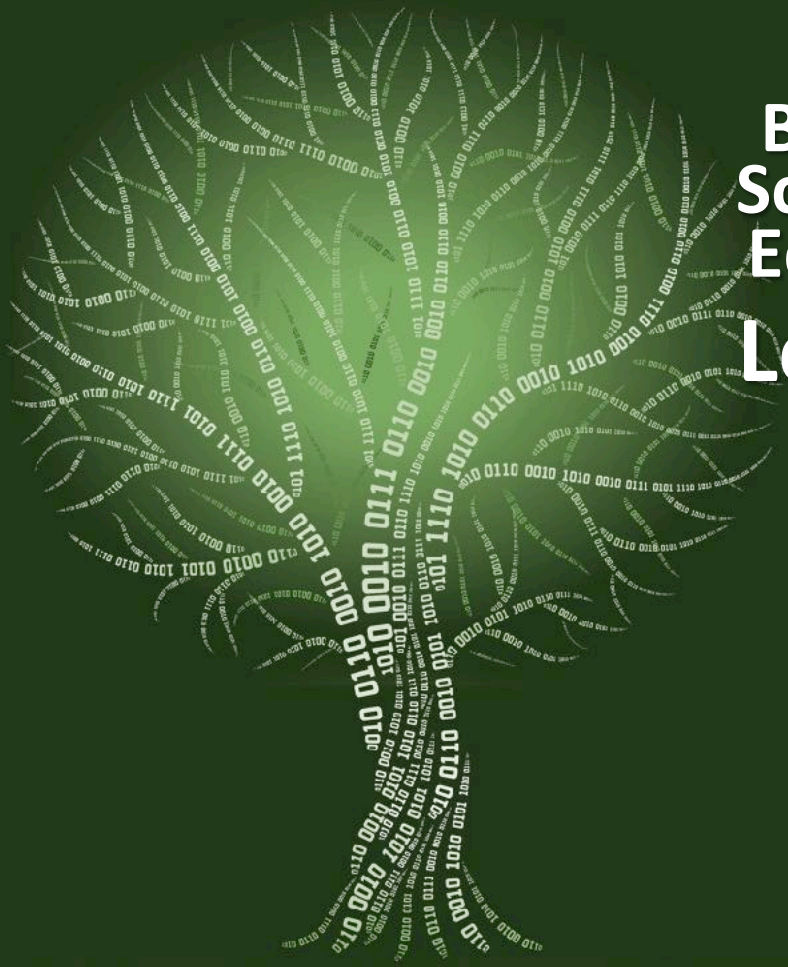
Center for Science of Information



Broader Impacts of the Center for Science of Information's Integrated Education and Diversity Program – Legacy and Lessons Learned

NSF Annual Site Visit

December 11, 2019

Brent T. Ladd
Director of Education
Center for Science of Information STC
Purdue University

Outline

- Goals & Legacy of Center Programs
- Education/Research Training Results
- Curriculum Results
- Diversity + Inclusion Results
- Broader Impacts Shared
- Lessons Learned
- Sustainability

https://soihub.org/legacy/

Education & Diversity Goals

Education Goal: Foster a community of practice in the science of information.

Education Goal: Increase awareness and knowledge of science of information in the broader community.

Diversity Goal: Increase participation of women, underrepresented groups, and U.S. citizens/permanent residents through integration with education and research programs.

"Learning is experience. Everything else is just information." ~ Albert Einstein

Brent T. Ladd
Director of Education

Bob Brown
Managing Director

Todd Coleman, Assoc. Professor, UCSD
CSoI Assistant Director Diversity

Deepak Kumar, Professor, Bryn Mawr
CSoI Associate Director

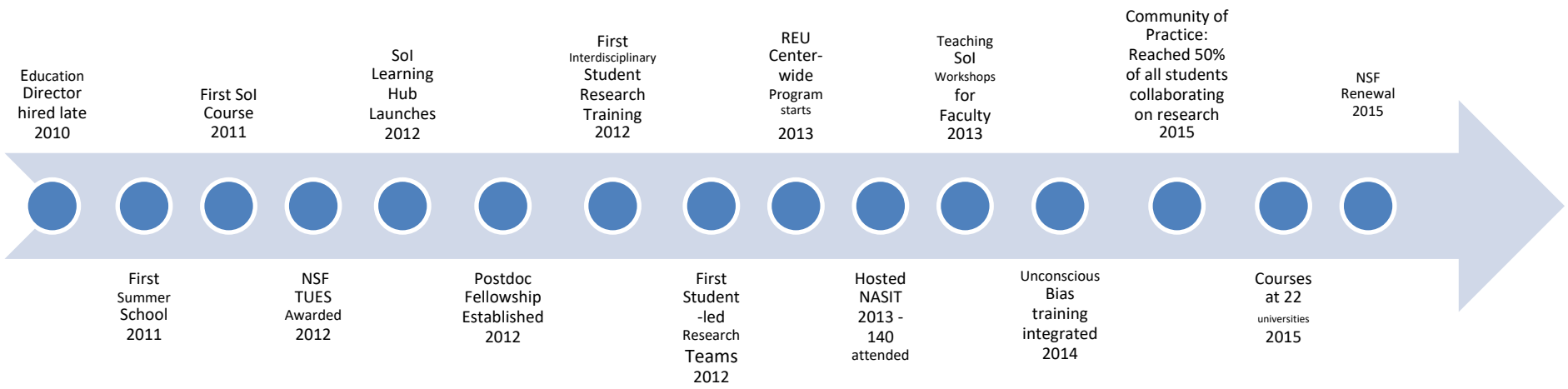
Mark D. Ward, Assoc. Professor, Purdue
CSoI Associate Director

Legacy Outcomes

- Network of next-generation scientists
- Alumni trained in interdisciplinary team science
- Science of Information curriculum for all
- Diverse community of young scholars entering academia and industry
- Broader impacts and lessons learned for the STEM community

