# Abstracts

**Adriana Ocejo** *Portfolio optimization with power utility under a regime-switching Market model*

We present a power utility maximization from terminal wealth problem. We assume that an agent optimally builds her portfolio by investing in a bond and a risky asset whose price dynamics follow a diffusion process with regime-switching coefficients modeled by a continuous-time finite-state Markov chain. We deduce the associated Hamilton-Jacobi-Bellman equation to construct the solution and the optimal trading strategy, and provide a verication theorem for the value function. By means of a Laplace transform method, we show how to explicitly compute the value function and illustrate the method with the two-states case. This method is interesting in its own right and can be adapted in other applications involving hybrid systems.

Keywords: Portfolio optimization, utility maximization, regime-switching processes, Laplace transform.

**Birce Palta** *The Alternating Schwarz Method for numerical solutions of the fourth order PDEs containing singularities*

Domain decomposition methods solve boundary value problems (BVP) by splitting them into smaller BVPs on subdomains. In this study, two of the domain decomposition methods, the Schwarz Alternating and the Additive Schwarz, are implemented in the framework of Isogeometric Analysis (IGA) with Galerkin method for the fourth order problems. The Galerkin Method for fourth-order equations requires $C^1$-continuous basis functions to solve subproblems. Although implementing $C^1$-continuous basis functions in the conventional Finite Element Analysis is difficult, it is easy to construct highly regular B-spline functions. However, B-spline functions corresponding to open knot vectors do not satisfy the boundary conditions for the fourth order problems. To satisfy boundary conditions, we modify B-spline functions by using partition of unity (PU) functions with flat-top. Since the standard IGA has limitations to solve fourth order equations containing singularities, we consider a mapping method to deal with singularity. The mapping method lessens the drawbacks of enrichment methods (e.g., GFEM and X-FEM) such as large condition numbers and integrals of strongly singular functions. This proposed mapping method is tested to one-dimensional singular problems and extended for two-dimensional problems on cracked domains.

**Brittany Hansen** *The hyperbolic Kac-Moody Lie algebra of type $G_2^1$ and its root multiplicities*

In 1968 V. Kac and R. Moody independently defined Kac-Moody algebras to be an infinite dimensional analog to finite-dimensional semisemple Lie algebras. Kac-Moody algebras are classified by symmetrizable indecomposable matrices known as generalized Cartan matrices (GCM), which fall into three categories: finite type, affine type, and indefinite type.

An important problem in the study of Kac-Moody algebras is to determine root multiplicities. Roots are classified as either real or imaginary. For Kac-Moody algebras of finite and affine type, the root multiplicities are known in generality. For indefinite type Kac-Moody algebras, however, it is still an important and open problem to compute the multiplicities of imaginary roots. In my dissertation, I utilize the path realization of crystal bases to determine the multiplicities of certain imaginary roots of the hyperbolic Kac-Moody algebra $HG_2^{(1)}$ of indefinite type.

**Colleen Robles** *An introduction to Hodge theory and its application to the study of algebraic moduli.*

I'll give a general introduction to some Hodge theoretic questions that are motived by anticipated applications to the study of moduli.

**Minerva R. Brauss** *Job Satisfaction Factors Influencing Mentorship of STEM vs. Non-STEM faculty in Academia*

The recruitment and promotion of faculty is critical for higher education. Mentoring has been identified as a significant element in addressing the underrepresentation of women and minorities (Kosoko-Lasaki, Sonnino, & Voytko, 2006). Bilimoria et al (2006) showed that there is a significant difference by gender on effective institutional leadership, institutional mentoring, internal relational support and academic job satisfaction. Using data from "The Collaborative on Academic Careers in Higher Education" (COACHE) 2011 survey, this study focuses on faculty job satisfaction/fulfillment, job importance and mentoring, and provides a window into faculty members' job satisfaction/fulfillment and the importance of these factors, when compared by gender and discipline. The study looks at mentoring of pre-tenured faculty and provides an analysis on factors influencing the mentoring activity by type of discipline and faculty status.

