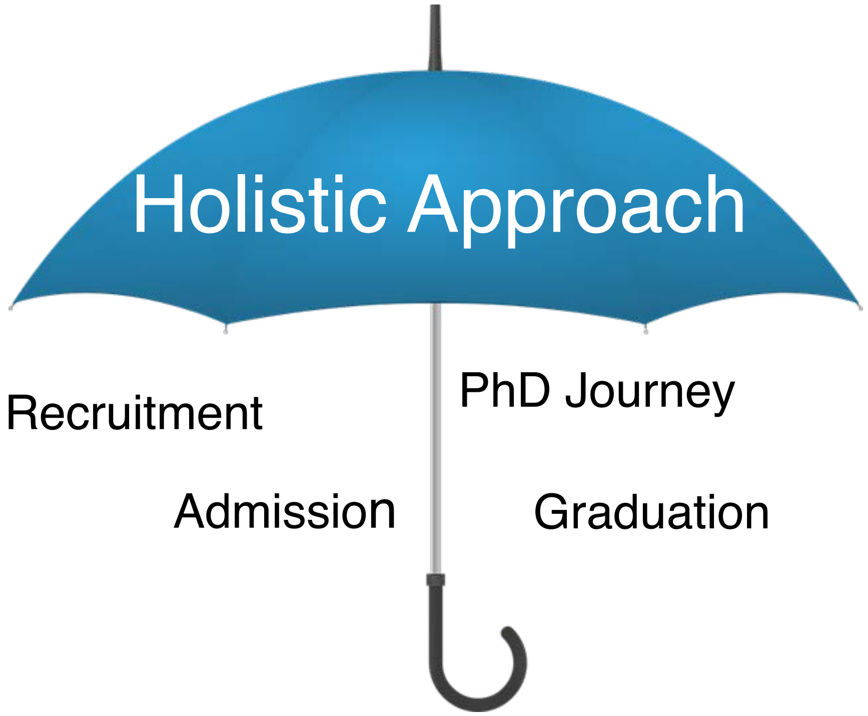
DEI Example: Thriving Stars

EECS THRIVING STARS GOALS

- ✓ Increase representation of women* graduate students toward parity
- ✓ Improve graduate experience for men and women
- ✓ Encourage other PhD programs to follow our lead

EXPAND TO OTHER GRAD PROGRAMS IN THE COLLEGE

- ✓ Work with ORC, IDSS (SES, Stats, TPP), CCSE
- ✓ Engage broader set of undergraduate majors
- ✓ Build cross-program graduate community



*women and underrepresented genders

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Thriving Stars Advisory Board

Co-Chair
Maria Klawe
Harvey Mudd

Anne Dinning
DE Shaw

Susan Dumais
Microsoft

Carol Espy-Wilson
U. of Maryland

Susan Hockfield
MIT

Songyee Yoon
NCSOFT

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Faculty Hiring

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Core Faculty Hires (EECS)

Junior: 16 hires (11 in new College positions), 5 current searches (all new)

Degree of strategic focus going forward

YuFeng (Kevin) Chen
EECS [EE and AI+D]

Henry Corrigan-Gibbs
EECS [CS]

Mohsen Ghaffari
EECS [CS]

Marzyeh Ghassemi
EECS [AI+D], IMES

Dylan Hadfield-Menell
EECS [AI+D]

Sam Hopkins
EECS [CS and AI+D]

Mina Konakovic Lukovic
EECS [AI+D]

Yoon Kim
EECS [AI+D]

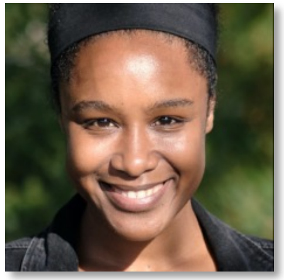
Anand Natarajan
EECS [CS]

Jelena Notaros
EECS [EE]

Jonathan Ragan-Kelley
EECS [CS and AI+D]

Vincent Sitzmann
EECS [AI+D]

Tess Smidt
EECS [EE and AI+D]



Ashia Wilson
EECS [AI+D]

Mengjia Yan
EECS [CS]

Sixian You
EECS [EE]

SENIOR

Martin Wainwright
EECS [AI+D]

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Strategic Search Areas for Shared Faculty

- Appointed in a department across MIT and in the College of Computing
- 25 new such shared faculty positions – 5 searches this year