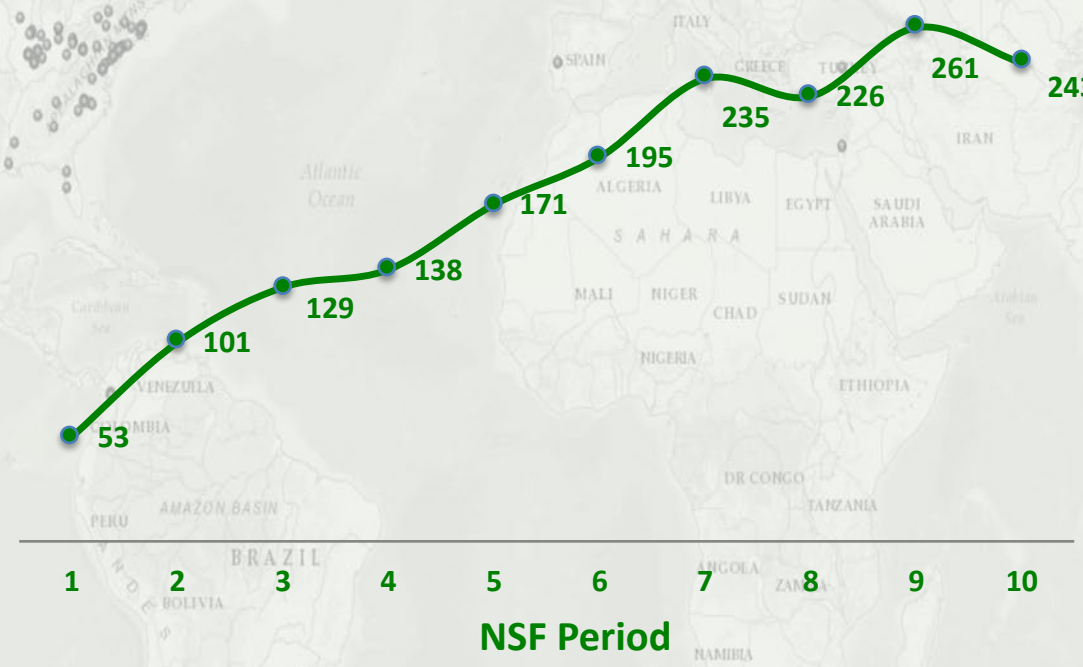
First 5 Years

First Five Years Highlights: Education and Diversity Program



Network of Collaborating Scientists

243 Active Student & Postdoc Members



Network of Collaborating Scientists

Summer Training in Data Science + Team Science

Network of Collaborating Scientists

19 Interdisciplinary Multi-institutional Student Research Teams, with

28 Universities

23 Departments

1:1 Female : Male

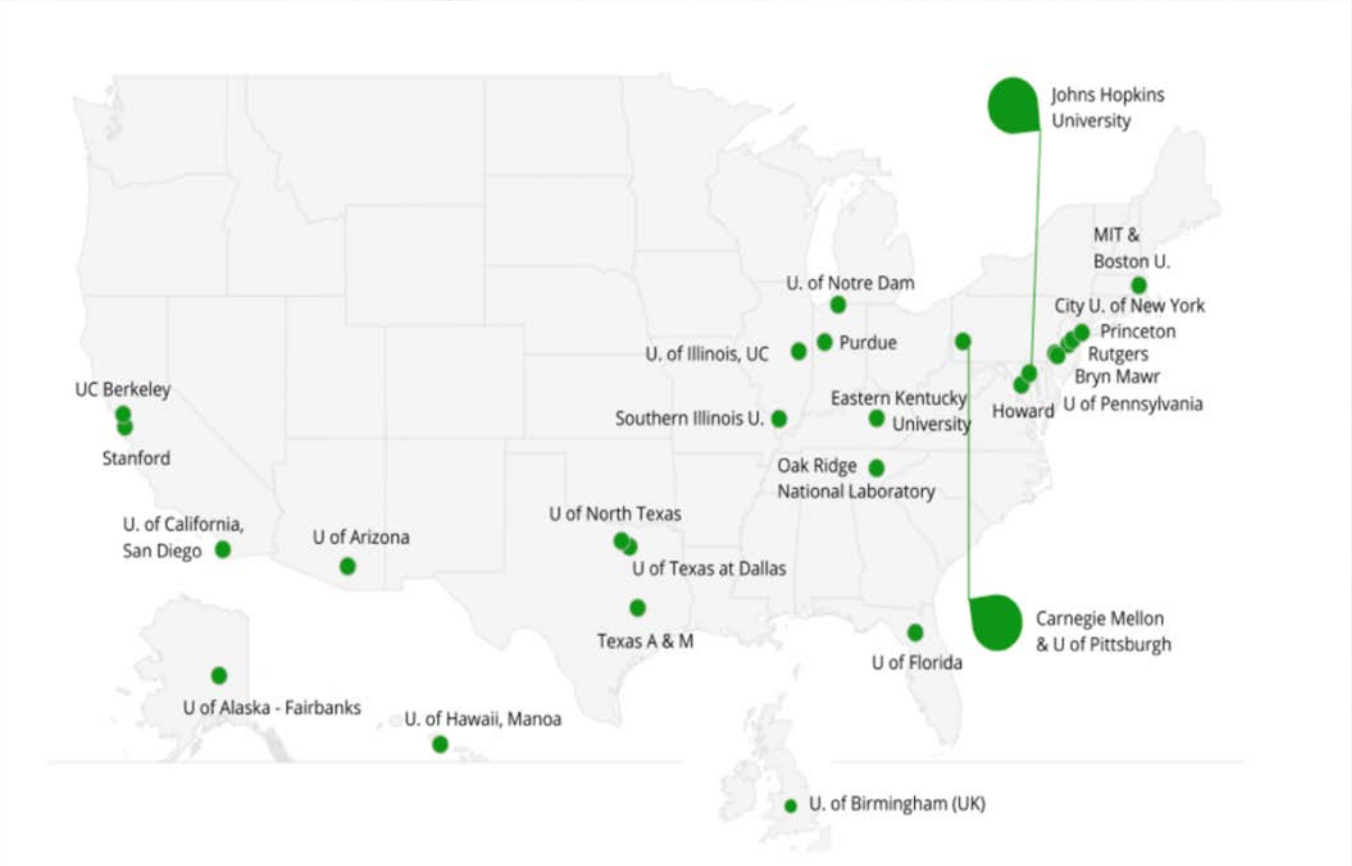
Co-produced 25 Journal and 51 Conference Publications

