# Science of Information Summer School 2012
# Outcomes & Survey Results

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## Center for Science of Information



## Hosted by Stanford University

## May 30 – June 1, 2012

**Center for Science of Information**
A National Science Foundation
Science & Technology Center

NSF

Photos by Bob Brown and Stefano Rini

**Summary:**

Forty-three post-docs, graduate, and undergraduate students representing twelve universities participated in the second annual Science of Information summer school held May 30 – June 1, 2012 at Stanford University. The two primary purposes of the school were to 1) orient students to current research and approaches to grand challenges in the areas of communications, knowledge extraction from data, and life sciences problems where information theory can provide insights, and 2) foster networking between the students such that they gained knowledge of their peers' projects and ideas. Eleven CSoI faculty, one post-doc, and one senior research scientist presented surveys and tutorials.

Student feedback* shows the school succeeded in terms of broadening their understanding of the Center research currently moving forward, as well as networking, as students reported enjoying meeting and learning about their peers.  Nearly all students agreed or strongly agreed that they gained practical skills from professors and their peers that they can put to use in their own research, as well as gained an understanding of the key concepts being developed in science of information.

The most common suggestions (from informal student comments in person during the school, coupled with results from this survey) for improving the school is to reduce the number and length of the faculty presentations, while devoting more time for student discussions, lengthening the time for the poster session (or multiple sessions), as well as including a problem for groups of students to work on together. A few students also suggested more time to spend with the faculty presenters outside of the presentation.

"I was amazed to discover the interactive and friendly nature of students at the summer school.  This was the most open scientific environment I have ever had the opportunity to be a part of." ~ Student Participant

* An evaluation survey was developed with input from an expert in Engineering Education at Purdue University.  We followed dissemination and follow-up methods proposed by Dillman (2000). 51% of participants completed the anonymous survey.

Please describe three to five most important things (concepts, new tools, connections with people, etc.) that you gained as a result of the summer school *(each row is a different student response)*:

Concepts, connections with new people, a look into topic variety, etc.

I better understand what information theory is, and how it is applicable to many fields. I enjoyed meeting people from different schools and scientific fields.

*I learned about the application of information theory to a variety of fields.  *I discovered the concept of capacity and its application to DNA sequencing.  *I was exposed to a general background of information theory topics that I hadn't learned aside from my own personal readings.

new concepts, connecting with people, learning about the school in general.

connections  knowledge  ideas for problems to look at

-exposure to research areas not commonly treated in engineering   -ease of interaction with scientist from other areas  -possibility of personal connections

1) I learned a great deal about the use of information theory in tackling important biological questions.  This summer school really demonstrated the potential power of computational strategies for analyzing questions that I am used to tackling from a more cellular/molecular approach.  I think the potential to combine these methods can allow for major progress into various fields.    2) I was amazed to discover the interactive and friendly nature of students at the summer school.  This was the most open scientific environment I have ever had the opportunity to be a part of.  I was thrilled to see how willing people are to discuss ideas and data and to consider establishing collaborations.  And it was really cool to hear about the different experiences of students in math, computer science and engineering.  I really appreciated the chance to interact with students and postdocs who have very different educational backgrounds relative to my own.    3) I found some of the talks extremely valuable and almost wish the topics could be expanded into some sort of online course.  For example, I particularly enjoyed Anath Grama's: Introduction to Network Biology.  I really liked how the lectures were a balance of 1) professors providing more general information on fundamental concepts, 2) more indepth discussions of how the science of information is utilized in the actual research efforts of various faculty members.    4) There were many concepts that were new to me, but I loved hearing them and just getting a sense of the wealth of diverse topics addressed by the Center.  I think this provides an excellent foundation for thinking about our personal areas of expertise from an entirely different perspective.  Andrea Goldsmith's talk was an example of this.    5) I thought many of the talks were presented on a very accessible

level, regardless of our background.  I thought David Tse's talk was a nice example of this.

A broad view of the directions that information theory is heading in;   Meeting other students and post-docs from different disciplines;   An overview of basic biology terms and genetics to help me understand how information theory concepts can be applied to the field.

Connection with people  Concepts  Poster presentation skills.