Social, Economic, and Ethical Implications of Computing and Networks – initial hire with Sloan School and search this year (*Philosophy*)

Computing and Natural Intelligence: Cognition, Perception, and Language – initial hires with Brain and Cognitive Science and search this year (*Architecture*)

Computing in Health and Life Sciences – initial hire with Chemical Engineering

Computing for Health of the Planet (Climate)
3 searches this year (*EAPS, MechE, NSE*)

Computing and Human Experience (Humanities)

Complementing and expanding strength in strategic areas

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Shared Faculty Hires

- 2 shared hires in new College positions (from 5 searches last year)
- 2 shared hires in department positions
- 5 current searches (all new positions)

Manish Raghavan
Sloan, EECS [CS]
Social, Economic and Ethical Implications

Nidhi Seethapathi
BCS, EECS [AI+D]
Computing and Natural Intelligence

Connor W. Coley
ChemE, EECS [AI+D]
Computing in Health and Life Sciences

Guangyu Robert Yang
BCS, EECS [AI+D]
Computing and Natural Intelligence

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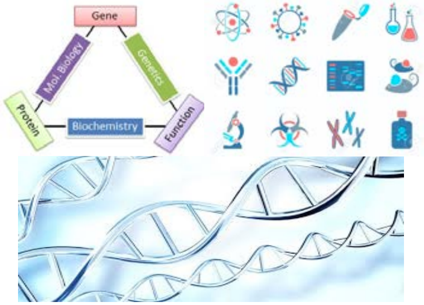
Education

Educating "Computing Bilinguals"

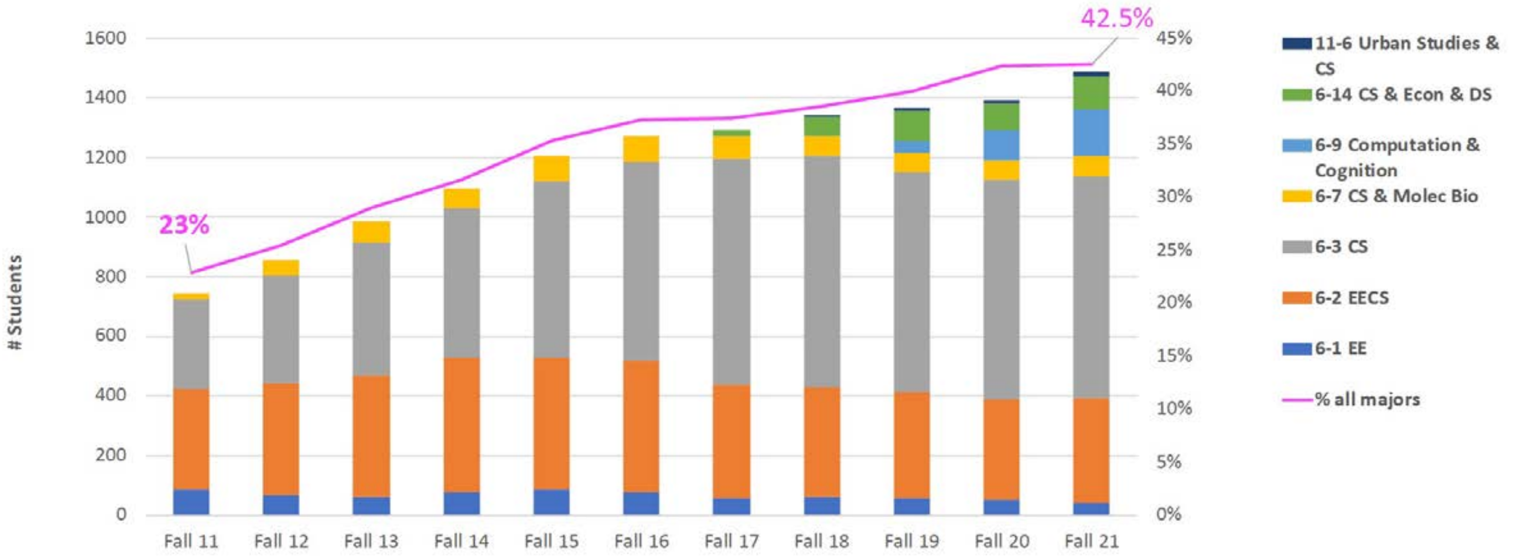
- Infusing coordinated computing education across disciplines
- Blended majors – beyond simply combining two, such as double major or major and minor (requires faculty engagement between programs)
  - Freeze on additional blended majors until better understood
- Common Ground – subjects that bring together forefront of computing with problems and methods from various domains
- Ties to SERC – integrated education on social and ethical aspects of computing