https://soihub.org/legacy/studentResearch.html

Network of Collaborating Scientists

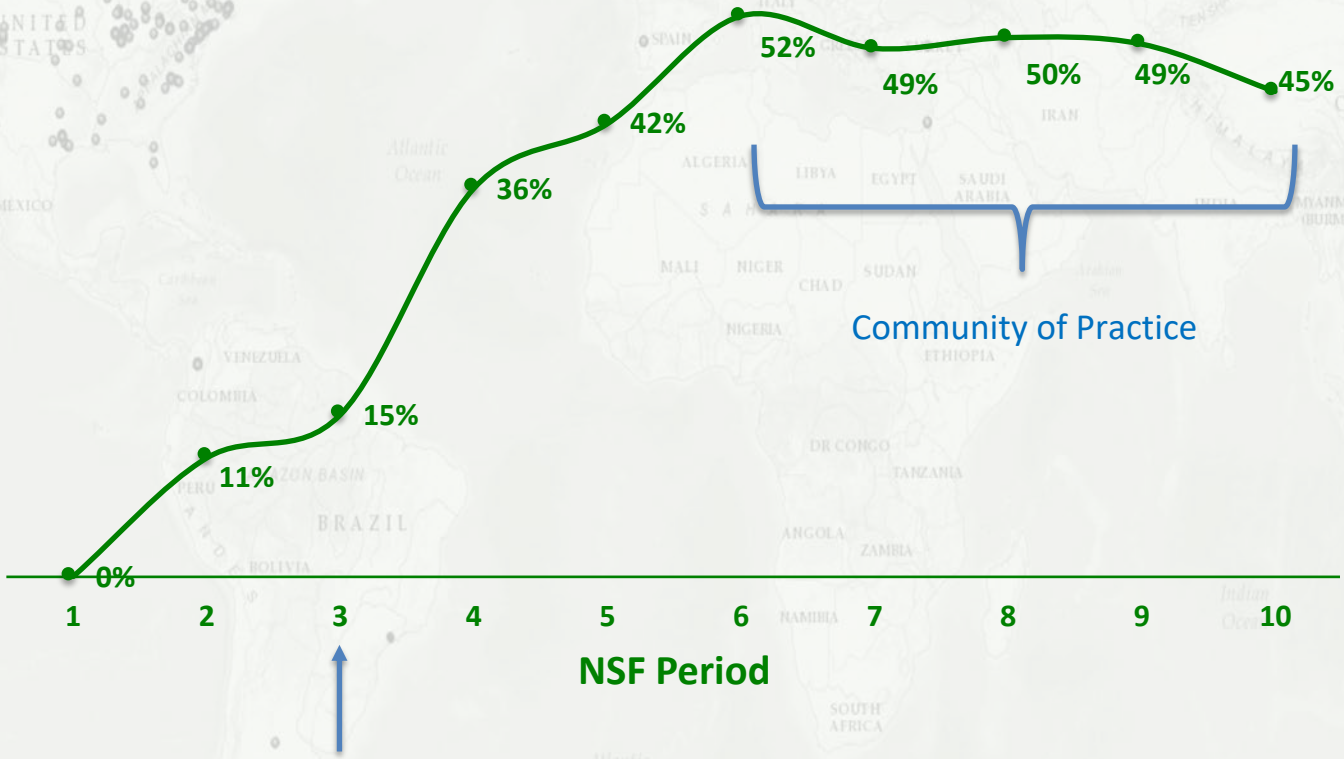
Universities & Domain Areas Represented on Teams

- Agronomy
- Anthropology
- Behavior and Brain Science
- BioEngineering
- Biology
- Chemical Engineering
- Civil Engineering
- Computational Biology
- Computer Engineering
- Computer Science
- Ecological Science and Engineering
- Educational Psychology
- Electrical and Computer Engineering
- Electrical Engineering
- Environmental Engineering
- Forestry and Natural Resources
- Geology
- Languages
- Math
- Medical
- Physics
- Sociology
- Statistics



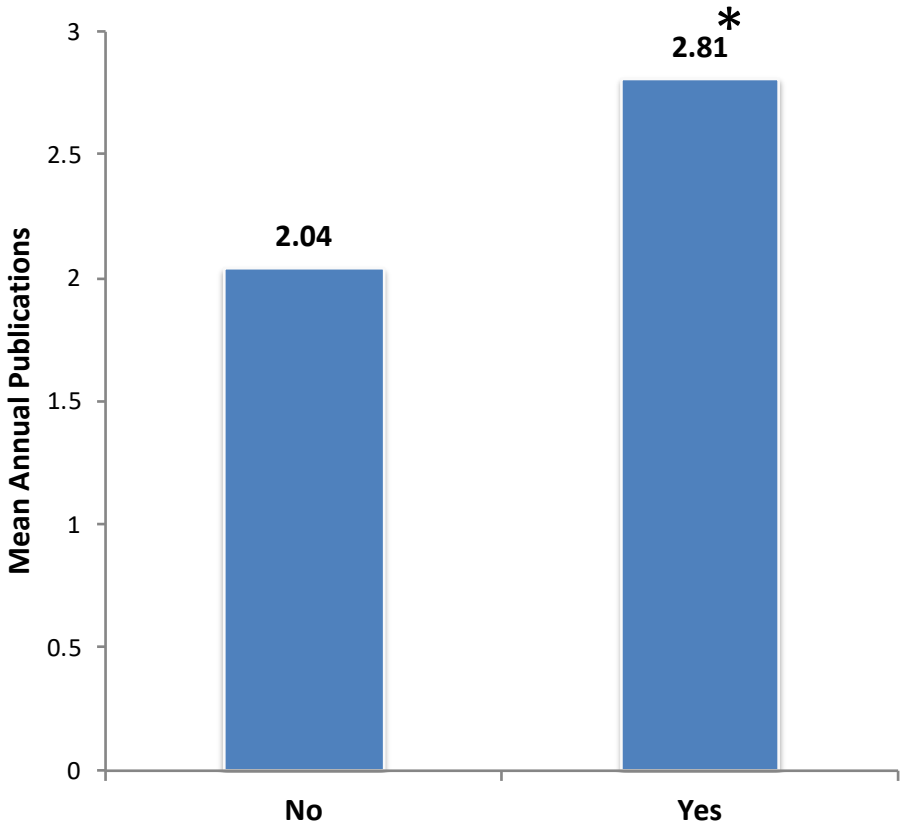
Network of Collaborating Scientists

Percentage of Student & Postdoc Members Collaborating on Research in the Center



Network of Collaborating Scientists

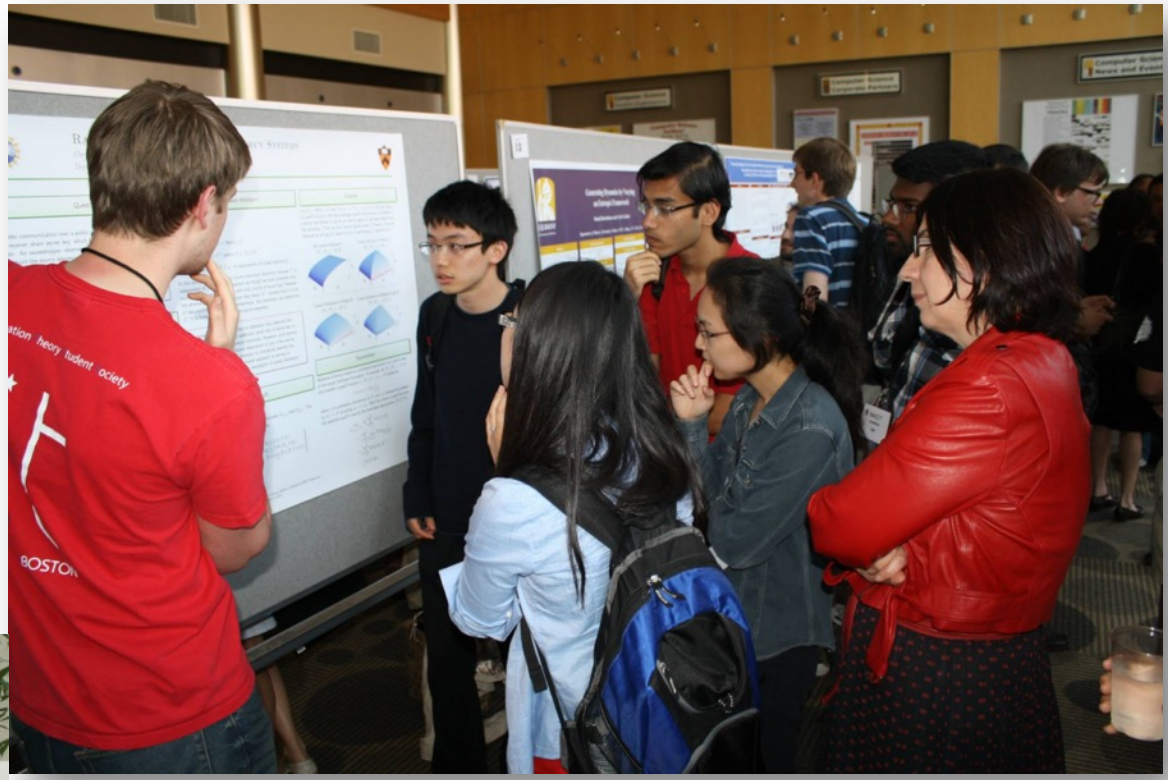
CSoI Graduate students with at least one publication per sample year collaborating beyond their major professor vs. students not collaborating in the CSoI network

