2021 MAA Golden Section Meeting, Student Poster Session Abstracts (Posters 1–5)

1 *SwingBeats: An IoT Haptic Feedback Ankle Bracelet (HFAB) for Dance Education*

Yu Yang Chee, Alissa LaFerriere, Jesse Mayer (Santa Clara University)

Abstract. Dancing involves doing specific movements on specific beats of the music, but many struggle with keeping track of the beat and what movement comes next. To help, the SwingBeats project has developed IoT Haptic Feedback Ankle Bracelets (HFABs) to signal learners when and how to move their feet to the beat of the music, providing the learner with immediate feedback. Tap dance is a style of dance focused on rhythmic footwork which is characterized by the sounds of the metal taps affixed under the toes and heels of the dance shoes striking the floor. Tap dance is the perfect style of dance for testing in this phase of the system's development as this style focuses on the feet rather than the whole body.

2 *Numerical Range of Block Toeplitz Matrices*

Sarah Mantell (Cal Poly, San Luis Obispo)

Abstract. The numerical range of a bounded linear operator on a Hilbert space is a convex subset of the complex plane and succinctly captures information about the operator's eigenvalues and eigenspaces. The numerical range of any Toeplitz operator with an affine symbol is a circular disk. However, examples illustrate cases where the numerical range of a block Toeplitz operator with symbol $A_0 + zA_1$, both A_0 and A_1 complex matrices, is not a disk. We establish some conditions on A_0 and A_1 such that the block Toeplitz operator with symbol $A_0 + zA_1$ has numerical range equal to a disk.

3 *Analysis of the State of COVID-19 Pandemic in Florida, Montana, Hawaii, and Alaska using mathematical modeling*

Allen Bryan (Junipero Serra High School); Kevin You (Palo Alto High School); David Zhang (Mountain View High School)

Abstract. We used mathematical modeling to analyze the data and determine the severity of the COVID-19 pandemic for the states Florida, Montana, Hawaii, and Alaska, and compared the way the pandemic has manifested in these different states. We discovered that the prevalence of outside social activities in the state, as well as the regulations in place by the state, were the largest determining factor of the spread of COVID-19. Our data also show that the effectiveness of the vaccine is dependent on the size of the state, but has not generated enough data to determine its effectiveness at slowing the spread of the virus.

4 *Examining and Predicting Trends in COVID-19 Cases in Washington State and Arizona Using Mathematical Modeling*

Andy Chen (Saratoga High School); Ryane Li (Valley Christian High School)

Abstract. Despite various countermeasures, COVID-19 cases and deaths have only continued to increase throughout 2020 and 2021. Using data gathered from February 18th, 2020 to Jan 30th, 2021 detailing daily COVID-19 total cases and deaths in Washington and Arizona, we determined trends in both the rate of the spread of the coronavirus as well as the cumulative number of cases. By graphing our data and creating polynomial regression models, we were able to identify three distinct periods in which the rate and spread of COVID-19, as a result of different statewide coronavirus policies, varied significantly. We've concluded from our evidence that as COVID-19 cases and deaths only continue to grow at an increasing rate, states must tighten social distancing measures until cases begin to fall as vaccinations are administered.

5 *The Impact of COVID-19 on Mathematics Classes: Voices of CSUF Students*

Chris Verville (California State University, Fullerton)

Abstract. Abstract: This research focuses on analyzing more than 5,000 student survey responses regarding the greatest benefits and challenges of taking mathematics courses during a pandemic. Though most students found the time saved from not commuting to school beneficial, many students indicated a strong preference toward taking courses in-person. A number of students, including those from underrepresented minority groups, tended to struggle with the logistics associated with virtual courses environment due to extenuating circumstances. Findings from this study suggest that as colleges and universities move into a post-pandemic time, university leaders will need to bring students into the conversation in a meaningful way to create multiple paths towards academic success.

2021 MAA Golden Section Meeting, Student Poster Session Abstracts (Posters 6–10)

6 *Using Mathematical Modeling to Compare and Predict Trends Between Daily COVID-19 Total Cases and Deaths in New York, New Jersey, and Illinois*

Owen Xu Li (American School Foundation); Cindy Jingru Wang (Palo Alto High School); Kevin Zhang (Mountain View High School)

Abstract. In this paper, we aim to explore the coronavirus case data from three states, New York, New Jersey, and Illinois with the appropriate lockdown factors to predict the number of cases in the future using a variety of mathematical models. We subsequently use a variety of functions, including linear, quadratic, and polynomials to predict the association between virus cases and days from lockdown. After the introduction of widespread vaccination efforts in December of 2020 across the US, we included data from January to analyze the impact of said vaccination efforts on the number of total cases and deaths in each state.

7 *Topological Data Analyses of U.S. Wildfires and COVID-19*

Ryan Beck, Matthew Nicholson, Sandy Riley, Isaac Travers (Humboldt State University); Lance Johnson, Maryfer Mendoza, Lily Schieberl (Sacramento State University)

Abstract. Topological Data Analysis (TDA) provides new and powerful visual representation tools to classify and cluster high-dimensional and complex data. This poster will explain one technique of TDA, the TDA Mapper algorithm, and discuss its applications to analyze COVID-19 and wildfires data in the United States. For the COVID-19 dataset, we examine the relation between ICU Occupancy as a time series for the most affected states in the US. For the wildfire dataset, we examine the relation between acres burned by wildfires over geographical locations across the US.

8 *Spheres of Planes in Generalized Quaternions*

Ian Gallagher, Andy Haase, Bailey Wickham (Cal Poly, San Luis Obispo)

Abstract. The quaternion algebra $\mathbb{H}$ is a 4-dimensional division algebra that contains within it conjugate 2-dimensional oriented subalgebras isomorphic to $\mathbb{C}$. We show this set is in natural bijective correspondence with the points on the 2-sphere, which we view as a moduli space. We show that similarly, $M_2(\mathbb{R})$ contains a sphere of 2-dimensional commutative subalgebras, divided into three isomorphism types, forming three conjugacy classes. We use the resulting partition of our moduli space to make a probability distribution for the three classes of commutative planes in $M_2(\mathbb{R})$.

9 *A Whole Lot of Values for Pi*

Nikhil Sahoo (Cornell University)

Abstract. We give an introduction to the classical result of Stanisław Gołąb, that the possible values of pi in normed planes comprise the interval $[3, 4]$. We also discuss Gołąb's classification of the extremal cases of 3 and 4. Finally, we introduce a more recent result for norms with quarter-turn symmetry and show that the minimizing case in this context provides a classification of inner product spaces.

10 *Informing the Need of Critical Thinking in Mathematics*

Arlena Liryce Gavino (California State University, Stanislaus)

Abstract. Many studies have proven that students do not think rationally about mathematical word problems. Using a survey that contains the original and modernized version of the "How Old is the Sheppard?" problem in California's Central Valley schools, we discovered the following: word choice does not play a role in students' performance on nonsensical mathematics problems; students improve their critical thinking skills from middle school to high school; performance on traditional mathematics problems has no correlation to their performance on nonsensical problem; and recognized that students' critical thinking has improved, but it still needs to be improved. This information may help teachers, textbook authors, and others invested in mathematics education create better material for students.