(a) insight into current research being pursued in the area, especially outside my own school of study.   (b) the chance to interact with other students in the center, exchanging ideas, references on problems of common interest, and just sharing a drink at a local bar,  getting to know them better. it acts as an ice breaker, and makes it easier to collaborate on research problems in the future.  (c) met some professors whom I had only known through papers  that they had written. It was nice to speak to them and exchange ideas on my problems.   (d) started thinking on the subject at broader level, and began to appreciate how different approaches can contribute to the shaping of an entire discipline.

open problems

- Connections to people working in topics related to mine and from different fields (biology mostly) with some mathematical background with which some questions can be discussed.     - The basic biology approach explained to engineers was very profitable.    - The school was good to know what was the state of the art of many interesting fields. Usually, it is not possible to keep updates of the most exciting results and this school was perfect to update.     -The poster session was a good tool to see what other people where working in and discuss some possible collaborations or related problems.

1. I had the opportunity to meet students from Germany and other institutions in the US that share the same research interests than me. Also, I met faculty that showed interest in what I am working on as a researcher. 2. Most of the content of the summer school was closely related to my research and certainly provided great insight in the problems of my interest.  3. I enjoyed all the information provided in the summer school, even those concepts that I am not familiar with were really important for my better understanding of Information Theory

1 interact with people to learn their specific research problems  2 have a chance to present my research to others  3 get a better big picture of the research conducted in the center

Finding people across universities to work with  Lectures on multiple disciplines meant to increase collaboration  Broader perspective of the field  Finding related areas where my research applies  Pitching my research to peers in a professional setting
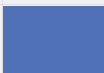
1) Interaction with students from other disciplines: The school brought together students from diverse backgrounds.  This is in contrast to typical IT events, where most researchers are "classical" information theorists.  2) The talks were interdisciplinary: For me, most of the bio-inspired material was new, and should

2)

3) help to inspire new ideas and research directions.  3) The level of interaction with center faculty was very good, and the quality of their talks was excellent.


Connections with people  concepts  presentation experience  outlook

- Met people that are working on related topics  - Got more insight about areas that I want to get involved in  - Learned much more about biology than ever before, making me more "literate" in those topics
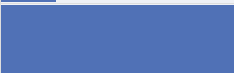
**Participating in the CSoI Summer School allowed me to gain a broad understanding of the research emerging in the field of science of information.**

| # | Answer | Bar | Responses | % |
|---|--------|-----|-----------|---|
| 1 | Strongly Disagree | | 0 | 0% |
| 2 | Disagree | | 0 | 0% |
| 3 | Agree | | 7 | 35% |
| 4 | Strongly Agree | | 13 | 65% |
| 5 | Neither Agree nor Disagree | | 0 | 0% |
| | Total | | 20 | 100% |



"I met some professors whom I had only known through papers that they had written. It was nice to speak to them and exchange ideas on my problems." ~ Student Participant

**Participating in the CSoI Summer School allowed me to learn about other students' and faculty research.**

| # | Answer | Bar | Responses | % |
|---|--------|-----|-----------|---|
| 1 | Strongly Disagree | | 0 | 0% |
| 2 | Disagree | | 0 | 0% |
| 3 | Agree | | 4 | 19.05% |
| 4 | Strongly Agree | | 17 | 80.95% |
| 5 | Neither Agree nor Disagree | | 0 | 0% |
| | Total | | 21 | 100% |



"There were many concepts that were new to me, but I loved hearing them and just getting a sense of the wealth of diverse topics addressed by the Center. I think this provides an excellent foundation for thinking about our personal areas of expertise from an entirely different perspective." ~ Student Participant

**Considering all of the lectures/tutorials you experienced please give an overall rating to the school tutorials/lectures:**

| # | Answer | Bar | Responses | % |
|---|--------|-----|-----------|---|
| 1 | Very Poor | | 0 | 0% |
| 2 | Poor | | 0 | 0% |
| 3 | Fair | | 1 | 4.76% |
| 4 | Good | | 14 | 66.67% |
| 5 | Very Good | | 6 | 28.57% |
| | Total | | 21 | 100% |

**Regarding the student poster research session:**

| # | Question | Strongly Disagree | Disagree | Agree | Strongly Agree | N/A | Responses | Mean |
|---|---|---|---|---|---|---|---|---|
| 1 | I obtained useful feedback to my projects/research from talking to other students and faculty members | - | 1 | 16 | 3 | 1 | 21 | 3.2 |
| 2 | I gained the experience of explaining my work to other professional peers via the poster session | - | - | 9 | 11 | 1 | 21 | 3.6 |
| 3 | I learned about other students' research efforts through the poster session | - | 1 | 11 | 9 | - | 21 | 3.4 |
| 4 | I started some level of professional connections with peers and faculty members through the poster session | - | 3 | 12 | 5 | 1 | 21 | 3.2 |



