Mathematics Conference and Competition of Northern New York 2024

(MCCNNY 2024)

March 2, 2024

Clarkson University

Conference Organizer

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Clarkson University

Thanks to Pi Mu Epsilon and Princeton University Press for providing students prizes!

MCCNNY 2024 Conference Program

9AM—3PM, Saturday, March 2, 2024
Snell 213, Clarkson University

9:00—9:10	**Opening and Welcome**			**Dr. Look** / **Dr. Joe Skufca**	**Snell 213**
9:10—9:55	Keynote: Mathematical Illustration, Experimentation, and Exploration			Dr. Gabriel Dorfsman-Hopkins	**Snell 213**
10:00— 10:45	Session 1 **Snell 213** **Chair: Drs. Clark-Stone and Dr. Rubasinghe**	Presenter	Session 2 **Snell 212** **Chair: Drs. Greene and Madore**		Presenter
	Classifying Bristle Cell Organization in Drosophila	Wisdom Attipoe	A mathematical model of blebbing clarifies the role of talin during bleb expansion		S.H. Dinuka S de Silva
	Concatenation of Matrix Products	Kyle Monette	Modeling the spread of retinal detachment (RD) and its effects on the dynamics of the rod outer segment (ROS) renewal		William Ebo Annan
	The Lamprey Location Dependent Model: How Flow Rate Can Influence Sex Ratios and Total Population	Eric Martin, Romeo Caldwell, Bryant Connolly	Evaluating the Importance of Glucagon in the Insulin Glucose Regulatory System: A Mechanistic Modeling Approach		Mackenzie Dalton
11:00—12:20	Jeopardy!!!			**Dr. Madore**	**Snell 213**
12:20—1:00	Lunch and Poster Presentation!!!			**Dr. Foisy and Yao**	**Snell 213**
	Algebraic Starscapes Using Complex Eigenvalues of Bohemian Matrices			Eliza Brown	
	Examining Gender-Based Differences in Students' Attitudes toward Engineering and Sociotechnical Understanding: A Structural Equation Modeling Study			Lucas Adams	
	IMU-based Automatic Prediction of Energy and Fatigue in a Single-Task Walking Gait			Zahra Mahdavi	
	Quantifying the Impact of Deep Learning-Enhanced Speech Preprocessing on ASR Accuracy			Ajan Ahmed	
1:00—1:45	Session 3 **Snell 213** **Chair: Drs. Meysami and Foisy**	Presenter	Session 4 **Snell 212** **Chair: Drs. Asante-Asamani and Look**		Presenter
	An Investigation of Achromatic and Harmonious Chromatic Numbers of Certain Classes of Graphs	Hannah Leopold-Brandt	Univariate and interaction assessment among risk factors on COVID-19 during pre-vaccination period in USA: A Negative Binomial Regression Analysis		Sucharitha Dodamgodage
	Dynamics and Learning for Stochastic Interacting particle systems I	Uresha Dias Rammini	Adverse effects as a predictor of tumor response in maintenance therapy of advanced lung cancer by pemetrexed and bevacizumab		Olivia Varricchione
	Dynamics and Learning for Stochastic Interacting Particle Systems II	Nipuni Senani de Silva Rammini	Unveiling Wildfire Dynamics: A County-Specific Analysis in California		Alex Lindquist, Nate Smullen, Victoria York and Shreejit Poudyal
1:55—2:05	Award and Closing!			**Dr. Madore**	Snell B10L