Blended CS Majors

6-7: CS & Molecular Biology



- Launched in 2011
- 70 (71) students Fall 21



New Majors:

6-14: CS, Economics & Data Science

- Launched in 2017
- 108 (128) students Fall 21

6-9: Computation & Cognition

- Launched in 2019
- 159 (166) students Fall 21

11-6: Urban Science & Planning with CS

- Launched in 2019
- 16 students Fall 21

The blended majors are at least as large as the non-computing majors in those departments (and additive)

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Common Ground for Computing Education

Multi-departmental collaborations across MIT

- Coordinated education for “computing bilinguals” across disciplines
- Classes and curricula meeting “common” needs and perspectives of multiple programs – developed and offered jointly by two or more departments
- Three current focal areas, plus coordination with SERC
  - Fundamentals of Programming and Computational Thinking
  - ML/AI/DataSci/Algorithms in Science, Engineering and Social Science
  - Fundamentals of Computational Science and Engineering (CSE)

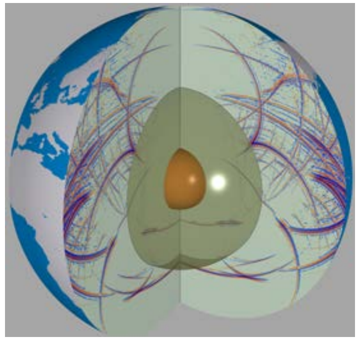
Premises of the Common Ground

- Departments are powerful for discipline-specific education, but cross-cutting approach is important for educating “bilinguals”
- Collaborations between faculty across departments are a key aspect – expertise for integration of relevant material and perspectives
- Value to and support of departments critical: for students (needs to satisfy requirements) and for sustainability (needs staffing commitments)
- Beyond individual subjects, coordinated and academically coherent cross-cutting curricula are important for students and employers

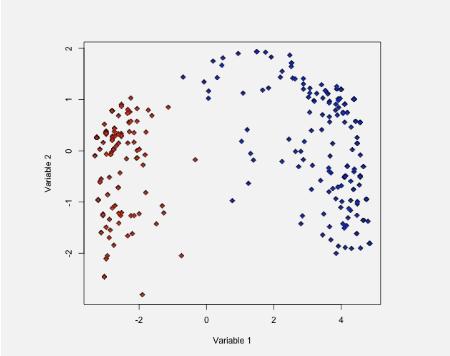
Common Ground Pilot Subjects

2020-21 Pilots

Introduction to Computational Science and Engineering (16.0002/18.0002)



Linear Algebra and Optimization (18.061)



Modeling with ML: from Algorithms to Applications (6.402/6.482, et al)

Interpretability	Transfer	Sparse Data
Causality	Evaluation	...

New in 2021-22

ESG Experimental Study Group

Programming Skills and Computational Thinking in-Context

Connects and combines basic computation in Python with basic concepts in the physics GIRs (ES.801, ES.802, etc.)

6.402 Modeling with Machine Learning: from Algorithms to Applications

(Subject meets with 6.482)
Prereq: Calculus II (GIR) and 6.0001; *Coreq: 1.024, 2.161, 3.100, or 22.042*
Units: 3-0-3

Focuses on modeling with machine learning methods with an eye towards applications in engineering and sciences. Introduction to modern machine learning methods, from supervised to unsupervised models, with an emphasis on newer neural approaches. Emphasis on the understanding of how and why the methods work from the point of view of modeling, and when they are applicable. Using concrete examples, covers formulation of machine learning tasks, adapting and extending methods to given problems, and how the methods can and should be evaluated. Students taking graduate version complete additional assignments. Students taking graduate version complete additional assignments. Students cannot receive credit without simultaneous completion of a 6-unit disciplinary module. Enrollment may be limited.
R. Barzilay, T. Jaakkola

ILLUSTRATES IMPORTANCE OF JUST-APPROVED NEW SUBJECT NUMBERING SCHEME FOR COMMON GROUND *x.Cyyy*

3.100[J] Machine Learning for Molecular Engineering

(Same subject as 10.402[J], 20.301[J])
(Subject meets with 3.322[J], 10.602[J], 20.401[J])
Prereq: Calculus II (GIR) and 6.0001; *Coreq: 6.402*
Units: 2-0-4
Credit cannot also be received for 1.024, 1.224, 2.161, 2.169, 3.322, 10.602, 20.401, 22.042, 22.42

