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<td>Friday, October 09, 2015</td>
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<td>Student AIM Seminar</td>
<td>Olivia Walch (University of Michigan)</td>
<td>Combining math and mobile apps for fun and profit</td>
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<td>Friday, October 16, 2015</td>
<td>4:10pm-5:00pm</td>
<td>Student AIM Seminar</td>
<td>David Prigge (University of Michigan)</td>
<td>The coupling of cell-centered and staggered-grid Lagrangian Hydrodynamics solvers in 2D</td>
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<td>Friday, November 06, 2015</td>
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<td>Student AIM Seminar</td>
<td>Martin Genzel (TU Berlin)</td>
<td>Sparse Proteomics Analysis: Toward a Mathematical Theory for Feature Selection from Forward Models</td>
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<td>Friday, November 13, 2015</td>
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<td>Andrew Brouwer (University of Michigan)</td>
<td>HPV as the Etiological Agent of Oral Cancer</td>
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<td>Friday, November 20, 2015</td>
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<td>Student AIM Seminar</td>
<td>Audra McMillan (University of Michigan)</td>
<td>An Introduction to Differential Privacy</td>
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<td>Student AIM Seminar</td>
<td>Chris Miles (University of Michigan)</td>
<td>Optimal control of a shell model for mixing</td>
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<td>Friday, January 22, 2016</td>
<td>4:10pm-5:00pm</td>
<td>Student AIM Seminar</td>
<td>Scott Rich (University of Michigan)</td>
<td>Utilizing Phase Response Curves to understand the activity of large neuronal networks</td>
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<td>Friday, February 05, 2016</td>
<td>4:10pm-5:00pm</td>
<td>Student AIM Seminar</td>
<td>Derek Wood (University of Michigan)</td>
<td>Sensor Array Imaging in Random Media</td>
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<td>Friday, February 12, 2016</td>
<td>4:10pm-5:00pm</td>
<td>Student AIM Seminar</td>
<td>Michael Newman (University of Michigan)</td>
<td>Introduction to Quantum Information</td>
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Abstracts

Student AIM Seminar
Friday, October 09, 2015, 4:10pm-5:00pm
1084 East Hall
Olivia Walch (University of Michigan)
Combining math and mobile apps for fun and profit

Mobile technology allows us to put research-level algorithms into the hands of users around the world. Here, I'll discuss several fun mobile apps developed by myself and others in the UMich Mathematics Department, as well as the underlying math involved in their creation. Topics include: image processing and segmentation, machine learning, and 3D printing.

Student AIM Seminar
Friday, October 16, 2015, 4:10pm-5:00pm
1084 East Hall
David Prigge (University of Michigan)
The coupling of cell-centered and staggered-grid Lagrangian Hydrodynamics solvers in 2D

Cell-centered (CCH) and staggered-grid (SGH) solvers are both useful in solving hydrodynamics equations in the Lagrangian formulation. CCH solvers have shown incredible promise in robustness, accuracy, and simplicity in Arbitrary Lagrangian-Eulerian (ALE) schemes. SGH solvers are often used in engineering applications to solve problems with nodal structure elements, such as beams or shells.

For the first part of this talk, we will discuss what a Lagrangian formulation of a problem is and what it means to be a cell-centered or staggered-grid solver for simple examples.

For the second part of this talk, we will look at an example from 2D hydrodynamics involving all of these concepts. We will discuss a hybrid method for coupling CCH and SGH solvers and compare the results from the hybrid method to the results from a strictly CCH solver and a strictly SGH solver on many different test problems. Visualization of how each solver performs on the test problems will be included. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344.
Student AIM Seminar
Friday, October 23, 2015, 4:10pm-5:00pm
1084 East Hall
Brandon Carter (University of Michigan)
How to (not) use lattices for fun and profit

With the introduction of quantum computing, many classical problems in computer science become much easier to solve. In particular, common asymmetric cryptographic protocols like RSA--and its elliptic curve counterpart--become easily broken, so new protocols are required. One class of candidates is constructed from (conjecturally) hard lattice problems.

We will give an overview of common lattice problems, and describe how these can be used for cryptographic constructions. Time permitting, we will focus on the weakness of one particular cryptographic primitive, SOLILOQUY, that has recently been found to be susceptible to quantum attack, and describe a potential direction that may avoid such weaknesses.
Tumor diseases, such as cancer, rank among the most frequent causes of death in Western countries. The clinical research of the last decades has shown that the pathological mechanisms of many diseases are manifested on the level of protein activities. In order to improve the clinical treatment options and early diagnostics, it is therefore necessary to better understand protein structures and their interactions. The related research field of proteomics focuses on analyzing the so-called proteome, which denotes the entire set of proteins of a human individual at a certain point of time. Unfortunately, proteomics-data, e.g., produced by mass spectrometry, is usually extremely high-dimensional. Therefore, it is a very difficult task to extract a disease fingerprint, which is a small set of proteins allowing for an appropriate classification of a patient's health status.