Victoria	York	Senior	Clarkson University	Data Science
Guangming	Yao	Faculty	Clarkson University	Math
Wisdom	Attipoe	Graduate St.	Clarkson University	Math
Shreejit	Poudyal	Senior	Clarkson University	Data Science
William	Annan	Graduate St.	Clarkson University	Math
Sumona	Mondal	Faculty	Clarkson University	Math
James	Greene	Faculty	Clarkson University	Math
Eric	Martin	Sophomore	Clarkson University	Civil Eng and Math
Sucharitha	Dodamgodage	Graduate St.	Clarkson University	Applied Statistics
Bryant	Connolly	Senior	Clarkson University	Math
Mackenzie	Dalton	Graduate St.	Clarkson University	Math
Moses	Adejumo	Graduate St.	Clarkson University	Chemical Engineering
Christopher	Perriello	Freshman	Clarkson University	Math
S. H. Dinuka S	de Silva	Graduate St.	Clarkson University	Math
Nathan (Nate)	Smullen	Junior	Clarkson University	Data Science, CS
Alex	Lindquist	Junior	Clarkson University	Data Science and CS
Uresha	Dias	Graduate St.	Clarkson University	Math
Lucas	Adams	Senior	Clarkson University	Math
Zahra	Mahdavi	Graduate St.	Clarkson University	Elect. & Comp. Eng
Ajan	Ahmed	Graduate St.	Clarkson University	Elect. & Comp. Eng
Nipuni Senani	Rammini	Graduate St.	Clarkson University	Math
Mohammad	Meysami	Faculty	Clarkson University	Math
Vijay	Kumar	Postdoct	Columbia University	Math
Bedel	Bokama Shambu	Sophomore	McGill University	Stat and CS
Peter	Bullard	Senior	McGill University	Math
Sarah	Weaver	Senior	St. Lawrence University	Data Science
Daniel M	Look	Faculty	St. Lawrence University	Math
Eliza	Brown	Senior	St. Lawrence University	Math
Olivia	Varricchione	Senior	St. Lawrence University	Math
Katie	Hallett	Sophomore	St. Lawrence University	Math
Patti	Lock	Faculty	St. Lawrence University	
Jesse	Clark-Stone	Faculty	SUNY Canton	Math
Kalani	Rubasinghe	Faculty	SUNY Canton	
Joel	Foisy	Faculty	SUNY Potsdam	Math
Allie	Kellogg	Senior	SUNY Potsdam	Math
Justin	Mossey	Junior	SUNY Potsdam	Math
Natalie	Monnat	Senior	SUNY Potsdam	Math Education
Jessi	Blackmer	Senior	SUNY Potsdam	Math Education
Jessica	Blackmer	Senior	SUNY Potsdam	Math Education
Blair	Madore	Faculty	SUNY Potsdam	Math
Cheryl	Miller	Faculty	SUNY Potsdam	
Karissa	Massud	Graduate	U. of Rhode Island	Math
Hannah	Leopold-Brandt	Graduate	U. of Rhode Island	Math
Kyle	Monette	Graduate St.	U. of Rhode Island(CU alu)	Math

Presentation Title and Abstract

Keynote Presentation

Title: **Mathematical Illustration, Experimentation, and Exploration**

Authors: **Dr. Gabriel Dorfsman-Hopkins, Assistant professor, Department of Mathematics, Statistics, and Computer Science, St. Lawrence University**

Abstract: We will explore how illustration can be a powerful tool for mathematical research and exposition. We will give examples of illustrations of mathematics drawing from a broad array of techniques, including computer graphics, sculpture, digital fabrication, and fiber arts. We will share some applications of these techniques, explaining how some of these projects led to new mathematical theorems, while others led to art installations, and in at least one case, both.

Poster Presentations

Authors: Eliza Brown

Faculty Advisor: Gabriel Dorfsman-Hopkins

Title: **Algebraic Starscapes Using Complex Eigenvalues of Bohemian Matrices**

Abstract: The fundamental theorem of algebra states that every polynomial equation with complex coefficients has complex roots. These roots can be mapped on the complex plane, resulting in beautiful, geometric patterns called algebraic starscapes. I developed python code to compute and graph the complex eigenvalues of specific families of matrices, utilizing St. Lawrence's supercomputer for the millions of computations this required. I experimented with matrix size and integer inputs, as well as a multitude of variables in the graphic generation phase. My final images highlight the effects of an eigenvalue's associated determinant. The eigenvalue's pixel color and brightness are modified by its determinant's sign (positive vs negative) and size (large vs small). I used techniques such as Gaussian blurring and kernel cropping to generate the images. Algebraic starscapes are visual mathematical models. As such, they bridge the divide between math and art. This allows even non-mathematically oriented people to appreciate the beauty of mathematics and open them to conversation about deep mathematical concepts.