Building on core material in 6.402, provides an introduction to the use of machine learning to solve problems arising in the science and engineering of biology, chemistry, and materials. Equips students to design and implement machine learning approaches to challenges such as analysis of omics (genomics, transcriptomics, proteomics, etc.), microscopy, spectroscopy, or crystallography data and design of new molecules and materials such as drugs, catalysts, polymer, alloys, ceramics, and proteins. Students taking graduate version complete additional assignments. Students cannot receive credit without simultaneous completion of 6.402.
R. Gomez-Bombarelli, C. Coley, E. Fraenkel

1.024 Machine Learning for Sustainable Systems

(Subject meets with 1.224)
Prereq: (1.000 and 1.010) or permission of instructor; *Coreq: 6.402*
Units: 1-1-4
Credit cannot also be received for 1.224, 2.161, 2.169, 3.100, 3.322, 10.402, 10.602, 20.301, 20.401, 22.042, 22.42

Building on core material in 6.402, emphasizes the design and operation of sustainable systems. Illustrates how to leverage heterogeneous data from urban services, cities, and the environment, and apply machine learning methods to evaluate and/or improve sustainability solutions. Provides case studies from various domains, such as transportation and urban mobility, energy and water resources, environmental monitoring, infrastructure sensing and control, climate adaptation, and disaster resilience. Projects focus on using machine learning to identify new insights or decisions that can help engineer sustainability in societal-scale systems. Students taking graduate version complete additional assignments. Students cannot receive credit without simultaneous completion of the core subject 6.402.
S. Amin

22.042 Modeling with Machine Learning: Nuclear Science and Engineering Applications

(Subject meets with 22.42)
Prereq: Calculus II (GIR) and 6.0001; *Coreq: 6.402*
Units: 2-0-4
Credit cannot also be received for 1.024, 1.224, 2.161, 2.169, 3.100, 3.322, 10.402, 10.602, 20.301, 20.401, 22.42

Building on core material in 6.402, focuses on applying various machine learning techniques to a broad range of topics which are of core value in modern nuclear science and engineering. Relevant topics include machine learning on fusion and plasma diagnosis, reactor physics and nuclear fission, nuclear materials properties, quantum engineering and nuclear materials, and nuclear security. Special components center on the additional machine learning architectures that are most relevant to a certain field, the implementation, and picking up the right problems to solve using a machine learning approach. Final project dedicated to the field-specific applications. Students taking graduate version complete additional assignments. Students cannot receive credit without simultaneous completion of the core subject 6.402.
Staff

2.161 Physical Systems Modeling and Design Using Machine Learning

(Subject meets with 2.169)
Prereq: 2.086; *Coreq: 6.402*
Units: 1-3-2
Credit cannot also be received for 1.024, 1.224, 2.169, 3.100, 3.322, 10.402, 10.602, 20.301, 20.401, 22.042, 22.42

Building on core material in 6.402, encourages open-ended exploration of the increasingly topical intersection between artificial intelligence and the physical sciences. Uses energy and information, and their respective optimality conditions, to define supervised and unsupervised learning algorithms as well as ordinary and partial differential equations. Subsequently, physical systems with complex constitutive relationships are drawn from elasticity, biophysics, fluid mechanics, hydrodynamics, acoustics, and electromagnetics to illustrate how machine learning-inspired optimization can approximate solutions to forward and inverse problems in these domains. Students taking graduate version complete additional assignments. Students cannot receive credit without simultaneous completion of 6.402.
G. Barbastathis

Online Executive and Professional Education

- Bringing relevant computing education to professionals
- Focus on quality, relevance, coordinated curricula, increased visibility
- New Sloan-Schwarzman Executive Education program on business and computing
  - Big unmet need for leaders in both technical and nontechnical roles
  - Pilot – MAKING AI WORK: MACHINE INTELLIGENCE FOR BUSINESS AND SOCIETY
- Planned new micro masters programs

Societal Implications

Social and Ethical Responsibilities of Computing (SERC)

SERC

Facilitating cross-cutting focus on ethical and societal questions

SERC Teaching

Supporting integrated focus on responsibilities
1. Embedded materials
2. Active learning projects
3. Case studies

