COLLOQUIUM 2021-2022

Roger Nichols - Oct. 1

Don Rubenstein, Cardiology Research at Prisma Health-Upstate, Greenville, SC; joint w/SimCenter (inv. by Chris) - Oct. 15

Ziwei Ma - October 22

Lakmali Weerasena - October 29

Philip Smith, BS student (Eleni Panagiotou) - November 19

Eleni Panagiotou - February 11

James Cummins, MS student (Chris Cox) - March 11

Mark McFeaters, MS student (Lakmali Weerasena) - March 25

Matt Villanueva, Greg Millican, Meg Kiessling - April 1

Emily Miller, BS student (Angelique Ramnarine) - April 07

Xiunan Wang - April 08

Theodora Bourni UTK (inv. by Eleni) - April 11

Tanner Smith, Ph.D. student (Boris Belinskiy) - April 26

J. Rafael Rodrguez Galvn, Univ. of Cdiz (inv. by Chris) - April 28

Francisco Ortegn Gallego, Univ. of Cdiz (inv. by Chris) - April 29

COLLOQUIUM 2021-2022

Roger Nichols

The Kreinvon Neumann Extension

of a Regular Even Order Quasi-Differential Operator

Department of Mathematics

University of Tennessee at Chattanooga

October 1, Friday 2021

3:30-4:20 pm

Abstract. Abstract: We characterize by boundary conditions the Kreinvon Neumann extension of a strictly positive minimal operator corresponding to a regular even order quasi-differential expression of ShinZettl type. The characterization is stated in terms of a specially chosen basis for the kernel of the maximal operator and employs a description of the Friedrichs extension due to Mller and Zettl.

Face masks must be worn by everyone in all indoor public spaces on campus. This applies to all faculty, staff, students, vendors, and campus visitors.

COLLOQUIUM 2021-2022

Donald S. Rubinstein

Cardiac Rotors: A New Perspective of Spiral Waves

MD, PhD, Medical Director of Cardiology Research

at Prisma Health-Upstate in Greenville, SC

October 15, Friday 2021

2:00-2:50 pm

Abstract. Heart rhythm disorders, arrhythmias, are commonly caused by a change in the path of the electrical wave that normally spreads across the heart muscle for each heartbeat. Many rapid arrhythmias are caused by the propagating wave to suddenly follow an abnormal circular path of conduction. Mapping of the abnormal path with application of energy across it, provides an effective treatment to eliminate the arrhythmia. The smallest of these paths is a rotating spiral-shaped wave, called a rotor. These periodic spiral waves, considered important components to sustain the arrhythmia of atrial fibrillation, are very elusive to track. A new method to specifically the identify the movement of cardiac spiral waves revealed several key differences from that of periodic waves that propagate outward in an expanding circular direction. These differences show that the Doppler effect does not apply to spiral waves.

Face masks must be worn by everyone in all indoor public spaces on campus. This applies to all faculty, staff, students, vendors, and campus visitors.

COLLOQUIUM 2021-2022

Ziwei Ma

An application of Support Vector Machine (SVM

in Arrhythmia Heartbeats Classification

Department of Mathematics

University of Tennessee at Chattanooga

October 22, Friday 2021

2:00-2:50 pm

Abstract. In this talk, I will introduce basic concepts of machine learning first. Then an application of SVM, a classical machine learning algorithm, to classify arrhythmia heartbeats will be introduced. At last, a couple of ongoing projects involving machine learning will be briefly presented.

Face masks must be worn by everyone in all indoor public spaces on campus. This applies to all faculty, staff, students, vendors, and campus visitors.

COLLOQUIUM 2021-2022

Lakmali Weerasena

Advancing local search approximations

for multiobjective combinatorial optimization problems

Department of Mathematics

University of Tennessee at Chattanooga

October 29, Friday 2021

3:15-4:05 pm

Abstract. This study proposes a local search algorithm for obtaining a representation of the Pareto set of Multi-objective Combinatorial Optimization (MOCO) Problems. The algorithm provides solutions using well-defined preference relations, theoretically deriving the representation quality, and constructing a tolerance function that depends on the problem characteristics. The algorithm starts with an initial representation. The computational results demonstrate that the algorithm significantly outperforms the initial representation, obeys the theoretical error bounds, and efficiently solves MOCO problems. Theoretically proven error bound is a feature not available in existing local search algorithms, and it is a challenging task with local search algorithms. This study begins to address this challenge.

