

Welcome to the 2019 CSSS

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1. Place and History
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3. Thoughts and Advice on CSSS
4. What are Complex Systems?(!)
5. Interdisciplinary Communication
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Santa Fe, NM, USA



Institute of American Indian Arts

“To empower creativity and leadership in Native Arts and cultures through higher education, life-long learning, and outreach.”



Institute of American Indian Arts

- IA IA is a dry campus
- Drinking is allowed in dorms
- **DO NOT DRINK in the DANCE CIRCLE**



History

- SFI has held the CSSS in Santa Fe since 1988
- We have also held several schools in China, India, and Chile.
- I attended the CSSS in 1996 and lectured at (04-09) and co-directed (06-09) the China CSSS.
- Since 1998 I have been on the faculty at College of the Atlantic.

Goals of the CSSS

1. Give students an introduction to some of the methods, tools, and concepts in Complex Systems
2. Give students experience working in diverse, interdisciplinary collaborations
3. Create an international, interdisciplinary network of complex systems scholars

Structure of the CSSS

1. Lectures on many different areas of complex systems.
2. Group research projects.
3. Conversations, meals, hikes, adventures, wanderings, connections, emergent phenomena, self-organization.

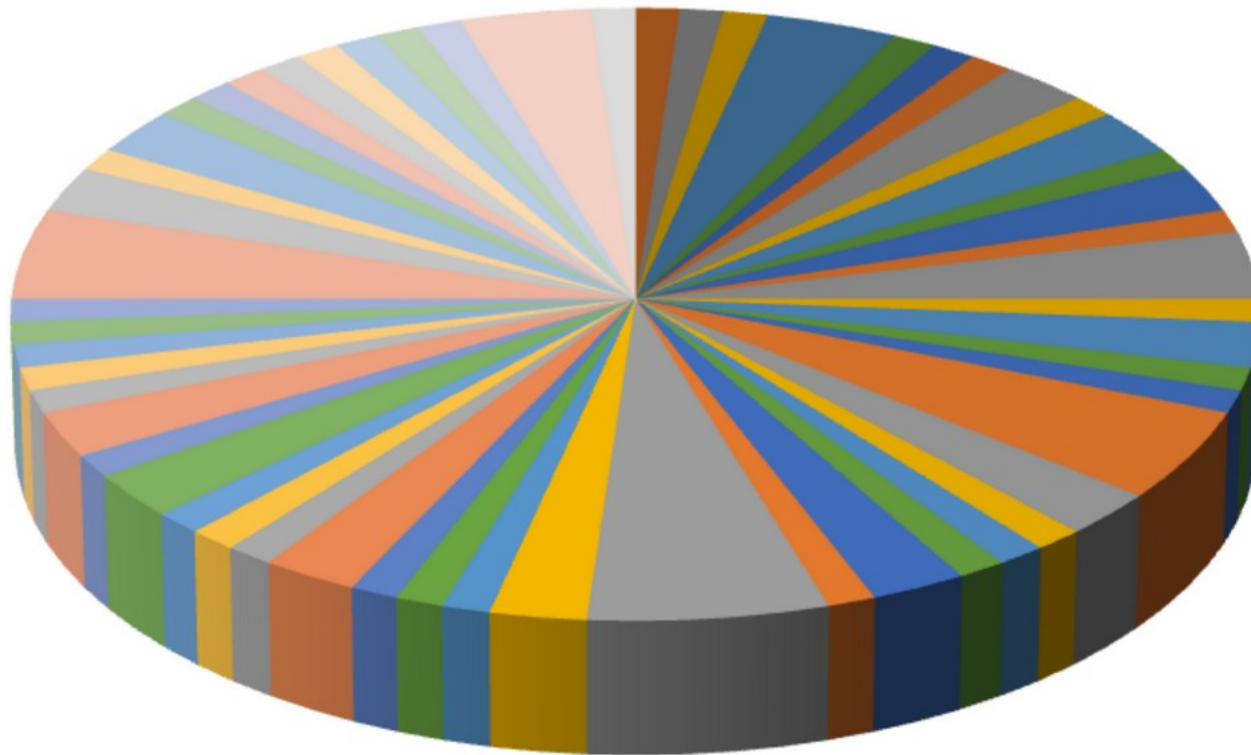
A bit about you

- You come from 27 different countries.
- About half are not native speakers of English.