SERC Research

Infrastructure for supporting research projects, e.g., Ethical Computing Protocol and Platform

SERC Engagement

Engagement beyond research and education, e.g., civic groups and public forums

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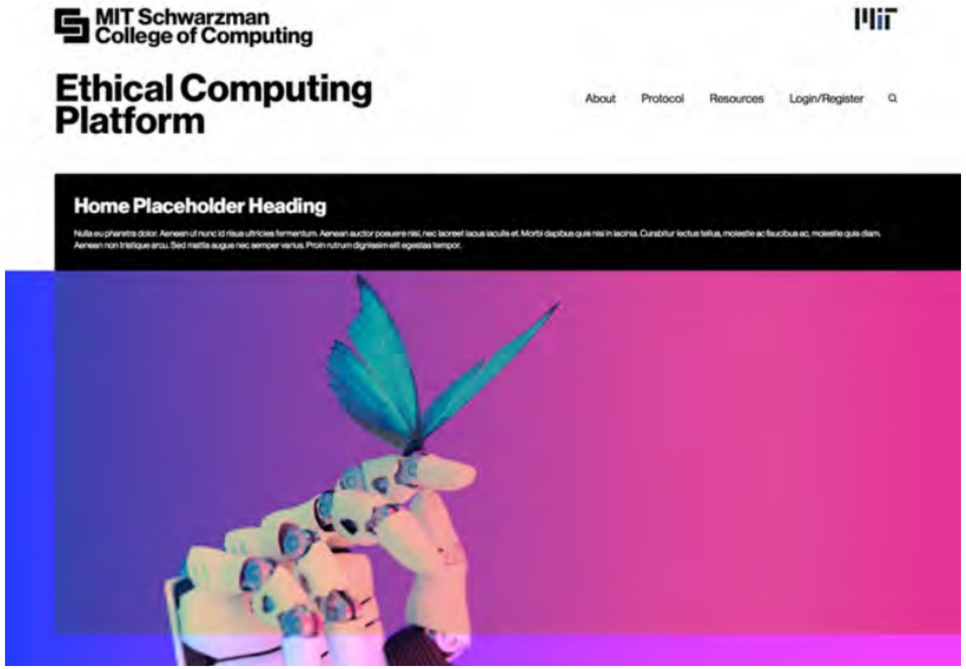
Ethical Computing Protocol/Platform

- Developing and supporting skills in the consideration of ethical implications of computing
- Ability to identify, address, and communicate about the ethical and societal aspects of technologies as they are developed
- Protocol and forthcoming platform that research groups can use iteratively to address a series of questions about benefits and burdens
  - Proposed research design
  - Data collection and protection
  - Potential unintended consequences



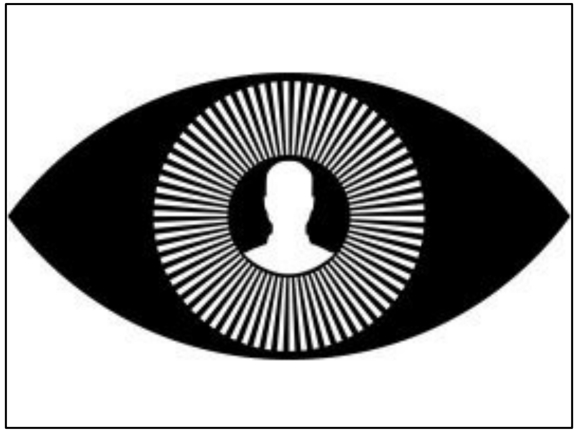
MIT Case Studies in Social and Ethical Responsibilities of Computing

The Case of the Nosy Neighbors

Johanna Gunawan, Northeastern
Woodrow Hartzog, Northeastern

Who Collects the Data? A Tale of Three Maps

Catherine D'Ignazio, MIT
Lauren Klein, Emory



The Bias in the Machine: Facial Recognition Technology and Racial Disparities

Sidney Perkowitz, Emory

The Dangers of Risk Prediction in the Criminal Justice System

Julia Dressel, Dartmouth
Hany Farid, UC Berkeley

All cases are freely available at **mit-serc.pubpub.org**

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IDSS – Combatting Systemic Racism

Organizers: Fotini Christia and Munzer Dahleh

- Initiative that facilitates and coordinates cross-disciplinary research on how to identify and overcome racially discriminatory processes across a range of American institutions and policy domains