Poster Presentations

Authors: Zahra Mahdavi, Anthony J. Lombardi, Masudul Haider Imtiaz1, Ali Boolani

Faculty Advisor: Masudul Haider Imtiaz, Ali Boolani

Title: **IMU-based Automatic Prediction of Energy and Fatigue in a Single-Task Walking Gait**

Abstract: Abstract: Our study presents a machine-learning model for automatically predicting energy and fatigue levels during single-task walking gait. Trained on wearable tri-axial accelerometer, gyroscope, and magnetometer signals, a Random Forest Regressor model achieved an average R2 value of 0.61. The study's findings suggest a significant correlation between gait patterns and mental states, highlighting the potential of using gait analysis as a non-invasive method for mental health assessment. Further research in this area could lead to the development of innovative tools for early detection and intervention in mental health disorders.

Pster Presentations

Authors: Ajan Ahmed; Masudul Imtiaz; Stephanie Schuckers
Faculty Advisor: Masudul Imtiaz; Stephanie Schuckers
Title: **Quantifying the Impact of Deep Learning-Enhanced Speech Preprocessing on ASR Accuracy**

Abstract: Despite significant advances in Automated Speaker Recognition (ASR) technologies, accurately recognizing speakers in noisy environments is still an enormous challenge. This limitation is especially noticeable in public datasets, where noisy recording conditions can significantly reduce performance. This study aims to close this gap by applying a deep learning-based denoising technique, specifically a Convolutional Neural Network (CNN) adapted for audio signal processing, to a well-known public dataset, the MS-SNSD dataset, which is known for its diversity of speech samples and recording conditions. The primary methodology involves preprocessing this dataset with the CNN-based denoising method to improve the clarity and quality of the voice recordings. The effectiveness of this preprocessing step is assessed using both traditional and ASR-specific metrics: Signal-to-Noise Ratio (SNR), Mean Opinion Score (MOS), and Perceptual Evaluation of Speech Quality (PESQ) are measured before and after denoising to quantify audio quality improvements. Additionally, ASR performance is evaluated using VeriSpeak, with a focus on match score and False Rejection Rate (FRR) to determine recognition accuracy. The focus of this research is on correlating these improvements in speech quality metrics with improvements in speaker recognition performance, with the goal of determining which metrics are most predictive of ASR success following denoising. By utilizing deep learning for noise reduction, this study not only demonstrates the potential for significantly improved ASR accuracy in noisy conditions but also establishes a methodological framework for predicting ASR performance improvements based on specific audio quality metrics. The findings are expected to help develop more resilient ASR systems that can maintain high accuracy in a variety of acoustic environments, expanding the applicability and inclusivity of speaker recognition technologies. This study emphasizes the importance of preprocessing in the ASR pipeline and the predictive value of SNR, MOS, and PESQ in improving speaker recognition capabilities, paving the way for

future advances in speech processing and automated identification systems.