Now that you're here...

- It's normal to be “weird” and interdisciplinary.
- You won't be asked “But is that physics?” (or biology, economics, etc.)

Disciplines of the CSSS Students



Thoughts on the Lectures

- There will be times when the lectures seem too slow, and times when they seem too fast.
- This is the nature of interdisciplinary work.
- Please ask questions during the lectures.
- Be critical but generous.
- Slides from all lectures will be posted on the wiki.
- **Let's work to minimize electronic distractions.**

Thoughts on the Projects

- Group projects in teams of 3-6
- You'll give a presentation and write a paper
- The process of the project is more important than the product
- Take risks. Experiment.
- Not all projects will work out. That's good.
- Amy and Louisa will provide additional details later today.

Complex Systems: Qualities

It seems to me that Complex Systems share many of the following qualities:

- **Emergence:** Systems contain patterns not obviously part of the rules giving rise to them.
- **Interactions:** Components are not isolated
- Combine **order and disorder**
- **Heterogeneous**
- **Adaptive or dynamic.**

Complex Systems: Topics

What are some things that people think are complex systems?

- Economies, Ecosystems, Evolution, Cities
- Brain, Immune System, Microbiome, ...

What types of questions do we ask?

- How does cooperation or complexity emerge?
- How does evolution or change occur?

Complex Systems = What Complex Systems people study?

Complex Systems: Methods & Tools

- Agent-based Models, Complex Networks
- Information Theory, Dynamical Systems
- Computation Theory, Statistical Mechanics
- Statistics, Machine Learning, etc.

Complex Systems: Cultural Practice

- Aubin and Dahan-Delmedcio, write that dynamical systems is “a vast process of sociodisciplinary convergence and conceptual reconfiguration...[blurring] a number of old epistemological boundaries and conceptual oppositions hitherto seemingly irreducible such as order/disorder, random/nonrandom, simple/complex, local/global, stable/unstable,”
- I think the same could be said of Complex Systems
- What has developed is a common vocabulary, set of questions, and cultural/epistemological values.

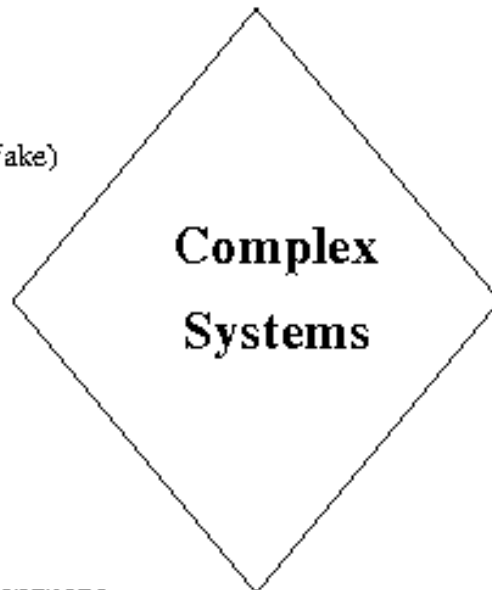
A Possibly Useful Diagram

Themes/General Principles??

Increasing Returns —> "Power laws"
Common Mechanisms for Emergence or Innovation
Stability through Diversity
Complexity Increases?
And many more?

Topics/Models

Neural Networks (real & fake)
Spin Glasses
Evolution (real & fake)
Immune System
Gene Regulation
Pattern Formation
Soft Condensed Matter
Origins of Life
Origins of Civilization
Origin and Evolution of Language
Population Dynamics
And many, many, more...



Tools/Methods

Nonlinear Dynamics
Machine Learning
Cellular Automata
Symbolic Dynamics
Evolutionary Game Theory
Agent-Based Models
Information Theory
Stochastic Processes
Statistical Mechanics/RG
Networks
And many more ...

Foundations

Measures of Complexity
Representation and Detection of Organization
Computability, No Free Lunch Theorems
And many more...