"The school was good to discover the state of the art of many interesting fields. Usually, it is not possible to keep up to date of the most exciting results and this school was perfect to update me." ~ Student Participant

**Please indicate your level of agreement with the following statements regarding the overall summer school (lectures, breakout session, poster session, time for meeting/networking at lunches, etc)**

| # | Question | Strongly Disagree | Disagree | Agree | Strongly Agree | N/A | Responses | Mean |
|---|---|---|---|---|---|---|---|---|
| 1 | I learned about some practical experiences from professors and my peers | - | - | 13 | 8 | - | 21 | 3.4 |
| 2 | I learned how to translate the theoretical knowledge into practical skills | - | 4 | 12 | 5 | - | 21 | 3.0 |
| 3 | I learned some new skills | - | 5 | 10 | 6 | - | 21 | 3.0 |
| 4 | I understood some key concepts in the field of SoI | - | - | 10 | 11 | - | 21 | 3.5 |
| 5 | I learned some skills from professors and my peers which I can put to use in my own research/courses | - | 2 | 9 | 10 | - | 21 | 3.4 |
| 6 | I learned how to approach specific problems in the field of SoI | - | 2 | 17 | 2 | - | 21 | 3.0 |
| 7 | I learned how to relate the content of the lectures to a bigger picture in the field of SoI | - | 1 | 15 | 5 | - | 21 | 3.2 |

| Please list names of students and faculty at the summer school that you established any potential research connections: |
| --- |
| -  Ernest Kurniawan  - Idoia Ochoa |
| Sudeep Kamath  Jeffery |
| Professor Tsachy Weissman, Professor Deepak Kumar, Professor Olgica Milenkovic, Nima Soltani, Andrea Grigorescu, Victoria Kostina, Sheila Rosenberg, Professor Ananth Grama |
| While having had the opportunity to meet all of the students at the summer school, I, unfortunately, did not meet anyone working towards my specific goals, model validation. |
| Todd Coleman  Andrea Grigorescu  Raeed Chowdhery |
| Faculty: Sergio Verdu  Students: Apart from students in my own school, I interacted with Stefano, Thomas Courtade, Yu, Yuxin, and Varun on research problems. I am already collaborating with some members of the center. |

**The number of days and length of the school was just right.**

| # | Answer | Bar | Responses | % |
|---|--------|-----|-----------|---|
| 1 | Yes | | 18 | 85.71% |
| 2 | No, this many days would be better: | | 3 | 14.29% |
| 3 | No, this many hours each day would be better: | | 3 | 14.29% |
| | Total | | 24 | 100% |

No, This many days would be better:  4 days; 5 days; 5 days

No, This many hours each day would be better: 6 hours; 6 hours;  5 hours

**What would you like to see included and/or improved for the next CSoI Summer School?**

I wasn't able to stay for the poster session on the last day, so an extra day of housing would have been nice, but other than that, the summer school was great.

Next summer, I would like to see the presentation blocks diminish in size. My attention span only lasts for about an hour. I liked the student meals. It was good to socialize with other students in the center.

the 2+ hour last lecture was a bit rough since it was the very end of the program. splitting it up with breaks in between would have been nice.

more time for the poster session

The poster presentation session was simply too short and all the students are presenting, so they cannot see other's people work.

More emphasis on the traditional communications side of information theory. The biology applications are interesting, but they somewhat overwhelmed the other topics.

I think it would be great to have an expanded time for the poster session.  Maybe having a 3 hour poster session with  two groups A and B.  During the 1st 1.5 hours, Group A could stand by their posters and Group B could visit the posters.  Then during the second 1.5 hour session, the groups could switch.  This way, it would be easier for people to have the opportunity both to share their own research on their poster, and to visit other posters to learn about the research of others.

We must have a problem session related to the talks.  The day was very cramped.  More time for the big problem.  1hr 45 mins session in the mornings are too much especially for a diverse audience like us.

more "breaks" between talks, because thats when discussions take place.     some informal group activities

I think poster session would have provided better networking, ideas exchange and research opportunities if more time would have been allowed.

- The current content was quite good. The structure of one day for communication, one for bio was a good approach.

already very good. I think we might have a night of oral presentations. guys who have papers published in top conferences and journals recently could have their work presented orally, say 20 minutes each person.

