GSU Annual Undergraduate Mathematics and Statistics Research Conference for the Greater Atlanta Area Featuring Opportunities for Graduate Studies

Saturday, April 9, 2022

Access Live from 9:00 am to 5:00 pm via Webex here:
https://gsumeetings.webex.com/wbxmjs/joinservice/sites/gsumeetings/meeting/download/fe78de2d3da84c72bfd4794139af6289?siteurl=gsumeetings&MTID=m081b3e3ec51f2a5146e730ab250cc6aa

Conference Website: https://math.gsu.edu/xye/public/msurc/gsu-urc2022.html

9:00 am to 5:00 pm

Schedule

9:00 am to 9:15 am	Welcome Dr. Leslie Meadows, Georgia State University
9:15 am to 9:30 am	Opening Remarks Provost Nicolle Parsons-Pollard, Georgia State University
9:30 am to 10:00 am	Keynote Talk: Masks, Vaccines and Misinformation in the COVID-19 Pandemic Dr. Yi Jiang, Georgia State University
10:00 am – 10:20 am	Meet and Greet- Virtual Beverage Break
10:20 am – 10:30 am	Simulation of Tricalcium Phosphate Applied Upon a Titanium Dioxide Substrate by ab initio Methods Wynn Kwiatkowski, University of North Georgia
10:30 am – 10:40 am	Expected Utility Theory and outcome in preferences in Game Theory Carter Hinsley, University of North Georgia
10:50 am – 11:00 am	Exploring the Applications of Differential Equations and Statistics in Epidemiology with Examples from the COVID-19 Pandemic Timothy Doan, Gwinnett School of Mathematics, Science and Technology (Interning at Georgia State University)

11:00 am – 11:20 am	Individual and Community Level Factors Related to Contraceptive Access, Family Planning, And Reproductive Health Challenges Among Women In Kumasi, Ghana Jake Coldiron, SPH, Georgia State University
11:20 am – 11:30 am	Statistical Inference and Epidemiological Modeling Between Risk Factors and Seropositivity of Chaga Disease Yang Chen, Georgia State University Yuchen Jiang, Georgia State University
11:30 am – 11:40 am	Survival Analysis and Risk Factors of COVID-19 in Georgia Sangmyung Lee, Georgia State University
11:40 am – 11:50 am	The Chronic Index of Ring Graphs Lilian Shaffer, Georgia State University
11:50 am – 12:00 pm	Virtual Beverage Break
12:00 pm – 12:40 pm	Panel Discussion "Getting involved in undergraduate research: when, how and what?" Moderator: Dr. Florian Enescu (GSU, RIMMES Director) Participants: Lilian Shaffer (GSU), Dr. Guantao Chen (GSU), Dr. Mariana Montiel (GSU), Dr. Thomas Polstra (MSRI, CA), Dr. Yi Zhao (GSU)
12:40 pm – 1:00 pm	Keynote Talk: When is IRB Approval Necessary for Mathematicians to do Research? Dr. Paula Mullins, University of North Georgia
1:00 pm – 1:20 pm	Meet and Greet- Virtual Lunch Break and gift drawings
1:20 pm – 1:40 pm	The Doubling Time Analysis for Modified Infectious Disease Richards Model with Applications to COVID-19 Pandemic Brian Pidgeon, PhD candidate at Georgia State University
1:40 pm – 2:00 pm	Multithreshold Multipartite Graphs Yanli Hao, PhD candidate at Georgia State University

2:00 pm – 2:20 pm	Two-Species Interaction with Logistic Growth Anthony Morciglio, MS student at Georgia State University
2:20 pm – 2:50 pm	Keynote Talk: Navigating Graduate School at Georgia State Brian Pidgeon, PhD candidate at Georgia State University
2:50 pm – 3:30 pm	Panel Discussion with Recent Graduates and Graduate Directions Moderator: Dr. Andrew Fanoe, Participants: Graduate Directors, Professor Gengsheng (Jeff) Qin and Professor Zhongshan (Jason) Li, Dr. Russell Jeter, Luke Langston, Anthony Morciglio, Jenny Jeyarajah, Dr. Linda DeCamp, and Arun Suresh
3:30 pm – 4:00 pm	Keynote Talk: The Art of Reasoning: Why it is Meaningful to Pursue a Graduate Degree in Mathematics. Arun Suresh, PhD candidate at the University of Missouri
4:00 pm – 4:15 pm	Closing Remarks Dr. Leslie Meadows, Georgia State University
4:15 pm – 5:00 pm	Q & A with Graduate Directors Dr. Zhongshan Li, Georgia State University Dr. Gengsheng Qin, Georgia State University