Poster Presentations

Authors: Jan DeWaters, Felicity Bilow, Mohammad Meysami, Lucas Adams

Faculty Advisor: Jan DeWaters

Title: Examining Gender-Based Differences in Students' Attitudes toward Engineering and Sociotechnical Understanding: A Structural Equation Modeling Study

Abstract: This research study uses structural equation modeling to explore the relationships among undergraduate engineering students' attitudes toward and perceptions of engineering and their understanding and appreciation of engineering's broad, sociotechnical aspects, with a particular focus on examining how these relationships vary with respect to student gender and exposure to sociotechnical engineering coursework. Subjects were 314 undergraduate students at one small technically-focused research university, who completed Likert-type surveys in spring 2022. A factor structure previously determined through exploratory and confirmatory factor analysis revealed five latent variables that align with a framework proposed by Fila et al. [1] for teaching engineering within a humanistic lens to help students develop a sense of belonging and their engineering identity. Our SEM analysis showed that for all students, academic self-confidence and self-efficacy and a broad understanding of engineering both have a significant positive influence on their sense of belonging, which in turn has a significant influence on their attitudes toward persisting and succeeding in engineering. Appreciating the importance of non-technical skills in engineering had no significant influence on most students' sense of belonging with the exception of males with more than one sociotechnical course, where the influence was negative. The relationships among the latent constructs varied according to student gender and exposure to sociotechnical coursework, and are described in detail in the study. In essence, the findings point to the important connections between students' sense of belonging and their attitudes toward persisting and succeeding in engineering, which was more important for females compared to males and was stronger for females who were exposed to more sociotechnical engineering coursework. Furthermore, providing students' educational opportunities to bolster their self-confidence and self-efficacy, and improve their understanding of the breadth of engineering, will positively influence their sense of belonging. The study findings are limited by the small sample sizes and the reliance on students' self-reported exposure to sociotechnical engineering coursework.

Oral Presentations

Authors: WISDOM K. ATTIPOE, DR. E. ASANTE-ASAMANI, DR GINGER HUNTER

Advisor: EMMANUEL ASANTE-ASAMANI

Title:* *CLASSIFYING BRISTLE CELL ORGANIZATION IN DROSOPHILA MELANOGASTER

Abstract: Repeating patterns are important for epithelia that sense the environment. Optimizing the organization of these tissues helps them to function normally. A major challenge for researchers is the ability to quantify and classify complex cell and tissue patterns across wild type and perturbed conditions. We study this problem in the fruit fly Drosophila melanogaster, where the organization of sensory bristles on its thorax contributes to the proper function of its peripheral nervous system. A well-known perturbation in bristle cell organization is density, which has been found to increase in certain fly mutants. It is unclear if this density phenotype is shared by other mutants and whether additional pattern features beyond density exist that can be used to distinguish bristle patterns. In this study, we investigate the utility of clustering features of bristle organization in distinguishing between wildtype and perturbed patterns. The K-means algorithm is used to identify and quantify clusters. Our study finds that perturbed patterns generated through various genetic knockdowns show better organized clusters than wild type patterns.

Oral Presentations

Authors: Alex Lindquist, Shreejit Poudyal*, Nate Smullen, Victoria York, Ali Lotfi, James Greene, and Mohammad Meysami

Advisor: Mohammad Meysami

Title:* *Unveiling Wildfire Dynamics: A County-Specific Analysis in California

Abstract: In a time marked by an increasing frequency of natural disasters and their growing economic toll, the United States grapples with an annual average cost of 20 billion dollars attributed to these events. This study addresses the pressing issue of wildfires, which have emerged as a significant contributor to economic losses. We present a tailored modeling approach, focusing on various environmental factors as contributors shaping the occurrence of wildfires. Our goal is to develop a robust understanding of these factors to formulate effective strategies that can mitigate both the frequency and severity of wildfires. This research employs Bayesian methodologies to assess the impact of climate change specifically on Californian wildfires, conducting a suitable county-level analysis. Employing Bayesian methods, we categorize counties into distinct groups, namely “Top” and “Bottom,” based on their wildfire incidence. The aim is not solely to identify statistical differences between these groups but rather to unravel the interplay of underlying factors and discern which ones have a more impactful influence in each group.