My one minor criticism is for the poster session.  With all students presenting posters simultaneously (and for a relatively short period of time due to running behind schedule), it was difficult to see all the posters. Perhaps it would be more effective to have three smaller poster sessions; one each day, where a third of the students present their posters at a time.

More on network information theory

Perhaps more time to discuss individual research

More discussion sessions on research between students

**What do you feel are the key grand challenges in science of information that the Center should focus on? please describe:**

- I guess that the current approach to focus on mix results from theory to practical tools as the use of signal processing for DNA sequencing is very exciting and allows to show to biology people that signal processing and communication theory has a lot to say in the understanding of the nature.

Pertaining to the field I'm in, life sciences, I think a great point was brought up that we are collecting a great amount of data, and a challenge following this is the question of how best to store and extract data, and to make sure the digital data is accessible in the future.

Information theory has yet to act as a potent tool in model validation. No framework exists for process of taking experimental data and comparing it to model predictions using IT.

Solving fundamental limits in network information theory and obtaining practical coding schemes  Being able to store and query huge DNA sequences efficiently  Applying information sciences for big data. (social networks, advertising, etc).  Ability to deploy and use sensor networks at scale.

I think that the center should focus on the interdisciplinary aspect of bringing IT tools/insight to different fields.  There are undoubtedly many "low-hanging fruits" here, where a new perspective could lead to large developments in other areas.

The global spread of information science

The brain machine interface

Coming from a cellular/molecular neuroscience background, I think there are fundamental neuroscience questions that could be addressed through the combined expertise of members of the Center.  For example, there is a push in neuroscience to establish a connectome-a map of all of the connections between neurons. However, akin to many of the other "omics"-proteomics, genomics, etc.,  I think there is a fundamental issue of generating a wealth of data, without a clear sense of exactly how this data will be analyzed and used effectively to address fundamental scientific questions.  I think a key grand challenge is to figure out how to use big data like the connectome effeciently, and in a fashion where information can be easily accessible to multiple labs.  I also think that the Center could potentially play a role in using information from different diseases to inform research efforts in diverse areas.  For example, in our lab we have recently discussed examples such as the extremely high incidence of Alzheimer's Disease in Down Syndrome patients, or the potential connection between autism and gastrointestinal disorders.  Additionally, there are genes that play a role in multiple different types of cancer.  The Center seems poised to help synthesize information from diverse areas and find unique ways to offer additional insight into parallel connections between seemingly disparate focuses of translational research.

This isn't a "key grand challenge", but rather an important discussion that was absent: I think it would be interesting to have some ethical discussions about issues whose applications could be controversial, such as genetic testing and information security. There are moral issues at play here that the community seems to ignore in the interest of making new discoveries. It would be interdisciplinary and thought-provoking to have some experts explore some of the moral aspects of this research.

Thinking 5-10 years ahead, I would like to see a graduate program on the Science of Information. Today, we have representations from diverse backgrounds, and a lot of discussion involves telling each other what we do for a living. While, it is very exciting and productive, think of a scenario, where students like me can be groomed to naturally come up with challenging questions in the field of SOI, and have the tools to approach them.     Compression of the ever-increasing volume of biological data is a challenge that is affecting the progress of researchers in medicine and genomics. Information theoretic tools can help formulate this problem and attempt to create solutions that are efficient and make this data more organized and accessible. the center is a platform where both communities can exchange thoughts on which models are useful, and what properties are desired.



"Regarding grand challenges I think that the center should focus on the interdisciplinary aspect of bringing IT tools/insight to different fields.  There are undoubtedly many "low-hanging fruits" here, where a new perspective could lead to large developments in other areas." ~ Student Participant

**Given that the Center is charged by NSF to promote collaboration among faculty and students regarding grand challenges in the field, what methods do you feel would be most successful for involving students in this regard?**

The center seems to be on the right track by hosting the research collaboration session at Purdue later this summer.

Try to get more events and presence on other campuses (at my school, we didn't really do that much).

Small group discussions with faculty about their research would help us to actually meet them. Besides giving their talks, faculty interaction with students was somewhat limited -- no sit-down meals together, little social contact outside of the lecture hall. I met many students and post-docs, but my personal interaction with faculty was more limited.