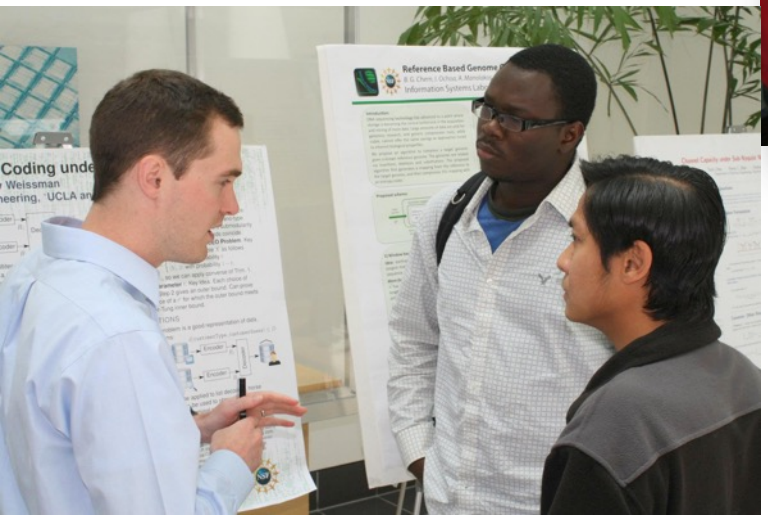


*n=256, F=11.89, p < 0.001

Network of Collaborating Scientists

2011 – Purdue
2012 – Stanford
2013 – CSoI hosted NASIT @ Purdue
2014 – UC San Diego
2015 – UC San Diego NASIT
2016 – Duke NASIT
2017 – GaTech NASIT
2018 – Texas A&M NASIT
2019 – Boston University/MIT NASIT





Summer Schools 2011 - 2019

- **Engaged 785 students + postdocs**
- **Broadened the student community**

Network of Collaborating Scientists


Science of Information Day – UC Berkeley

2013 – UIUC
2013 – UC Berkeley
2014 – TAMU
2014 – Howard
2014 – MIT
2015 – Princeton
2015 – Hawaii
2016 – Stanford
2017 – Bryn Mawr
2018 – UCSD
2019 – Bryn Mawr

CSoI Partners: Research & Teaching Forums

- **836 students + faculty**
- **"Center feel" at the Partners**
- **Local campuses invited**

Teaching SoI Forums

2012 – Bryn Mawr
2013 – Purdue
2014 – UCSD
2020 – Bryn Mawr

Network of Collaborating Scientists

70+ CSoI alumni have secured tenure track or lecturer positions directly after leaving CSoI

This accounts for ¼ of our graduates from our Grad and Postdoc programs. Another ¼ alumni matriculated from undergrad to Grad school and PhD to Postdocs.