Keywords: STEM and Non-STEM Faculty, Job Satisfaction/Fulfillment, Job Importance, Mentoring, and Tenure and On-Tenure Track Faculty

**Nicole Panza** *A Follicle Wave Model with Applications*

Abstract: Ovarian follicle waves have been reported in women by Baerwald et al. (2003). Typically two or three waves occur per menstrual cycle. A nonlinear differential equation model representing the hormonal regulation of the menstrual cycle for a two-wave and a three-wave cycle are presented. The model exhibits waves of antral follicles during a womans cycle using a Follicle Stimulating Hormone threshold function. The model is used to explore phenomenon such as early menopause and superfecundation.

Keywords: Biomathematics, Menstrual Cycle, Dynamical Systems, Differential Equations, Follicle Waves

**Preston Minter, Janessa Schwallie, Melissa Urena, David Woolford** *Super queuing in the super market*

The purpose of this study was to find the most effective use of a specific queueing system algorithm. This algorithm ideally seeks to distribute several incoming jobs into different queues to be serviced in the most time-efficient way possible. Using Pareto distribution, the program simulates the random arrival of jobs into the system, and user defined variables determine the average rate of arrival, average service time, and number of servers available to process jobs. Different experiments were run using various values of each variable to find the most efficient use of the algorithm. Through these experiments, it was found that the algorithm works best when the arrival rate of jobs changes between different values throughout one simulation cycle. Furthermore, the standard deviation from the average service time of the jobs has a great effect on the algorithms efficiency. When the deviation from the standard was simulated to be a high value, the average length of the queues in the system was found to be much smaller. Due to this, this algorithm has the potential to be applied in a wide array of environments in which a system of efficient queueing is needed.

**Renesha Rodriguez** *Bridge Designs for the Worst of Days*

Older existing bridges usually are not designed specifically for natural disasters such as earthquake or hurricanes. Using MATLAB, different bridge designs of existing bridges are modeled in 2D, and natural disasters are simulated using vertical and horizontal forces to understand how those bridges might handle the extreme conditions. From the simulation we can observe deflection within the design and the relative error between the simulation and realistic bridges. These theoretical results will shed light on how different bridge designs serve for different purposes. These results will be used to determine how specific material, designs, and amount of material used for building bridges affects how well the bridge does in a natural disaster. Using this research future bridge can be better designed in areas of the world that are often exposed to natural disasters such as Japan or Florida. The goal of the research is to gain a better understand of what happens to different bridge designs under these extreme conditions, and how we can design better bridges or reinforce existing bridges to overcome natural disasters.

**Sinae Kim** *Implicitly enriched Galerkin (mapping) methods for numerical solutions of fourth order partial differential equations containing singularities*
Using Partition of unity (PU) functions with flat-top, B-spline functions are modified to satisfy boundary conditions of the fourth order equations. Since the standard Isogeometric Analysis(IGA) as well as the conventional FEM have limitations in handling fourth order differential equations containing singularities, we consider two enrichment methods (explicit and implicit) in the framework of the p-, the k, and the h-refinements of IGA. We demonstrate that both enrichment methods yield good approximate solutions, but explicit enrichment methods give large (almost singular) matrix condition numbers and face integrating singular functions. Because of these limitations of external enrichment methods, we extensively investigate implicit enrichment methods

(mapping methods) that virtually convert fourth order elliptic problems with singularities to problems with no influence of the singularities. Effectiveness of the proposed mapping method extensively tested to one-dimensional fourth order equation with singularities. The implicit enrichment (mapping) method is extended to the two-dimensional cases and test it to fourth order partial differential equations on cracked domains.

**Talia Fernós** *The Mathematics of Gerrymandering* Gerrymandering is the practice of drawing district lines to influence the outcomes of elections. North Carolina is in the middle of redistricting now after being ordered by the Supreme Court to redraw 28 legislative districts for racial gerrymandering which disenfranchised African-American voters with "almost surgical precision. In this talk we will discuss the mathematical questions that arise from gerrymandering. First, how to gerrymander most effectively, and second, what solutions to gerrymandering might look like.