Face masks must be worn by everyone in all indoor public spaces on campus. This applies to all faculty, staff, students, vendors, and campus visitors.

COLLOQUIUM 2021-2022

Philip Smith

The second Vassiliev measure of Uniform random walks

and polygons in confined space

Department of Mathematics, student

University of Tennessee at Chattanooga

November 19, Friday 2021

2:00-2:50 pm

Abstract. Biopolymers, like chromatin, are often confined in small volumes. Confinement has a great effect on polymer conformations, including polymer entanglement. Polymer chains and other filamentous structures can be represented by polygonal curves in 3-space. In this study, we examine the topological complexity of polygonal chains in 3-space and in confinement as a function of their length. We model polygonal chains by equilateral random walks in 3-space and by uniform random walks in confinement. For the topological characterization, we use the second Vassiliev measure. This is an integer topological invariant for polygons and a continuous function over the real numbers, as a function of the chain coordinates for open polygonal chains. For uniform random walks in confined space, we prove that the average value of the Vassiliev measure in the space of configurations increases as $O(n^2)$ with the length of the walks or polygons. We verify this result numerically, and our numerical results also show that the mean value of the second Vassiliev measure of equilateral random walks in 3-space increases as $O(n)$. These results reveal the rate at which knotting of open curves, and not simply entanglement, are affected by confinement.

Face masks must be worn by everyone in all indoor public spaces on campus. This applies to all faculty, staff, students, vendors, and campus visitors.

COLLOQUIUM 2021-2022

Eleni Panagiotou

Topological Metrics of Biopolymer Structure and Function

Department of Mathematics

University of Tennessee at Chattanooga

February 11, Friday 2022

3:30-4:20 pm

Abstract. Proteins and other biopolymers can be represented by mathematical curves in space. Understanding the structure of such macromolecules is at the core of very important problems in biology, such as protein folding, protein aggregation, and cell nucleus organization and function. The single, pairwise, or multi-chain characterization of entanglement complexity becomes rigorous in the context of mathematical topology. In this talk, we will introduce a novel and general topological approach to analyze the structures of macromolecules. We will apply our methods to proteins and show that these enable us to create a new framework for understanding protein folding, which is validated by experimental data. When applied to the SARS-CoV-2 spike protein, we see that topology can predict residues where mutations can have an important impact on protein structure and possibly in viral transmissibility. These methods can thus help us understand biopolymer function and biological material properties in many contexts with the goal of their prediction and design.

Face masks must be worn by everyone in all indoor public spaces on campus. This applies to all faculty, staff, students, vendors, and campus visitors.

COLLOQUIUM 2021-2022

James Cummins, MS Mathematics Graduate Candidate

Modeling of Spiral Waves Arising in Atrial Fibrillation

Department of Mathematics

University of Tennessee at Chattanooga

March 11, Friday 2022

2:30PM-3:30

Lupton 393 and
$https://tennessee.zoom.us/meeting/register/tJwlceqtrTIsG9I1-6Gq-EitF0eOnHP_EnG0$

Abstract. The objective of this study is to model spirals arising in atrial fibrillation. Spiral wave fronts, known to cardiologists as cardiac rotors are responsible for heart arrhythmias. The modeling of the path of the spiral will ultimately assist in the prediction of wave front strikes to electrodes positioned inside the heart. This study involved developing a linear ray model to assist in the understanding of a rotating wave front and ultimately applied to different spiral models. Both the Archimedean spiral and a spiral derived from the Bessel function are used as possible candidates to resemble cardiac rotors found in the heart. We conclude by comparing the two spirals strike frequencies to electrodes and discuss their non-Doppler anomalies.