- Bring together social scientists and humanists with computer scientists and data scientists to further computational tools that can help effect structural and normative change towards racial equity
  - Create a data lake, utilize computational statistical tools and mechanisms to identify and eliminate structural issues

- Project teams in specific domains including: Healthcare, Housing, Policing, and Social Media

AI Policy Forum

- A series of individual and group sessions with policymakers, for grounded and informed discussion on AI policy issues
- Participation of MIT faculty is of great value

Task Force Discussions

Finance

Healthcare

Mobility

Upcoming: Social Media, Insurance

International and Group Sessions with US and International Policymakers

OECD-MIT Dialogue

OECD
BETTER POLICIES FOR BETTER LIVES

Global Deep Dive

Washington Conversations

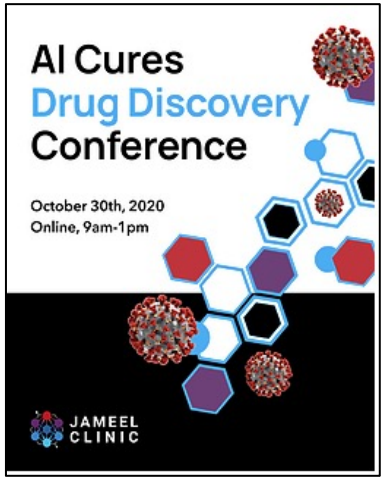
AIPF Summit

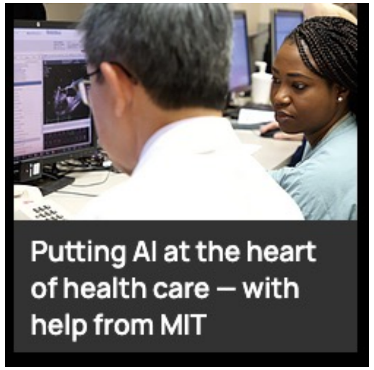
April 20-21,2022

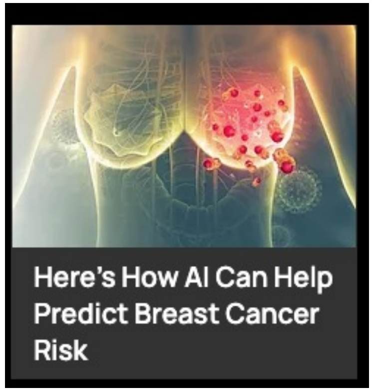
Synergies

Synergies: Computing and Life Sciences

- Jameel Clinic – AI & Healthcare
  - Translating AI/ML to practice in healthcare providers
- New Schmidt Center at Broad – data science and biology
  - Caroline Uhler, MIT co-director
  - Broad-EECS faculty search
- Connections with Ragon Institute
  - AI and immunology, seed projects (Bruce Walker)







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Synergies: AI And Natural Intelligence

The Quest views the engineering of artificial intelligence and the scientific understanding of natural intelligence as interlocking aspects of a single, collaborative grand challenge

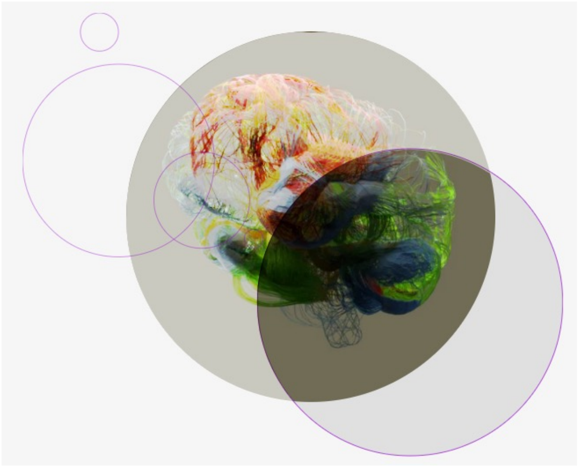
Missions each address foundational questions of natural intelligence where current AI falls short, to advance both the science and the AI

The Development of Intelligence, *led by Josh Tenenbaum and Vikash Mansinghka*, seeks to engineer a system that learns the way a person does, starting as a baby

Embodied Intelligence, *led by Leslie Kaelbling and Nancy Kanwisher*, seeks to design and develop modular and compositional intelligent behavior in physical agents

New Hardware Architectures for Intelligence, *led by Bilge Yildiz and Jesus del Alamo*, seeks to emulate biological learning utilizing electrochemically tunable synapses, for better and more energy-efficient neural networks