Oral Presentations

Author: William Ebo Annan

Advisor: Diana White

***Title:* Modeling the spread of retinal detachment (RD) and its effects on the dynamics of the rod outer segment (ROS) renewal:**

Abstract: Retinal detachment (RD) is the separation of the neural layer (NL) from the retinal pigmented epithelium (RPE), thereby preventing the supply of nutrients to the cells within the NL of the retina. In vertebrates, primary photoreceptor cells, consisting of rods and cones, undergo daily renewal of their outer segment through the addition of disc-like structures and the shedding of these discs at their distal end. When the retina detaches, the outer segment of these cells begins to degenerate, and if surgical procedures for reattachment are not performed promptly, the cells can die, leading to blindness. Recent mathematical models and experimental work provide insight into how retinal detachment affects the renewal of a rod's outer segment, as well as the survival time of a rod cell in a detached retina. The progression of retinal detachment results in a progressive loss of vision. In this work, we develop a mathematical model that combines the spatial progression of retinal detachment with the dynamics of the rod outer segment under different rates of eye movement. We use an immersed boundary method to simulate fluid-structure interactions. Understanding the progression of retinal detachment and its effects on the population of rod cells will help predict the timeframe within which retinal detachment surgery can restore vision.

Oral Presentations

Author: Hannah Leopold-Brandt

Advisor: Nancy Eaton, University of Rhode Island

***Title:* An Investigation of Achromatic and Harmonious Chromatic Numbers of Certain Classes of Graphs**

Abstract: In this project, we examine both the achromatic and harmonious chromatic numbers of graphs whose chromatic number is either 2 or 3. Given a graph, G, a harmonious coloring of G is a proper vertex coloring such that each color pair is used at most once. The minimum number of colors used to create such a coloring is known as the harmonious chromatic number of G, denoted $\chi H(G)$. A complete coloring of a graph G is a proper vertex coloring such that each color pair is used at least once. The maximum number of colors used to create such a coloring is known as the achromatic number of G, denoted $\psi(G)$. We note that it is always true that $\psi(G) \leq \chi H(G)$ for any graph G. Here we provide bounds for these numbers, existence of graphs where they are the same, and instances where the distance between the two numbers is maximized for paths, cycles, bipartite graphs, and trees.

Oral Presentations

Author: Kyle Monette, **University of Rhode Island (CU alumni)**

Advisor: Prashant Athavale

Title: ***Concatenation of Matrix Products***

Abstract: Matrix multiplication comes across as a nonintuitive operation which stands in contrast to more simple ones like addition or transposition. However, the nature of this operation allows for interesting properties that are, for instance, impossible with integers. Namely, we are interested in sets of integer matrices where the product is equal to the elementwise concatenation of the matrices, and sets where the product is equal to the matrix sum. For the former we call the set "concatenation equivalent" (CE) and for the latter we call it "addition equivalent" (AE).
In this talk, we explain the necessary and sufficient conditions for matrices to be CE or AE based on their spectrum and other characteristics. We also briefly discuss how to generate a matrix to complete a CE pair and how this result can be generalized to a larger product.

Oral Presentations

Authors: Mackenzie Dalton, Dr. Emmanuel Asante-Asamani, Dr. James Greene

Advisor: Emmanuel Asante-Asamani and James Greene

Title: ***Evaluating the Importance of Glucagon in the Insulin Glucose Regulatory System: A Mechanistic Modeling Approach***

Abstract: The insulin-glucose regulatory system is a tightly monitored system of the body. The pancreatic islets of Langerhans contain both beta and alpha cells which produce insulin and glucagon, respectively. Insulin is the only hormone in the body that lowers blood glucose levels by acting like a key for glucose to enter cells. Without insulin, cells in the body cannot utilize glucose, the primary source of energy for cells. In contrast, glucagon functions as a hormone which elevates blood glucose levels by promoting the breakdown of glycogen in the liver. Maintaining blood glucose within a safe range is vital since both excessively high and low levels can be life-threatening (hyperglycemia and hypoglycemia, respectively), and these two hormones work together to achieve this balance. In this work we aim to underscore the significance of glucagon in the insulin-glucose regulatory system. We construct a three compartment mechanistic model that includes insulin, glucose and glucagon. We then validate our model by fitting it to publicly available insulin, glucose, and glucagon data from pigs subjected to an intravenous glucose tolerance test (IVGTT). Lastly, we investigate how decoupling insulin from the system, as seen in diabetes, disrupts the regulation of glucose and glucagon.

