MAA

MATHEMATICAL ASSOCIATION OF AMERICA

PRESENTS

NREUP 2021 VIRTUAL POSTER SESSION

September 17, 2021
3:00pm - 4:30pm ET

SCHEDULE OF EVENTS

3:00pm **Introduction:** NREUP Leadership

3:05pm **Virtual Posters Breakout**

- American University #1
- American University #2
- Siena College
- Spelman College
- Texas A&M University-Commerce #1
- University of Guam #1
- University of Guam #2
- University of Guam #3

3:30pm **NREUP Alum Panel Discussion:**

Victor Moreno - 2004 NREUP Alum

Brittany Mosby - 2005 NREUP Alum

Kehinde Salau - 2005 NREUP Alum

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SCHEDULE OF EVENTS

4:00pm **Virtual Posters Breakout**

- Andrews University
- Embry Riddle Aeronautical University
- Fairfield University
- Texas A&M University-Commerce #2
- University of Guam #4

4:25pm **Closing:** NREUP Leadership

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PROJECT ABSTRACTS

In order of presentation

American University, Poster #1

Riodan Array Representations of Catastrophe Paths

Faculty Advisors: Dr. Monica Jackson, Dr. Leon Woodson
Student Presenters: Jai James

For this poster we examine several specific sets of integer lattice paths consisting of up steps (1,1), level steps of either length (1,0) or (2,0), and down steps of various lengths. Many of these lattice paths will generate significant sequences, notably the Catalan, Schröder and Motzkin Numbers. We also show how generating functions can be obtained using these integer lattice paths that will result in the aforementioned sequences. This paper will also prove the existence of Riordan Array representations of the notable paths. Lastly, this paper will consider Catastrophe paths and examine how one set of integer lattice paths consisting of up steps of length (1,1) and down steps of arbitrary length (1,-1),(1,-2),(1,-3),(1,-4)... is a binary shift "between" the Catalan Path and Motzkin Path. There are also results considering a potential connection between a 'faux' catastrophe path and rooted trees.

American University, Poster #2

Counting Spiders on Trees

Faculty Advisors: Dr. Monical Jackson, Dr. Leon Woodson
Student Presenters: Kobe Lawson-Chavanu, Imhotep Hogan, Don Edwards

An ordered tree, also known as a plane tree or planar tree, is defined recursively as having a root and an ordered set of subtrees. One characteristic of ordered trees are spider legs and spiders. A spider leg is a path from the leaf to the root where a spider is a combination of spider legs that only intersects at the root. In this poster, we will count spiders on various types of trees.

Siena College

Guns, Zombies, and Steelhead Axes: Cost-effective recommendations for surviving human societies

Faculty Advisor: Dr. Scott Greenhalgh
Student Presenters: Ahmani Roman

In pop culture, there are many strategies to curtail zombie apocalypses. However, it remains unclear what routes we should take to eliminate zombies effectively and affordably. So, we created a mathematical model to examine interventions that armed adults with steelhead axes or provided enough ammunition and a 9mm handgun to kill zombies in either a "single-tap" or "double-tap". We investigate each case over two years under slow, moderate speed, and fast zombies scenarios. We quantify health burden by zombies averted, disability-adjusted life-years averted, and determine cost-effectiveness using the incremental cost-effectiveness ratio. Our predictions show the single-tap intervention is the best for stopping the zombie apocalypse, as it would avert hundreds of millions of zombies and deaths while also being the most cost-effective intervention. Altogether, this suggests conserving ammunition and supplying ranged weapons would be an effective use of limited resources in the event of a zombie uprising.

PROJECT ABSTRACTS

Spelman College

Modeling the Impact of an Imperfect Vaccine and the Loss of Immunity on the Coronavirus Outbreak in the United States

Faculty Advisor: Dr. Enahoro Iboi
Student Presenters: Deahn Holmes, Ciera Sherrill, Ayanna U. Woodfolk, Jasmin Jean-Louis

The coronavirus outbreak in the United States continues to pose a serious threat to human lives. Despite the emergence of an anti-COVID vaccine, the number of cases, mortality, and hospitalization continue to rise globally, including in the US. We developed a mathematical model to assess the impact of an imperfect vaccine and the loss of immunity on the coronavirus outbreak in the US. Our simulation support the need for a vaccine booster as waning/loss of immunity increases daily cases, hospitalization, and death in the US.