Collective Intelligence, *led by Tom Malone, Aleksander Madry and Jacob Andreas*, seeks to enable effective collaboration of multiple humans and machines



New College Building

Site Location – Opening Summer 2023

South Facade

Window on Vassar

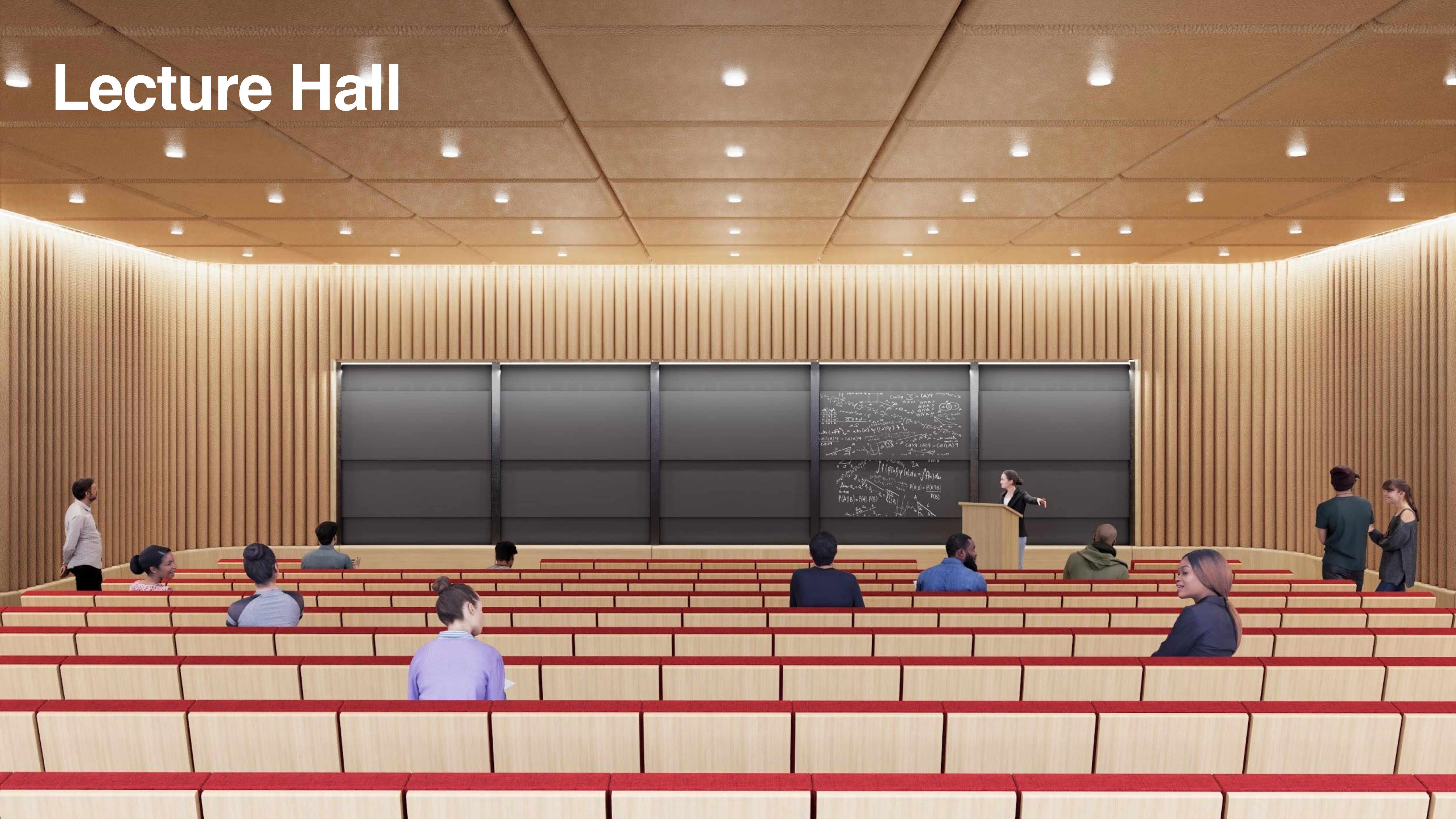
Lobby

Lobby

Convening Space

60p Classroom

Lecture Hall



Level 4 & 6

Level 5 & 7

Level 8 Event Space

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