In the first part of this talk, we will see that the assumption of sparsity can help us to cope with this challenge. In this context, the method of Sparse Proteomics Analysis (SPA) will be introduced, which is a combination of various generic algorithmic steps enabling us to build sparse and reliable classifiers. The second part of the talk is then devoted to a theoretical foundation of SPA. Relying on a simple linear forward model for the data, we will see that very recent results from high-dimensional estimation theory can be used to prove rigorous recovery guarantees.

The human papillomavirus (HPV) infects multiple sites in the human epithelium (genitals, oral cavity, anal canal) and is responsible for over 90% of anogenital cancer and an increasing percentage of cancer of the oral cavity, primarily in the oropharynx. We leverage age-period-cohort (APC) epidemiological models combined with multistage clonal expansion (MSCE) models (stochastic models of cancer biology) to consider temporal trends and demographic differences in incidence of oral squamous cell carcinomas in the Surveillance, Epidemiology, and End Results (SEER) cancer registry for three groups of subsites: presumed HPV-related, presumed HPV-unrelated, and oral tongue. This method allows us to distinguish between period and birth cohort temporal effects as well as make inferences about the underlying cancer biology.
Sebastian is a belieber so, over the years, everyone in the department has told him (in confidence) whether or not they like the Beibs. The recruits for next year would like the fraction of the department who are beliebers made public to help aid their decision. Michael is against this statistic being released because he worries it might reveal something embarrassing about him. The field of differential privacy addresses the two main questions: are Michael's fears valid? How can Sebastian release a useful version of this statistic and stay friends with Michael? In addition to ensuring that Michael's belieber status does not become public information, differential privacy places the notion of privacy in a rigorous mathematical framework and gives us a way to quantify privacy loss.

In the first part of this talk we'll discuss the VC-dimension of a set of queries. The VC-dimension can be thought of as a measure of how "complex" a class of functions is. This is a tool borrowed from the much older field of learning theory. We'll discuss why it is useful in learning theory and how the VC-dimension of a set of queries is related to how accurately we can answer the queries in a differentially private manner.

Optimal mixing is significant to process engineering within industries such as food, pharmaceutical, petrochemical, and more. An important question in this field is "How should one stir to create a homogeneous mixture while being energetically efficient?" To answer this question, we consider an initially unmixed scalar field representing some concentration within a fluid on a periodic domain. This passive-scalar field is advected by the velocity field, our control variable, constrained by a some physical quantity such as energy or enstrophy. We consider two objectives: local-in-time optimization (what will maximize the mixing rate now?) and global-in-time optimization (what will maximize mixing at the end time?). In this presentation, we use the $H^{-1}$ mix-norm to measure mixing. To gain a qualitative understanding of optimal mixing, we will examine a simplified model of mixing by using a shell model of passive-scalar advection.
Since the era of Hodgkin and Huxley in the 1950s, the neurons in your brain have been modeled with various degrees of accuracy and complexity as systems of differential equations. Since these models typically exhibit oscillatory properties, a common way to analyze their properties is with the Phase Response Curve (PRC). PRCs illustrate how a perturbation delivered at various phases of an oscillation differentially advance or delay the timing of subsequent oscillations. For neurons, the perturbations are synaptic activity and the oscillations are action potential firings.

In this talk, I will first provide a background of the mathematics underlying the PRC and its application to analyzing systems of connected oscillators. I will then provide results from my current research that show how the properties of a neuron's PRC can change the overall behavior of a large neuronal network and briefly discuss the biological importance of these results.
On the first day of a complexity theory course, a teacher generally introduces the complexity classes P and NP: the set of tasks that can be done efficiently on a deterministic and nondeterministic computing agent, respectively. These classes are the most important because they represent the boundary between things we can actually do on our computers in a reasonable amount of time, and things we can't.

More recently, quantum mechanics has stretched this computational boundary even further: tasks that are fundamentally impossible using the computers of today might not be for the computers of tomorrow (or at least, maybe a century from now).

The field of quantum information theory explores this question: assuming quantum mechanics is valid, what type of computational power does its view of nature give us? This is the new boundary of things we could actually do on our computers.

In this talk, I will give an abbreviated introduction to the basics of quantum information. I will discuss a few of its applications, and if time permits, I will give a brief overview of my research in the direction of quantum cryptography. I'll assume nothing more than some linear algebra and familiarity with tensor products.