Advancing Student Participation in Research Experiences (ASPiRE)

ABSTRACTS

Seidler Hall
Florida Gulf Coast University
Saturday, February 3, 2018

Faculty Talks

Using Mathematics to Unlock Biological Mysteries / Young, Mathematically Gifted, and Black.

Candice Price. *Assistant Professor, University of San Diego.*

Abstract: Mathematical modeling is an effective resource for biologists, since it provides ways to simplify, study and understand the complex systems common in biology and biochemistry. Many mathematical tools can be applied to biological problems, some traditional and some more novel, all innovative. This presentation will review some the mathematical tools that I use to study biological issues including knot theory applied to DNA-protein interactions and social networks to study evolutionary success.

In February 2017, Erica Graham, Raegan Higgins, Shelby Wilson and myself created the website "Mathematically Gifted and Black" to highlight the contributions and service of Black Mathematicians to academia, education, government industry and society. This website hit on the importance of representation, knowing OUR history and knowing OUR impact. In this presentation, I will also tell you about my mathematical journey through the lens of reflection of my participation in the creation of the website www.mathematicallygiftedandblack.com.

Fast and Stable Algorithms for Structured Matrices.

Sirani M. Perera. *Assistant Professor, Embry-Riddle Aeronautical University.*

Abstract: Structured matrices arise in many applications in applied mathematics, electrical engineering, linear system theory, control theory, statistics, mechanics, etc. This elaborates the importance of structured matrices and why those have been closely studied and considered as the hottest research topic in Numerical Linear Algebra. There are two main kinds of structured matrices: (i) matrices of the moment type and (ii) recurrent matrices. In this talk, we will use both kinds of structured matrices to derive fast and stable algorithms.

At first we derive $\mathcal{O}(n^2)$ Euclid-type algorithm and observe it as a Schur-type algorithm for the matrices with displacement structure of Bezoutian. Then, we address more generalized $\mathcal{O}(n^2)$ Euclid-type algorithms for the wider class of polynomials which we call quasiseparable polynomials. Next, we present a fast $\mathcal{O}(n^2)$ and stable algorithm to solve trigonometric interpolation problems. Finally, we use a matrix factorization technique to introduce the fastest DCT/Inverse-DCT algorithms based

on sparse and scaled orthogonal matrices. Furthermore, the language of signal flow graph representation of digital structures is used to describe these DCT/Inverse-DCT algorithms with image compression results.

Machine learning approaches to modeling visual processing.

Chris DiMattina. *Assistant Professor, Florida Gulf Coast University.*

Abstract: Boundaries between image regions are defined not only by differences in first-order cues such as luminance and color, but also by second-order cues such as contrast and texture. However it remains poorly understood how second-order boundaries are represented in the visual system. Here we introduce a machine learning approach to modeling psychophysical performance with second-order boundaries. We address how human subjects integrate texture information across space, and across multiple orientations of texture elements. We demonstrate that our methodology can reveal spatial summation strategies used in different perceptual tasks, and can help to distinguish between competing models of second-order perception. We discuss future directions of research involving undergraduate Math students.

Student Talks

Proposing a TEDEd Lesson.

Alejandra Brewer Castano, Alexander Faus, Kelly Kramer, and Katie Tragakis.
Undergraduate Students, Florida Southern University.

Abstract: TEDEd is an online media organization which allows educators to work with a team of producers and animators to create engaging videos spanning across various curricular subjects for the benefit of youth and education. As part of a directed study, we researched, developed, and proposed several TEDEd video ideas in the subject of mathematics which had not yet been featured as TEDEd topics. Our proposals ranged from Game Theory to The Trachtenberg Speed System of Basic Mathematics. In this presentation, we will discuss our suggested subjects as well as the process of creating and submitting a TEDEd proposal.

Computer Modeling and Waldo.

Chance Hamilton. *Undergraduate Student, Florida Gulf Coast University.*

Abstract: We implement existing machine learning and image processing techniques to develop an open source computer program that is able to play Where's Waldo. Our program utilizes trained Support Vector Machines (SVMs) and low level color filters to create a decision matrix that predicts the likelihood that a given character is located inside each 48 × 48 pixel box. Our Python program has achieved a 100% success rate of finding Waldo and the Wizard with few false positives.

Positive Solutions to an Asymmetric Reaction-Convection-Diffusion Equation.

Sandra Ferris. *Undergraduate Student, Florida Gulf Coast University.*

Abstract: We consider positive solutions to the asymmetric reaction-convection-diffusion equation of the form: $-u''(x) = \beta\, u'(x) + \alpha(x)\lambda\, f(u),\ x \in (0,1)\ u(0) = 0 = u(1)$where β and λ are positive constants. Here α is a decreasing function, $\alpha: [0,1] \to \mathbb{R}$, and $f(u)$ is a positive function, $f: [0,\infty) \to \mathbb{R}$. We study the existence of positive solutions to the equation using the quadrature method, and we used *Mathematica* for our computations.

A Simple Proof that π is irrational.

Noah Drake. *Undergraduate Student, Florida Gulf Coast University.*

Abstract: The purpose of this presentation is to introduce the audience to Ivan Niven's elementary proof that π is irrational. While the main ideas are comprehensible to students of elementary calculus (Calculus 1 and 2), the details of Niven's proof are liable to incite anxiety and confusion in the absence of clarification. Hence, this presentation hopes to clarify those details for the young student of mathematics and, perhaps, introduce the older students to a proof involving one of our most famous constants. Furthermore, this presentation may serve as a nice introduction to nonelementary number theory.

Graph Decompositions.

Alejandra Brewer Castano. *Undergraduate Student, Florida Southern University.*

Abstract: A graph decomposition can be described as the partition of a graph into disjoint sub graphs. The most well-known graph decomposition is the Steiner Triple System. In a Steiner Triple System, a complete graph is decomposed into triangles. Similarly, we decompose a graph into smaller sub graphs - more specifically, we decompose a complete graph with a hole using a smaller complete graph minus one edge.

Improved solutions to the vertex separator problem based on the first order optimality conditions.

Christie Mauretour. *Graduate Student, University of Florida.*

Abstract: The vertex separator is an NP-hard optimization problem on graphs. The goal is to find the smallest collection of vertices whose removal breaks the graph into two disconnected subsets that satisfy specified size constraints. In the paper "Continuous quadratic programming formulations of optimization problems on graphs" it was shown that the vertex separator problem is equivalent to a continuous bilinear quadratic program. Using this formulation, an algorithm to quickly compute approximate separators was developed. Our goal is to improve the solutions based on the first optimality conditions.