- Based on Fig 1 of Shalizi, pp. 33-114 in Deisboeck and Kresh (eds.), Complex Systems Science in Biomedicine (New York: Springer-Verlag, 2006); <http://arxiv.org/abs/nlin.AO/0307015>

Some Broad Questions

- Are there general principles of complex systems?
- Are there tools and methods that unite complex systems?
- What is the nature of a “solution” to a problem in complex systems?
- Are there cultural practices and norms common across complex systems scientists?
- But.... Don't spend too much energy worrying about the definition of complexity or complex systems.

Sexual Harassment Policy

- SFI has a policy to prevent sexual harassment and assault.
- All staff, faculty, and students are bound by this policy.
- I am happy to answer questions (later) about SFI's policy.
- If you have concerns about sexual harassment or sexual assault, talk to any CSSS staff member or Janet Gunn, SFI's title IX coordinator.

Communication Patterns

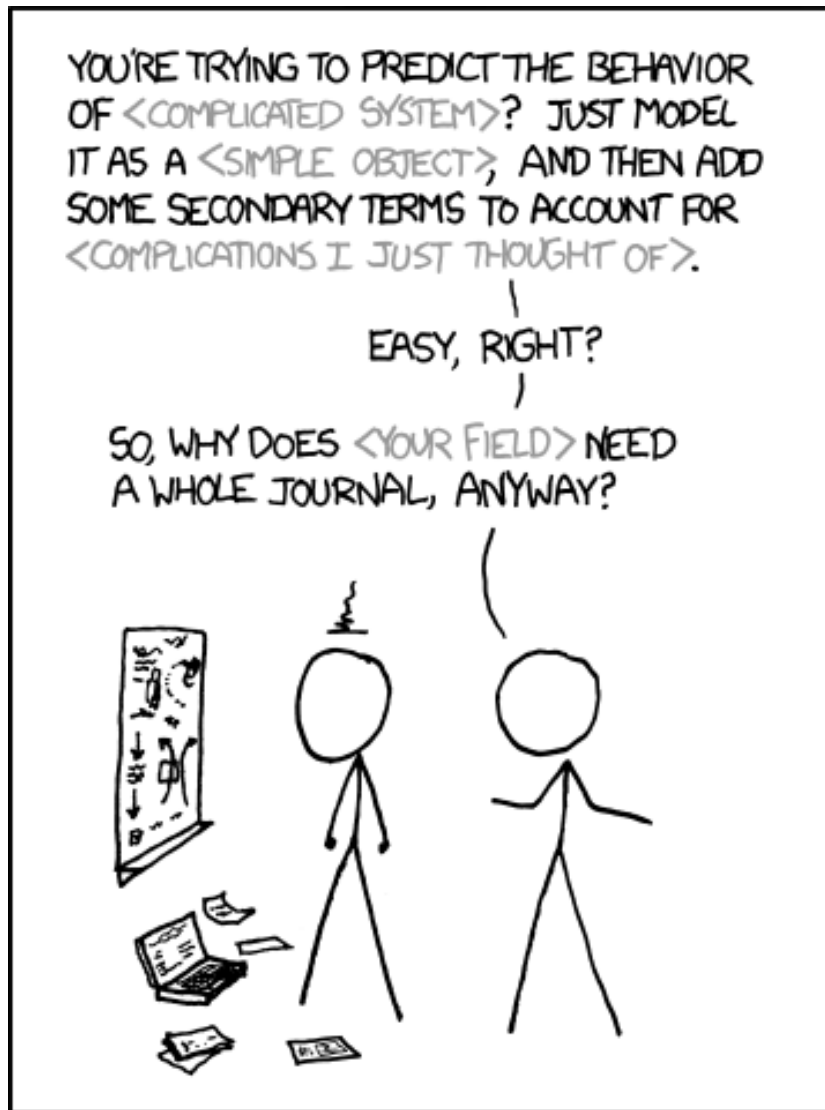
Creating a space where all can contribute and flourish takes attention and care:

- Step up, step back
- Be mindful of gendered communication patterns
- Use “I” statements
- Gently lean into discomfort
- Communication and collaboration is an active, shared responsibility

Interdisciplinary Collaboration

- Hard
- Important
- Rewarding

Disciplinary Humility



- Physicists: Don't do this.
- Disciplines should not be placed in a hierarchy.
- We all have something to learn from each other.
- <https://xkcd.com/793/>

LIBERAL-ARTS MAJORS MAY BE ANNOYING SOMETIMES, BUT THERE'S NOTHING MORE OBNOXIOUS THAN A PHYSICIST FIRST ENCOUNTERING A NEW SUBJECT.

