Celebration of Women in Mathematics Day
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Research Lightning Talks

Samantha Brozak
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Integrating wastewater-based epidemiology and mechanistic models: Implications for public health and variant emergence

Wastewater-based epidemiology (WBE) is an emerging tool for community disease surveillance. WBE has become prominent during the COVID-19 pandemic as a near-real time, cost-effective method for surveillance without delays associated with clinical data. Community transmission and variant emergence may be monitored through quantifying and sequencing viral particles shed via stool by infected individuals. We connect a standard epidemic SEIR model to the dynamics of viral RNA in the sewer shed. Using data from the greater Boston area from October 2020 to January 2021, we show that this model captures the temporal fluctuations of viral particles, but prevalences peaks earlier and higher than reported. We also show how WBE and the SEIR model can be extended to improve our understanding of the circulation of multiple strains of a disease, specifically COVID-19.

Kasturi Barkataki
PhD student, Mathematics

The Virtual Spectrum of Linkoids and Open Curves in 3-space

The entanglement of open curves in 3-space appears in many physical systems and affects their material properties and function. A new framework in knot theory was introduced recently that enables to characterize the complexity of open curves in 3-space without any closure or diagram approximation schemes. The method relies in using appropriate tools from the theory of knotoids (open arc diagrams) and integrating over the sphere. Even though many invariants of knotoids exist, linkoids, which are multi-component open arc diagrams, are less well understood. In this talk we will introduce a new collection of invariants of linkoids. This is done via a new rigorous connection between linkoids and virtual knots and links, which is an extension of that of knotoids and virtual knots. This leads to a collection of novel measures of entanglement of open curves in 3-space which are continuous functions of the curve coordinates and tend to their corresponding classical invariants when the endpoints of the curves tend to coincide.

Lydia Gabric
PhD student, Statistics

A Bayesian approach to discrimination-free insurance pricing

In recent years, many jurisdictions have implemented anti-discrimination regulations that require protected information to be excluded from insurance pricing calculations. With the rise of complex pricing methods, insurers are facing the dual challenge of complying with evolving anti-discrimination regulations while maintaining accurate pricing outcomes. In response, recent studies have sought to develop discrimination-free pricing methods through probabilistic inference. However, for these methods to produce unbiased and non-discriminatory results, the estimation process will require individual-level discriminatory data which are often prohibited to insurers due to regulatory constraints. In this study, we propose a Bayesian discrimination-free pricing method that integrates a hierarchical finite mixture model with latent variables in lieu of explicit discriminatory information. Supported by a simulation study and an empirical analysis based on real insurance data, our Bayesian approach is capable of inferring the hidden relationship between variables and consequently producing unbiased discrimination-free pricing results.
Co-authors: Dr. Shuang Zhou and Dr. Kenneth Zhou

Jade Buzinski
Master's student, Mathematics

A Convolutional Neural Net to Predict Turbulence in Stratified Inclined Ducts

The ocean is responsible for a huge amount of heat capacity in the global climate system, owed in large part to the energy transfer driven by internal waves below the surface. These complex interactions are frequently studied via numerical simulation or laboratory-scale physical experiments. One such experiment is the Stratified Inclined Duct (SID) setup, with which Cambridge University researchers have obtained over 50,000 frames of shadowgraph data, illustrating various flows. This work is part of an ongoing effort to automate regime classification of flows in real time using machine learning, enabling research to prioritize relevant data and minimize storage costs.

Hanh Vo
Post Doctoral Associate

Short geodesics with self-intersections

We consider the set of closed geodesics on a hyperbolic surface. Given any non-negative integer k, we are interested in the set of primitive essential closed geodesics with at least k self-intersections. Among these, we investigate those of minimal length. In this talk, we will discuss their self-intersection numbers.