COLLOQUIUM 2021-2022

Mark McFeaters, MS student

An integrated approach for the design of compact, connected reserve systems

Department of Mathematics

University of Tennessee at Chattanooga

March 25, Friday 2022

2:00PM-2:50

https://tennessee.zoom.us/j/97014236861

Abstract. Modern reserve planning developed from the convergence of several threads starting in the 1970s. In the modern design of nature reserves, conservationists seek to designate areas for protection that i) protect as many species as possible and are ii) extensive, iii) compact, and iv) connected to one another. Reserves that protect more species will be more effective biologically and more easily justified economically and politically. Extensive reserves can support large populations less vulnerable to chance variation in numbers and external factors such as fires, floods, and hurricanes. Compact reserves will be less affected by threats that enter through boundaries. Finally, connected reserves allow individuals to move between sites, buffering against downward fluctuations in numbers and allowing species to track changing climates. However, there are mathematical and computational challenges in establishing efficient reserves that achieve these four objectives. We propose a sequence of mathematical approaches to achieve these four goals in the current work. We first identify core areas that are extensive and compact. We then identify contiguous corridors between these core areas based on species conservation goals, allowing the reasonable replacement of core elements. This suite of models allows the joint designation of an efficient and effective system of compact protected areas with their connecting corridors.

COLLOQUIUM 2021-2022

Matt Villanueva, Greg Millican, Meg Kiessling

Alternative Grading Methods

Department of Mathematics

University of Tennessee at Chattanooga

April 1, Friday 2022

3:30-4:20 pm

Abstract. Everything changes as time progresses. Not long-ago mid-term grades were handed out to students in class and were never seen by the Records Office. Final course grades were filled out on a bubble-sheet and walked up the hill for submission at the Records Office. Homework was completed on paper and handed in for grading by the instructor. Now, homework is completed online with students receiving immediate feedback and the opportunity to try again and mid-term and final grades are submitted electronically to the Records Office. What about the methods used to determine these final grades and the grade scales? Have they changed as well? New methods for determining grades are being introduced and tested in several subject areas and at different levels across academia. How will these methods work with the grade scales we are required to use when reporting student grades for official records? These are the questions we will address today as we present information we have learned while investigating alternative grading methods. This is not a presentation of new research but rather a sharing of information and experiences which will hopefully be useful for us all as we adapt and grow with the changing times.

COLLOQUIUM 2021-2022

Emily Miller, BS student

Department of Mathematics

University of Tennessee at Chattanooga

April 7, Thursday 2022

4:30PM-5:20

https://tennessee.zoom.us/j/95746154534

Abstract. Considerable amounts of resources are allocated to assist and retain students during their first and second years in college, and many universities provide extra support to students as they prepare to graduate and start their professional careers; however, resources are not often specially aimed at third year students (i.e., students in their junior year). The primary goals of this study were to contribute to the body of literature and gain a better understanding of the relationships between students ACT scores, their Tennessee High School Quality ranking scores, and their cumulative GPA at the end of their junior year. This research project also considered the possible impact that the transition to online learning designs may have had on junior-level students GPAs during the COVID-19 pandemic by comparing students who did not experience the COVID-19 pandemic during or prior to the junior-year (2015-2019 cohorts) and students who did experience the COVID-19 pandemic and the transition to online learning (2021 cohort). An understanding of these relationships and differences is important because students are usually beginning their upper-level courses for their designated majors during their third year of college; therefore, their GPAs are beginning to reflect, not only the students abilities to understand basic knowledge in a subject area, but also their abilities to understand complex, content-specific material. This information could be useful to university educators and administrators as they work toward making data-driven decisions about the programs and resources that are allocated to assist their students during all years of their postsecondary education career.

There were three quantitative research questions:

1) Is there a significant, predictive relationship between high school quality, ACT scores, and end-of-junior-year of college GPA?

2) Is there a significant difference between the GPAs of college juniors in 2021 versus those from 2015, 2016, 2017, 2018, and 2019?

3) Is there a significant difference between the GPAs of college juniors in 2021 versus those from 2015, 2016, 2017, 2018, and 2019 in STEM and non-STEM fields?

Statistical analyses involving multiple regression and analysis of variance were used to answer these questions. It was determined that ACT score is a statistically significant predictor of students GPAs at the end of their junior year in college, and the GPAs of 2021 juniors were significantly different to the GPAs of juniors from previous years.

