Integrated Science and Mathematics (iSciMath) at WSU

Mission

To build an integrated community capable of solving the highly challenging, data-intensive problems required to transform science and technology in modern society, by training students and professionals to deeply understand the mathematical and computational tools needed to extract insight from complex data.

In Brief

- What? To build a broad community that transcends traditional academic classifications, capable of highly efficient communication to bring a broad range of skills and technologies to bear on the most important and pressing problems in science.
- Where? WSU in Pullman, but with a full virtual online presence.
- When? Starting Fall 2020, building to a full program in 3 years.
- Who? Mathematics, Physics, Chemistry, Economics, and Life Sciences faculty at WSU, growing to include broad participation from academia, industry, and national labs.
- How? Institutional, industrial, and private support will ensure maximum flexibility, enabling us to respond rapidly to pressing needs.

Frequent interactions, and a carefully curated set of courses and seminars will ensure members speak the same technical language.

Goals

The Integrated Science and Mathematics (iSciMath) project aims:

- To build an ideal environment to train and inspire **graduate students** to solve problems using deep mathematical insight. The goal is to create a strong community where graduate students interact passionately, sharing their work. Through the program, students will be taught a common "language" and mathematical background to facilitate efficient and and effective communication. Ease of interaction – open doors – will make the hard work needed to solve important problems fun. This environment will be **highly productive**, identifying the essence of both problems and tools without the distraction of extraneous details. This essence is useful, and without the cruft, can be easily applied in diverse contexts.

i.e. common notations and concepts.

Simple but not simplistic. *I.e. covariant metric- and coordinate-free formulations without index gymnastics.*

- DITTO FOR FACULTY. A silo-free collaborative environment where faculty are encouraged to work on important interdisciplinary projects. Faculty will participate as needed in educational aspects so they too develop a common language. Faculty will be drawn from across the university, including **mathematics**, **physics**, **statistics**, **economics**, **engineering**, **computer science**, **chemistry** – essentially anyone interested in using modern mathematical methods. In the broader iSchool, alternate metrics for impact will allow faculty to be appropriately rewarded for impact beyond the standard model of publications and funding, and with appropriate compensation for teaching for both faculty and their departments.
- SEMINARS, ADVANCED CLASSES, frequent teas, and an vigorous visitor program. Develop an ecosystem that consistently inspires and connects those within the iSciMath and beyond.
- COMPUTATIONAL COLLABORATIVE MAKERSPACES for immediate exploration, validation, and communication of ideas. By providing tools such as CoCalc for rapid but realistic prototyping, participants can ground their understanding by ensuring convergence of theory and computational analysis. Interactive exploration enables rapid but deep exploration of complex ideas with many alternative creative strategies.

The `cocalc.com` platform provides a full computing environment (virtual machines) hosted on the cloud allowing for real-time collaborative analysis.

- HONEST OUTREACH. Members of the iSciMath community will become full participants in the Complexity, Data, and Learning Group (CDLG) immersive education project providing honest outreach to the community from elementary school to the general public. Explain sophisticated concepts in simple terms without compromising the integrity or utility of the idea. Ideally the audience will be able to actually use these ideas. Pursuing this goal will enable the reduction of problems and tools to their essence (goal 1).
- RECRUITING AND RETAINING TALENT. These goals will make it possible to recruit and keep very motivated and inspired (and therefore inspiring) students and faculty.
- INTERDISCIPLINARY IMPACT. This environment will lead to a high level of productivity solving important problems without boundaries. The interdisciplinary and creative nature of the group will generate significant impact, and be able to attract significant **funding**, especially from sources that are traditionally difficult to access from within silos. Original cool stuff will happen.

The Initial Plan

To get the iSciMath started, we will implement the following:

- SEMINARS: A carefully designed seminar series to expose members of the group to cutting-edge ideas, but expressed in an accessible manner. Two series will be run:
  1. **Overviews (1-3 lectures/topic):** Overview of ideas or fields, establishing a common language for the iSciMath community. These talks should be accessible to everyone in the group, providing "pigeon holes". May provide practical tools where possible. (Pre-lecture preparation is minimal.)
  2. **In-essence (5-20 lectures each):** More in-depth analyses, still accessible, but with teeth. These lectures will fill the pigeon holes, and provide the audience with real tools that can be used to solve problems. Interactive participation is required (readings, assignments, computations, etc.)

Edward Tufte has enlightening discussions about effectively communicating data: www.edwardtufte.com/tufte

- WEEKLY TEA: General social interactions over tea, coffee, or after work cocktail hours, book clubs etc. within the wider CDLG family and with visitors. These interactions should be frequent, casual, and unstructured to encourage serendipitous discovery. These environments must be friendly so that one can turn off judgement – a requirement for creativity.
- COCALC MAKERSPACE: Establish workflow and introductory videos to help people quickly get started with tools like Jupyter notebooks.
- VIRTUAL COLLABORATION SPACE: Large screen for Zoom, good camera capable of seeing board, microphones, etc.
- TOPICS: Reflecting current expertise in the iSciMath group, these represent some of the core material we feel is essential to our research.
  1. **Data Driven Inference + Geometric Analysis:** Geometric Measure Theory, Topological Data Analysis, inference of geometry from measurements — *Kevin Vixie, Bala Krishnamoorthy*
  2. **Quantum Computing:** NQN, WSU Quantum Initiative — *Michael Forbes*
  3. **QFT/Stat Mech Problems:** CFT, Duality, Perturbation theory and convergence, Asymptotic series, etc. — *Michael Forbes, Fred Gittes*
  4. **Computational GR:** Covariant formulations of fluid mechanics, relativity etc. Klein-Gordon equation, Green's Functions. — *Matthew Duez*
  5. **Computational Chemistry:** Modeling and Simulation of Complex, Multicomponent Solutions and Their Interfaces — *Aurora Clark*
  6. **Mathematical Economics:** Microeconomic Theory, Game Theory and Industrial Organization, Public and Environmental Economics — *Felix Munoz-Garcia*