Other Thoughts

- Engage. Be present. Connect.
- Explore. Self organize.
- Take care of yourself. Sleep. Recharge.
- Pace yourself. It can be a long month.
- We have a fantastic staff: please come to us with questions and ideas.

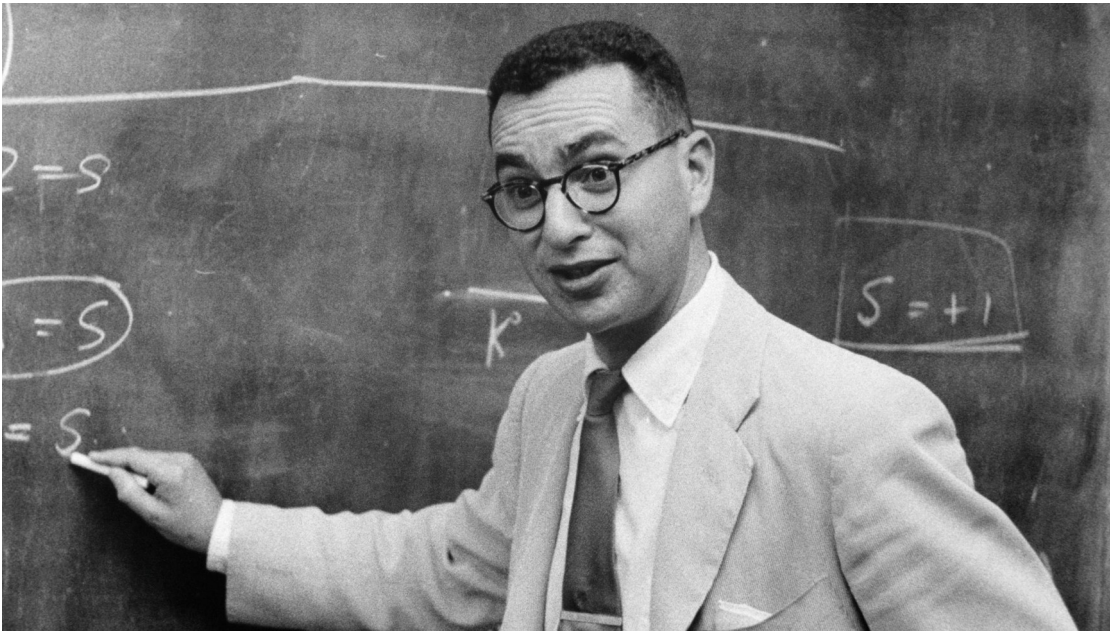
Alfred Hübler

May 16, 1957 – January 27, 2018



Murray Gell-Mann

September 15, 1929 – May 24, 2019



Conclusion

- Dive in to this amazing opportunity.
- We are at a special campus in a special city.
- We have a great line-up of faculty.
- We have a great staff. We're here to help.
- Take care of yourselves and each other.
- It's going to be an awesome month.

Readings

- Richard Levins, “Why Programs Fail,” *Monthly Review*. 61(10), 2010.
<https://monthlyreview.org/2010/03/01/why-programs-fail/>
- Clay Shirky, Why I Just Asked my Students to Put their Laptops Away. Medium.com. September 2014.
<https://medium.com/@cshirky/why-i-just-asked-my-students-to-put-their-laptops-away-7f5f7c50f368>
- Aubin, David, and Amy Dahan Dalmedico. "Writing the history of dynamical systems and chaos: *longue durée* and revolution, disciplines and cultures." *Historia mathematica* 29.3 (2002): 273-339.