REU Seminar Series

Thursday, 1:00pm, Nesbitt Room **August 9**

Michael Zieve, Faculty

Title: ***Nice functions are determined by their preimages of a few points***

Abstract: A polynomial over the complex numbers is determined up to a multiplicative constant by its preimages of 0, counting multiplicities. More surprisingly, such a polynomial is completely determined by its preimages of {0,1}, *without* counting multiplicities. I will present results along these lines for rational, entire, and meromorphic functions, going from the groundbreaking work of Polya and Nevanlinna in the 1920's to the most recent discoveries.

Jeremy D'Silva

(Mentor: Marisa Eisenberg)

Title: ***Identifiability of stage-structured compartmental models of infectious diseases***

Abstract: Mathematical models are prevalent in biological disciplines, and are commonly used in epidemiology for generating predictions and testing alternative intervention strategies. Accomplishing these goals often requires parameter estimation, wherein the models are fitted to data to draw mechanistic inferences about the system. Successful parameter estimation typically relies on the parameter estimation approach resulting in a unique set of parameter estimates from a given model and data. A necessary condition for fitting a mathematical model to real data is that the fitting approach works for perfect data. This property is called structural identifiability: a system is globally structurally identifiable (resp. locally structurally identifiable) if the map from parameters to outputs is injective (resp. has finite fibers). In this talk, we discuss definitions and techniques to study identifiability. We show that a class of nonlinear ODE models from epidemiology is not identifiable from incidence data, and discuss what additional parameter measurements are needed to ensure identifiability for this class of models. We prove the unidentifiability of the models, characterize the identifiability completely for a reduced case, and discuss the practical relevance of this work.

Shiliang Gao and Juntai Zhou

(Mentor: Daniel Burns)

Title: ***Min-max method and Gromov's Waist inequality***

Abstract: Waist inequality states that for any continuous map from S^n to R^k, there exists a fiber whose \epsilon neighborhood is at least as large (volume) as that of the corresponding \epsilon neighborhood of the standard equator S^(n-k). We will first talk about Morse theory and Min-max method which was used to first prove the waist inequality (under mild hypothesis on regularity and genericity) by Almgren. We will then discuss, using examples, some interesting aspects about the inequality itself and our conjecture on its relation with the large fibers of maps S^2 to R^1 (non-displaceable) under area-preserving maps of S^2, that is, in symplectic geometry.

Colby Kelln

(Mentor: Daniel Burns)

Title: ***An Exploration of Delzant's Theorem***

Abstract: It is a theorem of Delzant that symplectic toric manifolds (connected, compact, symplectic manifolds $\{(M^{2n}, \omega)\}$ equipped with effective hamiltonian torus actions by n-tori) are in bijection with Delzant polytopes (polytopes satisfying simplicity, rationality, and smoothness). The bijection is given by the moment map, a function that encapsulates quantities conserved by the action. We will explore this bijection and discuss future research paths.

JinCheng Wang

(Mentor: Daniel Burns)

Title: ***Limit Cycle of Dynamic Systems under Perturbation***

Abstract: Life takes place in a noisy environment and a stable limit cycle is expected, in a mathematical model, in order to allow for sustainability. S. Smale proved the existence of such a stable limit cycle for (Alan Turing's) two-cell system using the Van Der Pol oscillator. We take a further look at limit cycle under perturbation, from perspectives of both quality and quantity: Lienard theorem derived from Poincare-Bendixson gives the existence of a stable limit cycle and two timing and averaging method from Perturbation theory are applied to clarify its analytic properties.