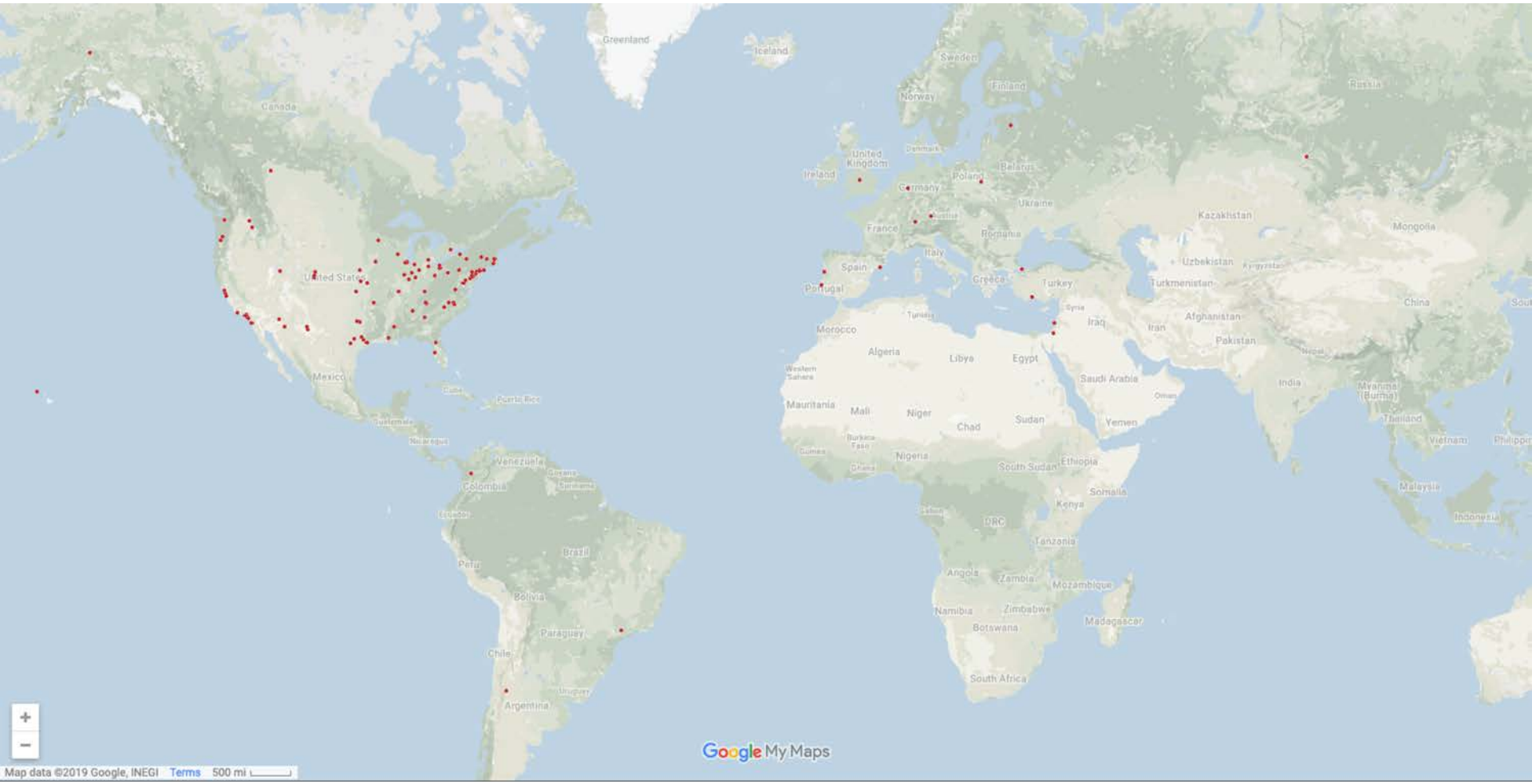
Network of Collaborating Scientists

Year	Name	Placement (Job, Academic position)
2010	Yury Polyanskiy	Assistant Professor, MIT
2011	I-Hong Hou	Assistant Professor, Texas A&M University
2011	Yihong Yu	Assistant Professor, Statistics & Data Science, Yale University
2012	Andrew Drucker	Assistant Professor, University of Chicago
2012	Guy Bresler	Assistant Professor, MIT
2012	Kyung Dae Ko	Faculty Instructor, FAES in NIH
2012	Ming Yang	Associate Professor, Duke University
2012	Rotem Oshman	Senior Lecturer, Tel Aviv University
2012	Stephanie Palmer	Assistant Professor, University of Chicago
2012	Yao Xi	Assistant Professor, Georgia Tech
2013	Farzad Hassanzadeh	Assistant Professor, University of Virginia
2013	Paul Ruvolo	Assistant Professor, Olin College of Engineering
2013	Wei Dai	Faculty Lecturer, Imperial College, London
2013	Yair Noam	Senior Lecturer, Bar-Ilan University
2013	Thomas Courtade	Assistant Professor, UC Berkeley
2013	Pulkit Grover	Assistant Professor, Carnegie Mellon University
2013	Yuval Benjamini	Faculty at Dept. of Statistics, The Hebrew University of Jerusalem
2014	Behrang Asadi	Faculty at Universidad de Malaga, Spain
2014	F. Lopez-Martinez	Assistant Professor, Communication Engineering Department, Universidad
2014	Jarek Duda	Assistant Professor (adiunkt) at Jagiellonian University
2014	Kamal Al Nasr	Assistant Professor, TN State University
2014	Mikhail Tikhonov	Assistant Professor, Washington University in St. Louis
2014	Stefano Rini	Assistant Professor, National Chiao Tung University
2014	Victoria Kostina	Assistant Professor, Caltech
2014	Viveck Cadambe	Faculty, Penn State
2015	Adel Javanmard	Faculty, USC, Marshall School of Business
2015	Dimiter Ostrev	Research Faculty, University of Luxembourg
2015	Flavio Calmon	Assistant Professor, Harvard
2015	Francine Wei	Assistant Professor of Computer Science The College of New jersey
2015	Han-Hsuan Lin	Research Fellow, National University of Singapore, Center for Quantum Tec
2015	Jia Tao	Assistant Professor of Computer Science, Lafayette College, PA

Network of Collaborating Scientists

2015	Joseph Pfeiffer	Assistant professor, Senior Machine Learning Scientist, Microsoft
2015	Phillip Ritchey	Instructional Assistant Professor, Texas A&M University
2015	Sebastian Moreno	Adjunct Professor, Purdue University
2015	Varun Jog	Assistant Professor, University of Wisconsin-Madison
2015	Yuxin Chen	Assistant Professor, Electrical Engineering, Princeton University
2015	Zhiying Wang	Assistant Professor, UC Irvine
2016	Alex Gittens	Faculty, RPI
2016	Alison Sanchez	Faculty, Economics, University of San Diego
2016	Andrew Iliadis	Assistant Professor, Temple University
2016	Calvin Newport	Faculty, Georgetown University
2016	Idoia Ochoa-Alvarez	Assist. Professor University of Illinois Urbana-Champaign
2016	Jinyuan Chen	Assistant Professor, Louisiana Tech University
2016	Luke Redington	Assistant Professor, Technical Communication, University of Maine
2016	Mahnoosh Alizadeh	Assistant Professor, UC, Santa Barbara
2016	Meisam Razaviyayn	Assistant Professor, department of Industrial and Systems Engineering, Uni
2016	Mohsen Ghaffari	Assistant Professor, Zurich
2016	Omur Ozel	Assist. Professor George Washington University
2016	Sanggyun Kim	Faculty, Electrical Engineering, Kyungpook National University, Korea
2017	Albert No	Assistant Professor, Hongik University
2017	Hsin-Hao Su	Faculty, University of North Carolina
2017	Ilan Shomorony	Assist. Professor University of Illinois Urbana-Champaign
2017	Pablo Robles-Granda	Assistant Professor, Notre Dame University
2018	Arun Padakandla	Assistant Professor, University of Tennessee Knoxville
2018	Hsin-Hao Su	Assistant Professor, Boston College Department of Computer Science
2018	Jonathan Ponniah	Assistant Professor, San Jose State University
2018	Kimon Fountoulakis	Assistant Professor, University of Waterloo
2018	Samuel Dunn	Assistant Professor of English, Sacramento State University
2018	Shusen Wang	Assistant Professor, Stevens Institute of Technology
2018	Soheil Feizi	Assistant Professor, University of Maryland, College Park
2018	Xiugang Wu	Assistant Professor, University of Delaware
2018	Serena Bradde	Assistant Professor, University of Waterloo
2018	Benjamin Matcha	Assistant Professor, Physics and Systems Biology, Yale University
2018	Armita Nourmohammad	Assistant Professor, Physics, University of Washington and Max Planck, Go
2018	Kanaka Rajan	Assistant Professor, Neuroscience, Mount Sinai School of Medicine
2018	Lele Wang	Assistant Professor, University of British Colombia
2019	Yuansi Chen	Assistant Professor, Duke University (starting Fall 2020)
2019	Pan Li	Assistant Professor, Purdue University (starting Fall 2020)
2019	Nariman Farsad	Assistant Professor, Ryerson University (starting Jan 2020)
2019	Nicole Eikmeier	Assistant Professor, Grinnel College
2019	Maurina Aranda	Assistant Professor, Southern Illinois University
2019	Abram Magner	Assistant Professor, State University of New York - Albany

Network of Collaborating Scientists



4,500+ student and faculty attendees at CSoI events represent 129 universities worldwide.

