



WPI

DEPARTMENT OF MATHEMATICAL SCIENCES

Week of April 22 - 25, 2019

Statistics Seminar Series

Matthew Harrison

Brown

Bayesian methods for brain-computer interfaces

ABSTRACT: TBD

**Monday, April 22, 2019
11:00AM-12:00PM
Stratton Hall 304**

Discrete Mathematics Seminar

Dan Dougherty

WPI

A Coq formalization of Boolean unification

ABSTRACT: We report on a verified implementation of two (well-known) algorithms for unification modulo the theory of Boolean rings: Lowenheim's method and the method of Successive Variable Elimination. The implementations and proofs of correctness were done in the Coq proof assistant; we view this contribution as an early step in a larger project of developing a suite of verified implementations of equational unification algorithms.

**Tuesday, April 23, 2019
10:00AM-11:00AM
Stratton Hall 203**

Analysis and PDE Seminar Series

Ryan Alvarado

Amherst College

From lower measure bound to Sobolev embedding and back Again

ABSTRACT: Historically, the Sobolev embedding theorem has played a key role in establishing many basic results in the area of analysis. Typically, sufficient conditions on the underlying measure have been imposed in order to guarantee the availability of the aforementioned theorem. In this talk, we will revisit the result in the context of metric measure spaces, and discuss some recent work which identifies a set of conditions on the measure that are both necessary and sufficient to ensure its veracity. A measure characterization of Sobolev extension domains as well as applications of our methods to spaces support p -Poincaré inequalities will also be discussed. This talk is based on joint work with Przemysław Górka (Warsaw University of Technology), Piotr Hajłasz (University of Pittsburgh).

**Thursday, April 25, 2019
12:00PM-1:00PM
Stratton Hall 309**

WPI Mathematical Sciences Award Ceremony

Including a Math Awareness talk by Prof. William San Martín examining the work of Chilean mathematician, physicist, social activist, and "anti-poet," Nicanor Parra (1914-2018). Professor San Martín will address how translation across mathematical and social languages can lead us to innovative ways to assess and communicate the unequal problems of our time.

**Thursday, April 25, 2019
4:30PM**

Sports & Recreation Center Room 412

Colloquium

Yousef Marzouk

MIT

Nonlinear filtering and smoothing with transport maps

ABSTRACT: Bayesian inference for non-Gaussian state-space models is a ubiquitous problem, arising in applications from geophysical data assimilation to mathematical finance. We will present a broad introduction to these problems and then focus on high dimensional models with nonlinear (potentially chaotic) dynamics and sparse observations in space

and time. While the ensemble Kalman filter (EnKF) yields robust ensemble approximations of the filtering distribution in this setting, it is limited by linear forecast-to-analysis transformations. To generalize the EnKF, we propose a methodology that transforms the non-Gaussian forecast ensemble at each assimilation step into samples from the current filtering distribution via a sequence of local nonlinear couplings. These couplings are based on transport maps that can be computed quickly using convex optimization, and that can be enriched in complexity to reduce the intrinsic bias of the EnKF. We discuss the low-dimensional structure inherited by the transport maps from the filtering problem, including decay of correlations, conditional independence, and local likelihoods. We then exploit this structure to regularize the estimation of the maps in high dimensions and with a limited ensemble size.

We also present variational methods---again based on transport maps---for smoothing and sequential parameter estimation in non-Gaussian state-space models. These methods rely on results linking the Markov properties of a target measure to the existence of low-dimensional couplings, induced by transport maps that are decomposable. The resulting algorithms can be understood as a generalization, to the non-Gaussian case, of the square-root Rauch--Tung--Striebel Gaussian smoother.

This is joint work with Ricardo Baptista, Daniele Bigoni, and Alessio Spantini.

**Friday, April 26, 2019
11:00AM - 12:00PM
Stratton Hall 203**