Abstracts

Anthony Morciglio- "Two-Species Interaction with Logistic Growth"

Mathematics is the language to which nature is written. The Mathematician is not an inventor but an interpreter of nature that attempts to understand the world around him or her. In the lens of the third eye, the world to which he (or she) observes can be described through a set of axioms or methods. In this discussion, I focus on the approach to explore the curiosity of a system of change. The interaction of two species plays a pivotal role in many applications in population ecology. This discussion focuses on translating the curiosity of the mind to abstraction of mathematical language and illustration of the different dynamics.

Brian Pidegon- "The Doubling Time Analysis for Modified Infectious Disease Richards Model with Applications to COVID-19 Pandemic"

In the absence of reliable information about transmission mechanisms for emerging infectious diseases, simple phenomenological models could provide a starting point to assess the potential outcomes of unfolding public health emergencies, particularly when the epidemiological characteristics of the disease are poorly understood or subject to substantial uncertainty. In this study, we employ the modified Richards model to analyze the growth of an epidemic in terms of (1) the number of times cumulative cases double until the epidemic peaks and (2) the rate at which the intervals between consecutive doubling times increase during the early ascending stage of the outbreak. Our theoretical analysis of doubling times is combined with rigorous numerical simulations and uncertainty quantification using synthetic and real data for COVID-19 pandemic. The doubling-time approach allows to employ early epidemic data to differentiate between the most dangerous threats, which double in size many times over the intervals that are nearly invariant, and the least transmissible diseases, which double in size only a few times with doubling periods rapidly growing.

Carter Hinsley- "Arrow-Pratt Measure & Indifference"

Expected utility theory extends the notion of outcome preferences in game theory to probabilistic games with uncertain outcomes. Even if two scenarios ("lotteries") present equal expected utility, a player's attitude towards risk may result in one scenario being preferred to another. The Arrow-Pratt measure of absolute risk aversion fully characterizes the attitude of a player towards risk given reasonable assumptions about the player's utility function. This characterization is discussed in detail. Additionally, we discuss for which pairs of lotteries in general there exists an Arrow-Pratt measure producing a preference relation which is indifferent as to which of the two lotteries is chosen, providing a starting point for variational study of utility.

Chen Yuchen- "Statistical Inference and Epidemiological Modeling Between Risk Factors and Seropositivity of Chaga Disease"

Given the severe impact of Chagas disease (also known as American Trypanosomiasis) on people at the risk for COVID-19, we designed the research project to estimate the prevalence of Chagas Disease (CD) among women and its related risk factors forecasting.

We regressed the age on the seropositivity for big datasets and proved their significant relevance (P-value < 0.0001). We also applied the empirical likelihood method to estimate the mean of the age, which has more accurate coverage probability than classic statistical models. After searching systematically in seven databases for cross-sectional and descriptive studies, we launched the correlation regression analysis to assess the influence of each risk factor on CD among socioeconomic characteristics and treatment-seeking behaviors and tried the machine learning methods to compare the predicates, which is essential for the evidence-based prevention and the treatment support.

Based on existing work and results from our own studies, we conducted the epidemiological modeling of infectious disease (SIR model) and trypanosomiasis vector-borne transmission dynamics to clarify the

spread of CD and the relationship between the infection rate of CD and age, duration of infection, as well as the localized infection rate. In addition, we considered some specific cases of direct human-to-human transmission caused by high blood transfusion rates, and the influence of usage of suppressive drugs in susceptible and infected populations.