Pathways for Student Collaboration
The Center as Catalyst

Informal

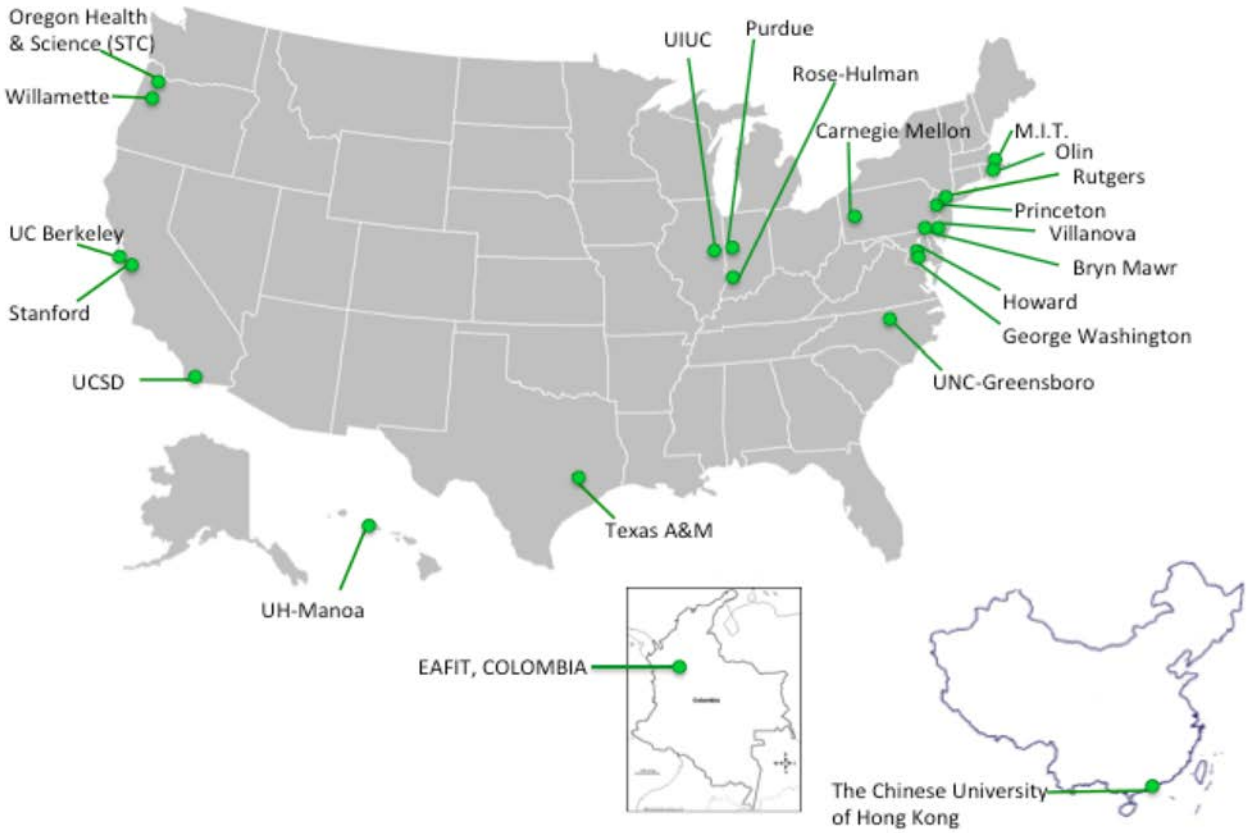
- CSoI Member in our Center Network
- Conferences (poster sessions)
- Summer Schools
- Annual Center Meetings

Formal

- Faculty Research Projects
- Co-Advisors
- Student Training Workshops
- Student-led Research Project Teams

Science of Information Curriculum for All

Classroom-based

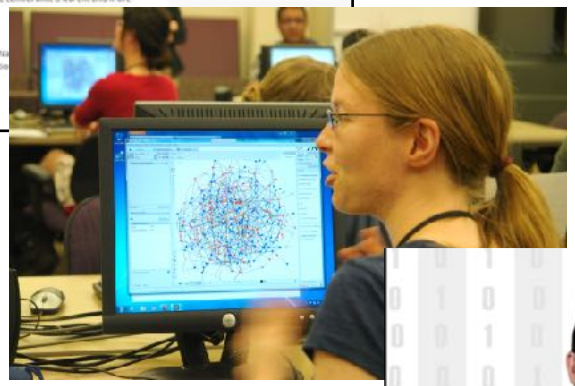


Courses associated with the Center showing university locations. All 11 Center partners, and 11 additional universities are represented. 7,000+ students enrolled at our partner SoI courses during periods 1-10