Oral Presentations

Authors: Eric Martin, Romeo Caldwell, Bryant Connolly

Advisor: Dr. Guangming Yao and Dr. Katie Kavanagh

Title:* *The Lamprey Location Dependent Model: How Flow Rate Can Influence Sex Ratios and Total Population

Abstract: Sea lampreys (Petromyzon marinus) are a unique species in the animal kingdom. They are an ancient species that has an interesting combination of metamorphosis, migration, and parasitic feeding that makes them popular for studying. The aspect that we will be focusing on in this paper is the sex ratio of the sea lamprey. The sex split of the sea lamprey is largely dependent on food availability, in cases where there is less food, the percentage of males is higher, and when there is less food, the percentage of males is lower. However, it is also worth mentioning that the percentage of males is always higher than the percentage of females. In this paper, we will investigate the effects that lead to the sex split and how the sex split affects the overall population.

Our approach to this problem involved creating a parameterized partial differential equation model, which we then manipulated to capture the specific conditions of three different locations: the Great Lakes, the Baltics, and the Atlantic Ocean. This equation utilizes both an Ordinary Differential Equation (ODE) model and the Lotka-Volterra Model, as both are often used for simulating population growth. The main determinant for this model will be the flow rate. This may be unexpected, but we found that the river's flow rate determined how much food each larva got, in the larval stage lampreys are stationary and filter out nutrients from the water stream, which in turn affects the sex split as explained above. This novel perspective on the population of sea lampreys adds a new take on research on the subject. Our investigation includes a sensitivity analysis of the model's parameters. This involves isolating each variable to determine their impact on the final solution. Notably, we examined the different locations and the possible effects of lampricides in the Great Lakes and how climate change could exacerbate the problems already faced by all three locations. The model's adaptability allows a nuanced exploration of how various factors could affect the sea lamprey population.

Through our models, we determined that flow rate had a significant impact on the sex split of sea lampreys and a sizable impact on the overall population. However, lampricide had a larger effect on the sea lampreys, which is in line with the current research. Furthermore, the number of eggs and mortality rate had the biggest impact on the final output. We also looked at population growth and sex split through the lens of climate change, which added a layer of complexity to our investigation. We went beyond investigating the specific impact that these changes may have on the population, but also how the population could impact the ecosystem at large, both through our current models and the lens of global climate change.

Our model offers great space for variability and can easily be tailored to any specific location where sea lampreys reside. This adaptability is the greatest strength of the model and leads to a more nuanced understanding of the solution from multiple perspectives. These results found by our model offer valuable insights into how sex ratios impact populations, but also how the flow rate impacts sex ratios and how the population may impact other parts of the larger ecosystem.

Oral Presentations

Authors: Sucharitha Dodamgodage, Thevasha Sathiyakumar, Dinushani Senarathna, Stephanie Andreescu

Advisor: Sumona Mondal,James Greene, Shantanu Sur

***Title:* Univariate and interaction assessment among risk factors on COVID-19 during pre-vaccination period in USA: A NegativeBinomial Regression Analysis**