Texas A&M University - Commerce, Poster #1

Properties and Parameters of Codes from Unit Graphs of Zn

Faculty Advisor: Dr. Padmapani Seneviratne
Student Presenters: Victor Ezem, Ashlee Story

The unit graph $G(Zn)$ of Zn has the vertex set V = {0,1,... n✣1}, all of the elements of Zn, and two distinct vertices x,y in Zn are adjacent whenever x + y is a unit in Zn. We study binary codes $C(Zn)$ obtained from the row span of adjacency matrices of $G(Zn)$. We determine parameters of $C(Zn)$ codes by grouping them according to the prime factorization of n and the gap size of $G(Zn)$, where the gap size of $G(Zn)$ is defined by n/2✣ ∅(n) and ∅(n) is the Euler-phi function. We find classes of self-orthogonal and linear complementary dual (LCD) codes among $C(Zn)$ codes and classify them according to the prime factorization of n and the gap size of $G(Zn)$.

University of Guam, Poster #1

A Model of the Dynamics of CRB-G with a Game Theoretical Analysis of the Effectiveness of Control Measures

Faculty Advisor: Dr. Hyunju Oh
Student Presenters: Jovic Aaron S. Caasi, Alex Leon Guerrero, Kangsan Yoon

The coconut rhinoceros beetle {Oryctes rhinoceros}, or CRB, is an invasive species in Guam that has greatly affected the island's coconut tree population. Native to South and Southeast Asia, it first arrived in Guam in 2007. Various control measures have been used to combat the spread of CRB, but many have been proved ineffective. Strategies used to control the spread of CRB include the removal of coconut tree breeding grounds. We present a mathematical model to understand the dynamics between CRB and coconut trees. Also, we construct a game-theoretical analysis of the effectiveness of removing moribund and coconut tree breeding grounds that individuals can choose to minimize the CRB damage to coconut trees. We find the maximum relative cost to remove a moribund tree is significantly higher than the maximum relative cost to remove a breeding ground.

PROJECT ABSTRACTS

University of Guam, Poster #2

Population Dynamics of the Mariana Eight-Spot Butterfly and Parasitoid Wasps: A Compartment Model Approach

Faculty Advisor: Dr. Hyunju Oh
Student Presenters: Cabrini Aguon and Andrew Lu

This research theoretically modeled the population dynamics between Guam's endangered Mariana Eight-Spot butterfly {Hypolimnas octocula marianensis} with two species of parasitoid wasps {Telenomus remus} and {Echthromorpha intricatoria}. We constructed a compartment model to analyze the influence of the number of host plants available and the number of all other parasitoid targets and computed the basic reproduction number to determine the proliferation of the respective wasp species in the system. We found control measures directly targeting the infection compartment rates eventually became ideal in controlling as host plants increased, while control measures targeting non-infection parameters eventually became ideal as other targets increased. In {T. remus}, the most sensitive non-infection parameters were the host plant count and the number of other targets, whereas in {E. intricatoria}, the rate at which larvae matured just slightly surpassed other pupa targets and host plants in sensitivity.

University of Guam, Poster #3

A Game Theoretical to Modeling Population Dynamics Between the H. o. marianensis, H. and H.bolina

Faculty Advisors: Dr. Hyunju Oh
Student Presenters: Andrea Gutierrez, Sean Hipolito, Yuan-Jen Kuo, Shaun Wu

The Hypolimnas octocula marianensis, also known as the Mariana Eight Spot Butterfly, is endemic to the island of Guam and was classified as endangered by the U.S. Fish and Wildlife Services in October 2015. Despite sharing many traits with two other butterflies in the same genus, the Hypolimnas anomala and Hypolimnas bolina, the H. o. marianensis is the only endangered species. However, the butterflies' host plant availability differs remarkably. This project aims to use evolutionary game theory to model the three butterfly species' populations over time and determine host plant proportions that will sustain the H. o. marianensis and allow it to coexist with the H. anomala and H. bolina. The game theory model analyzes the strategies a population of butterflies can take when laying eggs and determines which is the best. The results show that host plant availability significantly affects all butterfly species' proportions over time and must fall within certain ranges. These findings also suggest a specific order of host plant proportions needed to sustain the H. o. marianensis. Notably, the model demonstrates that the repopulation of the H. o. marianensis is highly dependent on the only variable within human control: the host plant proportions.

PROJECT ABSTRACTS

Andrews University

On the Delta-Unlinking Number of Algebraically Split Links

Faculty Advisor: Anthony Bosman
Student Presenters: Jeanelle Green, Moises Reyes, Noe Reyes, Gabriel Palacios

It is known that algebraically split links (links with vanishing pairwise linking number) can be transformed into the trivial link by a series of local moves on the link diagram called delta-moves; we introduce the delta-unlinking number, defined to be the minimum number of such moves needed. This generalizes the well-studied delta-unknotting number for knots to algebraically split links of arbitrarily many components. We prove that the delta-unlinking number is bounded below by half the unlinking number, the 4-genus, and the slice genus and (for proper links) has the same parity as the Arf invariant. We note relationships with other classical link invariants, such as the Milnor mu bar invariants, and using these determine the delta-unlinking number and tabulate the minimal delta-pathway for prime algebraically split links with up to 9 crossings, as well as determine the 4-genus for most of these links. We generalize several of the relationships to the delta-Gordian distance between proper links, i.e. the minimal number of delta moves needed to move one proper link into another.