Science of Information Curriculum for All

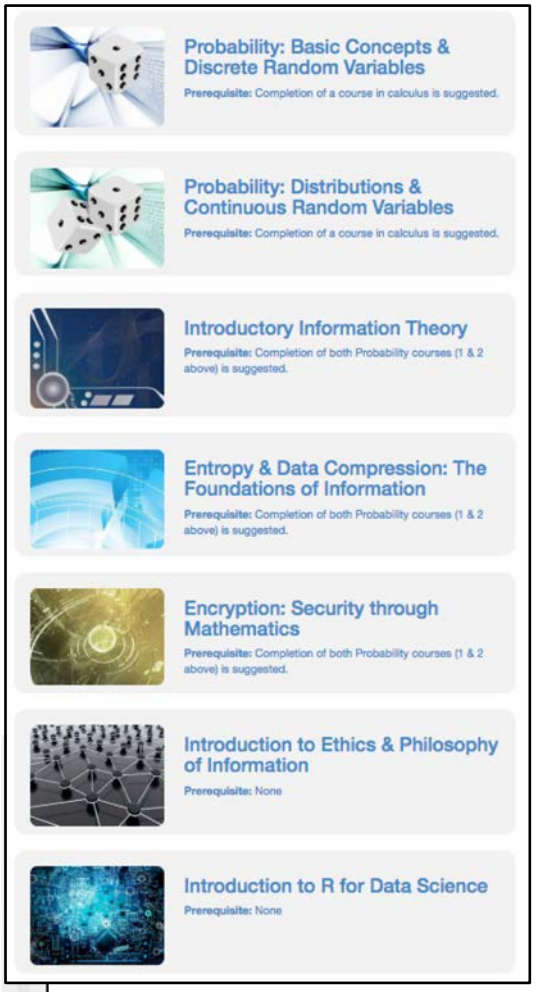
Online Courses

MOOC's



New Courses

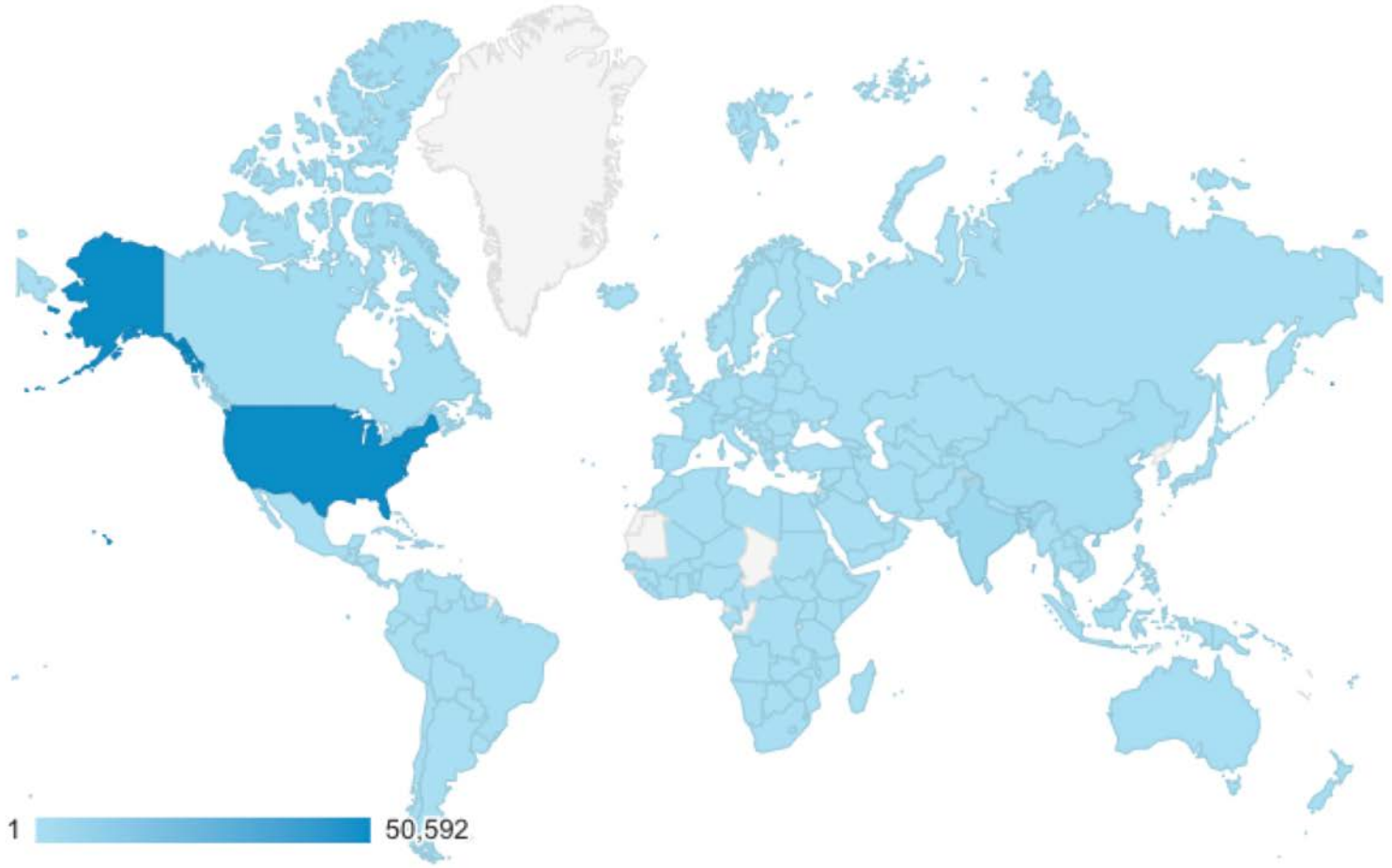
Video Tutorials & Seminars



Online Modules Series

https://www.soihub.org/resources/learning-hub-main/

Science of Information Curriculum for All



Since the inception of soihub.org learners from 184 countries, and all 50 U.S. states and 3 territories have used our content, with pageviews and downloads at 550K (through September 30, 2019).

SoI Courses Evaluation

Indirect and Direct Measures for Learning Objective Outcomes:

- Student surveys
- Faculty surveys
- Focus group interviews
- Grades (homework, tests)
- Class presentations
- Analysis of conceptual assignments (e.g. pre-post in-class writing assignment “What is Information?”)
- Individual student course projects

SoI Courses Evaluation

Percent of students with increases for indicators tied to learning objectives
(Likert Scale with four levels of change; maximum rating = 4).

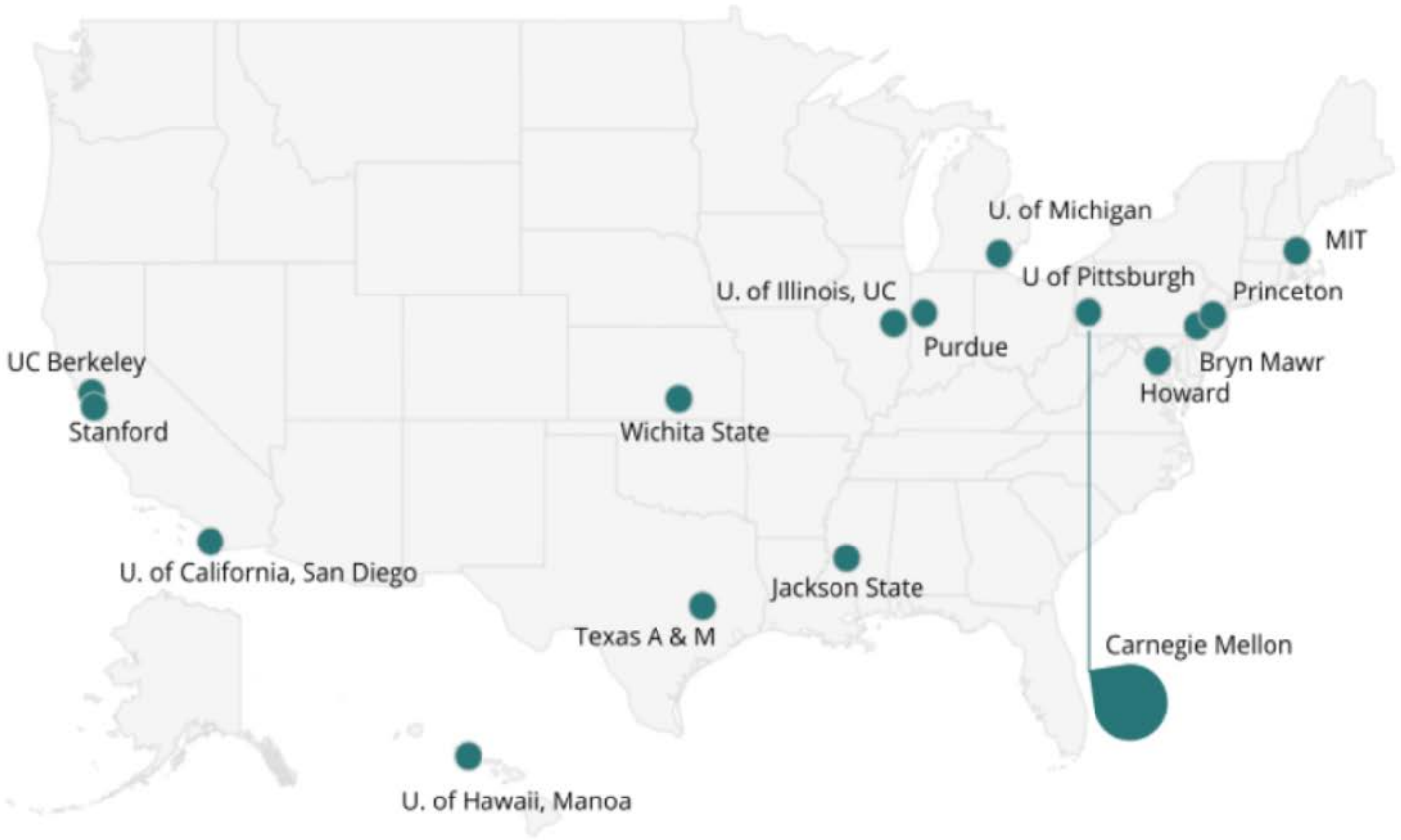
Indicator	Significant Increase	Moderate Increase	Slight Increase	No Change	Mean (max = 4)
Information Literacy	40.5	38.1	19.0	2.4	3.17
Data Skills	39.7	41.4	15.5	3.4	3.17
Multidisciplinary Understanding	37.5	43.8	14.6	4.2	3.15
SoI Awareness	38.6	42.1	14.0	5.3	3.14
Problem Solving Ability	25.0	41.7	29.2	4.2	2.88