Abstract:
This study demonstrates a new modeling approach with the use of clustered data handling and shows evidence of how both the univariate and bivariate associations of multiple risk factors could influence the vulnerability to COVID-19. A total of 3040 USA counties from the pre-vaccination period (January 2020–December 2020) were selected for modeling and subsequent analysis. We showed the potential of utilizing quartile clustering in conjunction with negative binomial regression to better understand the interaction effects between selected comorbidities as well as demographic and socioeconomic risk factors on the infection and fatality rates of COVID-19. All available data was separated into two equal Phases, Phase \textbf{1} and Phase \textbf{2} that correspond approximately to the first two pandemic waves; each Phase was further subdivided into three groups (\textbf{Low}, \textbf{Medium}, \textbf{High}) based on infection and fatality rates in order to understand whether the timing of COVID-19 has an effect on association of risk factors to COVID-19 burden. Negative binomial regression models without interaction effects were first constructed to identify significant risk factors, followed by the construction of models to determine the significant interaction effects of risk factors. The key finding suggests that selected sub-populations defined by the intersection of specific risk factors could be more vulnerable to COVID-19. Our analysis showed that the bivariate interaction of low education along with other factors such as elderly population, Hispanic, and non-Hispanic Black (NHB) population are more associated with increased infection, while the interaction effects of population density with the elderly population, male population with poverty, and Hispanic population with low education were associated with increased fatality. Furthermore, the univariate model did not capture the impact of obesity on infections, but through interaction analysis, a positive influence emerged when considering the interplay between obesity and the elderly population. Similarly, the univariate models failed to capture the impact of less education and the Hispanic population on infections, as well as the influence of poverty on fatality. However, employing interaction models unveiled these significant associations, emphasizing the added insights gained by considering the interplay between variables.

Oral Presentations

Authors: Olivia Varricchione and Alexander Haywood

Faculty Advisor: James Greene, Mohammad Meysami, Sumona Mondal, and Shantanu Sur

Title: Adverse effects as a predictor of tumor response in maintenance therapy of advanced lung cancer by pemetrexed and bevacizumab

Abstract: In the United States, cancer is the second leading cause of death, and is responsible for approximately 10 million deaths per year worldwide. There is an emerging interest in personalized therapy for cancer treatment, which utilizes individual patient characteristics to guide treatment plans for an improved outcome. Specifically, personalized medicine allows for better-informed treatment decisions, as cancer is highly heterogeneous, even within a specific variant. One aspect of cancer treatment where personalized therapy design may contribute to improved response is maintenance therapy. Maintenance therapy generally refers to any secondary treatment given after the disease has responded to an initial therapy and is used to prevent relapse as well as to delay tumor growth. In this work, we examine potential avenues for applying a personalized therapy approach to the results of the ECOG-ACRIN 5508 trial of combination pemetrexed and bevacizumab maintenance therapy for advanced nonsquamous non-small-cell lung cancer (NSCLC). Maintenance therapy with either pemetrexed or bevacizumab alone has been shown to increase overall survival in NSCLC, one of the most common subtypes of lung cancer. Other preliminary studies found that the combination of the two in maintenance therapy might have benefits for progression-free survival, and the combination was adopted for routine therapy. However, according to the clinical trial, the greater toxicity caused by the combination therapy offsets its advantages for progression-free survival. To further evaluate these trade-offs, Chi-Square tests of independence and a multinomial logistic regression model are used to explore the relationship between increased rates of toxicity and higher rates of response to maintenance therapy. A significant relationship between response and toxicity is present in all three treatment groups, but the details of the association differ between the combination and the individual therapies. This difference in association is present within individual toxicities as well. Additionally, toxicity parameters are more impactful for predicting a patient's response for the combination group compared to both therapies individually. These results may help doctors and patients determine on a case-by-case basis whether treatment should be continued despite toxicity manifestation and provide direction for future research into connections between response and toxicity, particularly in combination therapies.