Lilian Shaffer- "The Chromatic Index of Ring Graphs"

Graph theory is the study of graphs, structures that model relationships between objects. The results of this field are of interest not only to mathematics, but also to other fields whose objects of interest can be modeled in this way. Graph edge coloring is a well-established subject in graph theory. The goal is to color a graph with as few colors of possible such that each edge receives a color and that adjacent edges, that is, different edges incident to a common vertex, receive different colors. The chromatic index, denoted $\chi'(G)$, is the minimum number of colors required for such a coloring. There are two important lower bounds for $\chi'(G)$ on every graph. The first of these lower bounds is the graph's maximum degree, denoted $\Delta(G)$, which is the greatest number of edges that are adjacent to the same vertex. The second lower bound is the graph's density, denoted $\omega(G)$, which is a value derived from the relationship between the number of vertices in a graph and the number of edgesin the graph. Combining these two lower bounds, we know that every graph's chromatic index must be at least $\Delta(G)$ or $\omega(G)$, whichever is greater. In most cases, calculating this lower bound does not immediately return the chromatic index of a graph. In cases where the chromatic index is exactly this lower bound, we say that the graph is exact. Our investigation is concerned with ring graphs. A ring graph is constructed from a single cycle, a cycle being a path of vertices and edges such that no edges or vertices repeat. The exception to this is that the path ends on the same vertex on which it begins. A ring graph is obtained from a cycle by replacing each edge with some number of edges—whether no edges, one edge, or multiple edges. It has been known that any ring graph with an even number of vertices is exact. We prove here that every ring graph with an odd number of vertices is also exact.

Sangmyung Lee- "Survival Analysis and Risk Factors of COVID-19 in Georgia"

The pandemic caused by the coronavirus (SARS-CoV-2) has become one of the biggest health problems worldwide. The novel coronavirus has spread exponentially since 2019, resulting in several cases worldwide. The virus has shaken the global economy, restricted free movement, affected millions of people, and burdened medical staff, weakening them mentally, physically, and emotionally. Due to the increasing mortality rate and increasing rate of spread due to COVID-19, many methods have been developed to reliably predict patient survival based on symptom data and specific clinical parameters. Assessing instantaneous mortality during follow-up to specific risk factors is critical to determining the adequacy of mitigation strategies and setting priorities for controlling the COVID-19 pandemic. This study aimed to investigate risk factors associated with COVID-19 death in the Georgia population using survival analysis. A dataset for COVID-19 patients is used that database contains all 9157 positive COVID-19 cases in Georgia. To calculate infection risk and perform survival analysis and classification, we present two systems,

Cox Model and Kaplan-Meier, to study survival analysis for COVID-19, select patients with higher survival rates in hospitals, and help predict the most critical factors that will have an impact. Age was identified as an essential characteristic influencing mortality. The result shows that doctors make the right decisions for each patient's case, depending on the available treatment and medical tools.

Timothy Doan- "Exploring the Applications of Differential Equations and Statistics in Epidemiology with Examples from the COVID-19 Pandemic"

Predicting the future trends of epidemics is becoming increasingly important as COVID-19 remains a major threat to healthcare. There is still much uncertainty about the pandemic, but using phenomenological models to estimate the future effects of the pandemic could provide crucial information to society. In this research, I utilized the Modified Richard's Equation and Generalized Growth Model to study the growth of the epidemic. Furthermore, I analyzed the intervals between times cases double and utilized least squares approximation to estimate parameters for the equations that would model real data from the COVID-19 pandemic. This research can be used to anticipate the severity of future epidemic threats.

Wynn Kwiatkowski- "Simulation of Tricalcium Phosphate Applied Upon a Titanium Dioxide Substrate by ab initio Methods"

The focus of this research is to propose a method of calculating the adhesive strength of an amorphousatom oftricalcium phosphate—a material used in dentistry to cover a titanium tooth implant to increase osseointegration(the conduciveness of its mating to bone)—by using Density FunctionalTheory (DFT). The amorphousatom oftricalcium phosphate has shown to increase osseointegration between the coating and the bone. While fast osseointegration is most attractive, it is important to have a strong adhesive bond between the coating and the titanium implant. A measure of the coating-to-substrate (titanium implant) binding energy is the energy of this bond. We suggest a theoretical method of how to calculate the adhesion strength of tricalcium phosphatecoating on titanium substrate using ab initiocalculations. We slowly "buildup" tricalcium phosphate by way of calculating the binding energy between its constituent parts andtitaniumdioxide. We take into consideration that the dental coating is never on pure titanium, but on titanium dioxide due to the oxidation of titanium in an aggressive environment. We used the Gaussian09 DFT B3LYP with a basis set of 6-31G to structurally analyze the bond lengths, bond angles, dihedral angles, and point charges to understand the interactions of these substances and how they contribute to the strength of the bond.