CSoI Undergraduate REU Program (2013-current)

- 127 undergraduates from
- 16 universities working with
- 31 faculty that led to internships and jobs at
- 50+ companies and institutions

Diverse Young Scholars Entering Academia and Industry

CSoI Undergraduate Program Participating Universities



CSoI Undergraduate Program 2013-Current
127 student participants

- 60% Women (77/127)
- 27% are Hispanic, African American, and/or Pacific Islander (34/127)
- 91% are US Citizens or Permanent Residents (116/127)

Baselines for CS/EE undergrads:

18% Women, 10% Minority (source: NSF WMPD Report: Women, Minorities, and Persons with Disabilities in Science and Engineering)

79% U.S. citizens (source: NCES, IPEDS report, National Center for Education Statistics, Integrated Postsecondary Education Data System)

CSoI Supported Graduate Students (2019)*

- 30.7% Women
- 8.5% are Hispanic, African American, and/or Pacific Islander, American Indian
- 40.4% are US Citizens or Permanent Residents

**based on survey responses*

Baseline Graduate CS/CE programs:

21% women, 4% minority, 32% US citizens (source: Computing Research Association, Taulbee Survey, May 2017)

Graduate Student Engagement

2018 & 2019 Summer Data Science Training for Interdisciplinary Research Teams:

- 67% Women (33/49)
- 45% U.S. citizens/permanent residents (22/49)
- 35% African American, Hispanic, and/or Native American (17/49)

Interdisciplinary Student-Led Research Teams (2012 – Current):

45% Women (19 teams, 66 members)

Baseline Graduate CS/EE programs:

25% women, 4% minority

Diversity Student Case Studies

https://soihub.org/legacy/diversity.html

Center Post-Doctoral Fellows (10)

50 % of hires have
increased overall diversity

Women, U.S. Citizens, Minority

Results shared with the broader STEM education community

- Ladd, B.T. 2019. The Information Frontiers Program: Expanding Student Capacity for Crossing Domain and Institutional Borders. October 24, 2019, Association for Interdisciplinary Studies 41st Annual Conference, University van Amsterdam, Netherlands
- Ladd, B.T. and Ward, M.D. 2019. Training Students Concurrently in Data Science and Team Science. July 28, 2019, American Statistical Association, Joint Statistical Meetings, Denver, Colorado, USA
- Ladd, B.T. and Brown, R.E. 2019. Broader Impacts of the Information Frontiers Integrated Education and Diversity Program. May 1, 2019, National Alliance for Broader Impacts Summit, Tucson, Arizona, USA
- Ladd, B.T. 2018. Case Study of Interdisciplinary Student Research Teams: Factors, Outcomes, and Lessons Learned. Science of Team Science National Conference, Galveston, TX.
- Andronicos, K. and Ladd, B.T. 2018. Broadening Participation in the Science of Information. NSF INCLUDES Summit, Washington D.C.
- Kumar, D. 2011-17. ACM's SIGCSE Conferences
- Ladd, B.T. 2017-18. NSF STC Program Evaluation Committee
- Ladd, B.T. 2016. Panel member - National Online Learning Week conference. Purdue University
- C. Schimpf, K. Andronicos and J. Main, "Using life course theory to frame women and girls' trajectories toward (or away) from computing: Pre high-school through college years," *2015 IEEE Frontiers in Education Conference (FIE)*, El Paso, TX, 2015, pp. 1-9.
- Assisting new and fledging education and diversity programs (NSF-STC's, Purdue ERC)

Key Lessons Learned
(Education + Research Training Specific)

- **Focus on what will make the program a catalyst while providing unique desirable skills and knowledge** (*what's your niche? don't duplicate what others are already doing better than you can. What makes us > sum of parts?*). – Training students in the emerging SoI/Data science + interdisciplinary team science

- **Create multiple pathways for interdisciplinary training, exchange, learning, team research and applications.** – Build a community of practice

- **Focus Center as a catalyst and *the* hub for the wider student and professional community in our emerging science by supporting and coordinating new and useful curriculum** (*where are the gaps?, translate new research findings into the classroom, coordinate a series of introductory-to-foundational-to-advanced offerings*)
  – Build a hub for learning, inspire others to share and teach it

- **Commit to being inclusive and relevant to the entire community** (domain areas + full spectrum of participants) **by integrating a valued understanding of diversity in all trainings and opportunities** (*more on the next slide…*)

Key Lessons Learned

(Diversity + Inclusion Specific)

- **Fully integrate diversity into everything we do** (*education, research, opportunities, NOT a separate program!)* – Embedded diversity requires a solid education program
- **Full commitment to diversity and inclusion** – Leadership commitment, Funding commitment, professional development, multiple pathways for participation, we take it personally, we follow through with individuals
- **Provide a platform to spotlight** (*women, minorities, U.S. citizens*) – Prestige lectures, Summer School tutorials, Workshop leaders, Student virtual brown bag presentations and spotlight interviews, Postdoc fellows, REU fellows
- **Broadly value diversity** (*participant demographics, first generation, veterans, domain areas, institutions, ways of learning*) – Fosters deeper insights and exchanges among participants

Sustainability

STC Model is Brilliant – staff support for education - diversity

Going Forward:

- Continue to offer established online content as free choice (maintain soihub platforms)
- Classroom-based courses established at partners and other universities will continue
- Our graduates in academia and industry will continue to make an impact

Opportunities Post-STC (require new investment, partnerships, etc)

- Training workshops
- Organizing student and postdoc led interdisciplinary research teams
- REU-style program
- Assist faculty at other colleges to adapt/develop new curriculum
- Create and share education + diversity + inclusion model, training, assisting for STEM/CISE researchers

THANK YOU NSF
& REVIEW BOARD MEMBERS