Oral Presentations

Authors: S.H. Dinuka S de Silva,Emily Movsumova, Jessica Reznik, Zully Santiago, Derrick Brazill, Emmanuel Asante-Asamani

Advisor: James Clarkson Greene

Title: **A mathematical model of blebbing clarifies the role of talin during bleb expansion**

Abstract: Cells utilize two primary structures for migration: blebs and F-actin driven protrusions (FDP). Blebs are spherical cell membrane protrusions driven by intracellular fluid pressure, while FDP utilize rapid actin polymerization to propel the membrane forward. Cells can dynamically switch between FDP and bleb-based movement depending on their environment. Although FDP are well-characterized, many questions remain unanswered regarding the physical and chemical mechanisms governing bleb-driven motility. Particularly intriguing is the role of membrane-to-cortex binding proteins (such as talin) in regulating bleb size and frequency. Previous studies have suggested that the absence of membrane-to-cortex linker proteins produce larger and more frequent blebs. However, recent experimental data from Dictyostelium discoideum cells show that the loss of talin reduces the size and frequency of blebs. In this work, we present a mathematical model of bleb expansion in confined Dictyostelium discoideum cells, and employ this model to clarify the role of talin in bleb expansion.

Oral Presentations

Authors: Uresha Dias, Nipuni Senani de Silva Rammini

Advisor: James Clarkson Greene

Title: **Dynamics and Learning for Stochastic Interacting particle systems I**

Abstract: Interacting particle systems, also known as agent-based models, are utilized to study a wide range of physical phenomena across multiple scales; examples include the collective motion of bacteria, the flocking of birds and other animal species, and the coordination of mobile networks. Most such systems exhibit a form of emergence: local interactions which lead to large-scale coordination. A fundamental scientific question is thus discovering local interaction laws which lead to observed behavior. Furthermore, it is well known that in many systems, inter-agent communication is non-deterministic, but instead is influenced by varying degrees of noise.

We assume the dynamics are governed by a coupled system of stochastic nonlinear differential equations. The Kuramoto system is a fundamental model that elucidates how initially independent oscillators synchronize as they start moving coherently. The stochastic Kuramoto model, which incorporates a noise source, has undergone extensive investigation. Most of the research has focused on the case of white noise. This presentation lies in simulating the deterministic and stochastic model, particularly examining how the model varies with system noise levels and differences in coupling strength.

Oral Presentations

Authors: Nipuni Senani de Silva Rammini, Uresha Dias, James Clarkson Greene

Advisor: Dr.James Greene

Title: **Dynamics and Learning for Stochastic Interacting Particle Systems II**

Abstract: We apply a novel non-parametric statistical learning approach to infer the interaction kernel of agent-based models and assess the ability to learn dynamics, with and without specific emphasis on the learning efficiency as a function of the noise present. We present current results for the deterministic case, applied to models of opinion dynamics and the Lennard-Jones potential, the latter of which is utilized to describe the formation of crystal-like structures. Extensions to stochastic systems are also discussed, with future work being developed for both first- and second-order dynamical systems in the presence of state-dependent noise.

Oral Presentations

Authors: MeysamiAlex Lindquist, Shreejit Poudyal*, Nate Smullen, Victoria York, Ali Lotfi, James Greene, and Mohammad Meysami

Advisor: Mohammad Meysami

Title: **Unveiling Wildfire Dynamics: A County-Specific Analysis in California**

Abstract: In a time marked by an increasing frequency of natural disasters and their growing economic toll, the United States grapples with an annual average cost of 20 billion dollars attributed to these events. This study addresses the pressing issue of wildfires, which have emerged as a significant contributor to economic losses. We present a tailored modeling approach, focusing on various environmental factors as contributors shaping the occurrence of wildfires. Our goal is to develop a robust understanding of these factors to formulate effective strategies that can mitigate both the frequency and severity of wildfires. This research employs Bayesian methodologies to assess the impact of climate change specifically on Californian wildfires, conducting a suitable county-level analysis. Employing Bayesian methods, we categorize counties into distinct groups, namely “Top” and “Bottom,” based on their wildfire incidence. The aim is not solely to identify statistical differences between these groups but rather to unravel the interplay of underlying factors and discern which ones have a more impactful influence in each group.