COLLOQUIUM 2021-2022

Xiunan Wang

From Policy to Prediction: Forecasting COVID-19 Dynamics by Differential Equations and Machine Learning

Department of Mathematics

University of Tennessee at Chattanooga

April 8, Friday 2022

3:30PM-4:20

Lupton **** and https://tennessee.zoom.us/j/95746154534

Abstract. Accurate prediction of the number of daily or weekly confirmed cases of COVID-19 is critical to the control of the pandemic. In this talk, I will introduce our recently developed method in forecasting the daily confirmed cases of COVID-19 by combining a mechanistic ordinary differential equations (ODE) model and a generalized boosting machine learning model (GBM). Applying the method to both the pre-vaccination and post-vaccination cases, we obtain retrospective forecasts of COVID-19 daily confirmed cases in the US and identify the relative influence of the predictor variables. Our results indicate that the inclusion of data on non-pharmaceutical interventions can significantly improve the accuracy of the predictions. Moreover, we find that the most influential predictor variable is the policy of restrictions on gatherings. The approach used in this work can also be applied to the investigation of other infectious diseases.

COLLOQUIUM 2021-2022

Theodora Bourni

Curve Shortening Flow and Ancient Solutions

Department of Mathematics

University of Tennessee

April 11, Monday 2022

1:00PM-1:50

Lupton 390 and https

Abstract. We will first introduce and motivate the study of curve shortening flow (and the higher dimensional mean curvature flow in general) describing some of the well known applications. We will then focus on ancient solutions of curve shortening flow, which are solutions that have existed for all times in the past and are of interest in the study of geometric flows as they model singularities of the flows. In particular, we will present some classification results for convex solutions with and without boundary.

COLLOQUIUM 2021-2022

Tanner Smith

Optimization of the Critical Mass Described by a SturmLiouville Problem with Spectral Parameter in the Boundary Condition

Department of Mathematics

University of Tennessee at Chattanooga

April 26, Tuesday 2022

9:30PM-10:20

Lupton 393

Abstract. We find an optimal design of a structure that is described by a Sturm-Liouville problem with a spectral parameter in the boundary condition. While previous work on the subject focused on a somewhat simplified model with applications in classical mechanics, we focus on finding solutions to a general Sturm-Liouville problem. By virtue of the generality in which the problem is considered diverse applications, to both classical and quantum mechanics, are possible. We use methods of Calculus of Variations. That allows us to reduce the problem of the extremum of an appropriate functional to the explicitly solvable differential equations subject to the boundary conditions. We introduce the notion of pre-design and design. We define pre-design to be a solution to the variational problem without the requirement of positivity, which is physically natural. We define design to be a pre-design that is positive on the domain. Using this terminology, we may say that the previous research did not distinguish between these two objects, not to mention a narrow class of the differential equations considered. We present a classification of the set of all parameters of the problem that guarantee the existence of pre-design, as well as design. Furthermore, we present the analytic continuation of these solutions alongside the minimum solvability conditions which guarantee a pre-design to be a design. Examples show that the set of the parameters of the problem has quite a complex structure. Specifically, we find examples of the small variation of the parameters that result in the change of the existence of design to non-existence. Finally, we present an algorithm for testing these conditions, determining the optimal solution, and calculating the corresponding optimal mass and conduct the preliminary numerical experiments.

COLLOQUIUM 2021-2022

J. Rafael Rodrguez Galvn

Galerkin Schemes for Migration Processes in Biology

Department of Mathematics

University of Cdiz, Spain

April 28, Thursday 2022

3:30PM-4:20

Lupton 392

Abstract. Spatial migration of organisms or substances plays an important role in many biological models. And, for macroscopic PDE models, development of efficient numerical schemes preserving the properties of the continuous equations (bounds, energy law...) is an interesting challenge.

In this talk we show some biological models we are working on: migration of neuron precursor cells, chemotaxis, convective phase fields and tumors. Galerkin FCT numerical schemes are introduced and applied to some of them. Also we show a new discontinuous Galerkin scheme that we have developed very recently, review its properties and compare them to FCT.

COLLOQUIUM 2021-2022

Francisco Ortegn Gallego

Capacity solution to the thermistor problem in Sobolev and Orlicz-Sobolev spaces: analysis and numerical simulation

Department of Mathematics

University of Cdiz, Spain

April 29, Friday 2022

3:30PM-4:20

Lupton 392

Abstract. In this talk we study the existence of a capacity solution to a nonlinear elliptic coupled system in anisotropic Sobolev and Orlicz-Sobolev spaces. The unknowns are the temperature inside a semiconductor material and the electric potential. This system is a generalization of the steady state thermistor problem. The numerical solution is also analyzed by means of a fixed point technique or by using the least squares method combined with a conjugate gradient technique.