On the last day of the summer school, I was in an informal group discussion with multiple other students. A general consensus was that students would appreciate having a document listing the ideas for grand challenges suggested by the faculty.  Then the students could think about and expand on these ideas.  A meeting could then be held between faculty and students and postdocs where the group discusses the initial list of goals and talks about strategies to refine and/or expand this list.  Also, I think it would be fantastic if there could be efforts to actually create groups of student and postdocs to work on some of these challenges. It might be great to have time set aside at a meeting to begin to actually delineate some initial concrete directives on individual projects, and then to plan future smaller satellite meetings-or meetings via Skype-where individual collaborative groups could discuss progress made.  Then there could be a future meeting where all of the groups reconvene to discuss how the projects have progressed, changed, and evolved since the original large meeting.  This type of discussion could also provide insight into the feasibility of pursuing various grand challenges, and offer new directions or help indicate which directions should be expanded or refined accordingly.

focused summer schools are probably a good tool

Faculty should decide the problem and then involve their grad students in it. This way they can make student collaborations happen.

Creation of an exchange program, where students from one institute can visit (for varying periods of time, say over the summer for starters) another research group in the center.

I think all students should get involved and participation could be guaranteed by using surveys about some key aspects that should be previously identified and also some aspects that could be provided by students

- The poster session was good and useful to know each others work.  - Lunch times is also a useful way to discuss. Maybe it could be interesting that professors would have lunch with the students so they can discuss things in an informal manner.

one thing I can think is to have a special kind of funding for students to apply. If several students (not necessarily all belong to the center) with different background come up with an interesting problem, with preliminary results supporting the feasibility and worth of their research problem, they can apply the funds to

be supported directly to conduct the research.

I think the summer school was a great way to address this point. I am also confident that the student workshop in July will also be successful here.

Encourage people to interact across disciplines (which is hard because the research language used in 1 discipline is different from that used in other disciplines) Have bridging courses and encourage students to take them. Similar to cloudera.com, professors should start teaching online courses so everyone can benefit from them. Students should be allowed to take online courses across multiple universities for credit.

Increasing awareness



"I gained insight into current research being pursued in the area, especially outside my own school of study. Just the chance to interact with other students in the center, exchanging ideas, references on problems of common interest, and sharing a drink at a local bar, getting to know them better. it acts as an ice breaker, and makes it easier to collaborate on research problems in the future." ~ Student Participant

**Provide any additional comments or suggestions here:**

I had a really great time!

Please, keep organizing the summer school. It is an invaluable opportunity to exchange ideas and learn more about the field

- I really enjoyed this school :)

The school was a great experience. However, instead of making 1 long 2 hour lecture, it is useful to split it into chunks and let people relax and interact between chunks. (Research has shown that a human's attention span is about 10 minutes; that's why many online courses are splitting their lectures into 10 minute youtube video chunks. However, that finding is not yet applied to how we do lectures).

Thank you to the organizers and grad student helpers for a great week! It was an interesting and thoughtful program, and I learned a lot.

I think it would be great to incorporate student and postdoc presentations into either the summer school or some other type of Center gathering.  In particular, I met multiple postdocs at the social/informal activities-lunch/dinners- who were not presenting posters, but who had very interesting things to say about their research.  I would have loved to hear more detail about the work they were doing.   I think this would also serve multiple purposes:  1) postdocs can serve as great examples to grad students as to how to give presentations, design research questions/experiments 2) opportunities for oral presentations are great practice for postdocs.  Along this point, I think incorporating career development workshops into the summer school or other events could be very valuable.  Things like applying for funding, putting together a job talk, etc.

thank you for organizing this event: it was a great opportunity

**Student attendees represented 12 universities:**

Howard University

Princeton University

Purdue University

Stanford University

Technical University of Munich

University of California at Berkeley

University of California at Los Angeles

University of California at San Diego

Center for Technological Telecommunications (Spain)

University of Delaware

University of Illinois at Chicago

University of Nebraska at Lincoln

**Thank you** to faculty, staff, and students at Stanford for hosting the school (especially Dr. Andrea Goldsmith, Pat Oshiro, Nima Soltani, and Alexandros Manolakos), Bob Brown and Stefano Rini for sharing their photographic skills, the entire staff at Center for Science of Information, and the faculty members of CSoI who gave surveys and tutorials and made this a successful school.

**Additional details** of the schedule, videos and slides of lectures, and a link to photos from the school can be found at http://soihub.org/summer-school.php

Special Thank You to Pat Oshiro (above, 2nd from Right) for helping coordinate all the many details onsite, and Professor Andrea Goldsmith (below, Right) for hosting the school at Stanford!