Embry Riddle Aeronautical University

REU-DEIM Statistical Analysis of Hispanic voters' behavior in Palm Beach, Florida

Faculty Advisor: Dr. Mihhail Berezovski
Student Presenters: Kamila Soto-Ortiz

The Hispanic population is composed of those that identify with a "Spanish-speaking background and trace their origin or descent from...Spanish-speaking countries." This community is a growing one in the state of Florida. As of 2019, Hispanics make 26% of the state's population, making them a key demographic in Floridian elections. Ergo, understanding Hispanic voters' behavior in Florida is crucial for future elections. For starters, certain social factors have been related to voter behavior. The factors considered in this project are the voter's generation, zip code population density, zip code income and Hispanic group in relation to their voter activity and voter party affiliation. Of all the factors, only generations and Hispanic groups affected both voter activity and voter party affiliation. Voter activity was also influenced by zip code income, while voter party affiliation was also influenced by zip code population density.

Fairfield University

Forest Building Process on Paths and Related Graph Families

Faculty Advisors: Dr. Liyang Zhang, Dr. Zhanar Barikkyzy
Student Presenters: Jonathan Figueroa Reyes, Miles Mena

Given a simple graph, we can use the forest-building process to identify a spanning forest, as follows: we sort the edges of the graph in some order, then, moving in the order of the list, we keep each edge only if it is incident to a vertex that is not already incident to any previous edge, which will result in a spanning forest. To identify all possible spanning forests, we can repeat this process with every possible permutation of the edges. Therefore, the probability of obtaining a spanning tree (a single-component spanning forest) can be calculated as a fraction of the number of single-component spanning forests divided by the total number of spanning forests. We derive the probability of obtaining a spanning tree for graphs of various shapes and arbitrary sizes, cycles, paths attached to stars, and other families.

PROJECT ABSTRACTS

Texas A&M University-Commerce, Poster #2

Generalization of The Excess Area and Its Geometric Interpretation

Faculty Advisor: Dr. Mehmet Celik

Student Presenters: Haley Bambico, Sarah Gross, Francis Hall

The image area of unit disc D under $z \cdot h$ exceeds the image area under h (holomorphic on D). In his book, Hermitian Analysis, John D'Angelo precisely determined how the excess area on D generated by the multiplier, z, grows. After replacing z (in $z \cdot h$) with a finite Blaschke product, we identify precisely how an excess area grows. Further, we derive an upper and lower bound for the excess area growth associated with a finite Blaschke product in terms of the excess area with z. Additionally, we obtain an interesting identity after replacing holomorphic functions with harmonic functions on D in the excess area formulation. Furthermore, we move this formulation onto domains conformal to D. Inspired by D'Angelo's work, we employ Stokes' Theorem relating integration over D to integration on the boundary bD and utilize the relationship between the $L2$✣ norm of h and the $l2$✣ norm of the Taylor coefficients of h. We also apply holomorphic changes of coordinates and use the properties of the Blaschke product and its factors, along with the solution of the Dirichlet problem for the disk, the Cauchy Integral Formula, Cauchy's Theorem, some elementary inequalities, and properties of the Poisson kernel.

University of Guam, Poster #4

Modeling and Analysis of Oryctes Rhinoceros Behavior

Faculty Advisor: Dr. Hyunju Oh

Student Presenters: Gabriel Florencio, Ashley Yang, Michael Cajigal

In Guam, the increase of Oryctes rhinoceros, or rhinoceros beetles, – a species of beetles that prioritizes coconut trees as its source of nourishment – has led to a massive ecological problem since its first appearance in 2007. The rhinoceros beetle problem became exacerbated when the supertyphoon Dolphin struck in 2015. Since then, the rhinoceros beetle population has increased dramatically causing many more coconut trees on the island to become damaged. This research aims to focus on the behavioral patterns of rhinoceros beetles as it interacts with coconut trees and to model these patterns. The goal of conducting this is to analyze the results collected from modeling these patterns, from which we can discern the best course of action to take in order to help suppress the population enough to either create an equilibrium between the beetles and the coconut trees, or so that the trees reach a sort of herd immunity, where there are no more coconut trees being affected by rhinoceros beetles. When this has been achieved, the solutions can then be applied in the same fashion, modeled, and the data collected in order to provide evidence of the solutions' efficacy.

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