

## TALKS

**Hunter Brashaw** (Simpson College)

*Oral & Visual Forms of Assessment in a Mathematics Classroom* (Talk)

Over the years of the developing education system, one thing has seemed to remain consistent, testing methods. Not until recently have the effects of alternative or non-traditional been studied and how they have shown positive effects towards students. I am currently a student teacher at SouthEast Warren JH/HS in Liberty Center, Iowa. I will be testing the effects of Orally & Visually administered assessments compared to traditional testing methods, and determine whether or retention of material shows improvement.

**Milos Dordevic** (Simpson College)

*Cryptography* (Talk)

Though it has been used for thousands of years to hide secret messages, systematic study of cryptology as a science (and perhaps an art) just started around one hundred years ago. In this paper we will discuss current methods used in encrypting our daily messages and protecting our online systems (RSA Cryptography). We will also discuss the future that comes with quantum computers and quantum computing and the need for new encryption algorithms (Lattice Based Algorithms).

**Jonathan Engle** (Drake University)

*The Mathematical Modeling of Gentrification and Urban Development* (Talk)

When evaluating a specific community in a city, it is important to keep in mind that increasing money flow to that community does not always fix economic and social disparities. Gentrification is defined by the process of renovating and improving a district or location within a community so that it conforms to middle-class tastes, values, and expectations. The overall outcome of gentrification is increased economic activity, tax base, and money influx to a given community. However, people who were part of the community prior to gentrification typically find themselves at an economic disadvantage as the community moves from a low-income community to a more affluent community. Unable to afford the increased cost of living due to gentrification, original members of the community are often forced to move to adjacent and less developed areas of a city. Therefore, gentrification creates a vicious cycle of economic and social stratification where individuals displaced from a given community due to gentrification, are forced to move to areas where infrastructure for appropriate schools, hospitals, etc. may be lacking. Overall, this project seeks to answer the question: what is the nature of gentrification in a small city using Des Moines, Iowa as the case study, and what neighborhoods and regions in the city have experienced the greatest effects of the phenomenon? To assist us with answering the question, we developed a system of differential equations which tracks the movement of potential gentries from different areas of Des Moines. From here we analyzed the behavior of the system to predict the long-term consequences of mobility and its effect on government spending.

**Amber Guzzo and Mercedes Hendricks** (Drake University)

*Using an compartmental model to measure Bitcoin adoption in society* (Talk)

This presentation uses a predictive model to determine whether Bitcoin will be adopted as a universal currency for peer-to-peer transactions. This paper breaks down the probability of individuals adopting Bitcoin using a, SEIR model, a compartmental model used to measure the spread of epidemics. In this instance, we consider the adoption of Bitcoin as an epidemic that is spread peer- to-peer by sharing information and technology to purchase Bitcoin. We measure the spread of information by classifying individuals into groups determined by their knowledge, interest, and investment in the cryptocurrency. The purpose of this research is to determine how the spread of information peer-to-peer affects the number of Bitcoin users. We examine many scenarios using this model in order to understand what is truly necessary to create a “tipping point” in Bitcoin adoption. We consider individual preferences of using Bitcoin as well as peer-to-peer interaction of the currency. Outlined in this presentation is the possibility of either domination of the current fiat monetary system, the eventual domination of Bitcoin as a universal currency, or the coexistence of Bitcoin with the current currency system.

**Greyson Miller, Isaak Mouring, and Samuel Trujillo** (Drake University)

*A Mathematical Model of the Immune Response in COVID-19* (Talk)

Almost two years have elapsed since the commencement of the coronavirus disease 2019 (COVID-19) pandemic, and while we have made significant strides in containing the outbreak, there is still much that is

unknown as it relates to the progression of COVID-19 in the body which has hampered preventive and therapeutic measures against COVID-19. The immune system protects against viruses and diseases and produces antibodies to kill pathogens. It is well known that once the virus enters the body, it usually finds itself in cells that line your nose, sinus cavity, and throat. Symptoms typically follow, but there is a delay between symptoms showing and the actual infection as the virus starts to invade healthy cells and reproduce. Although symptoms vary widely in the early stages of infection, if the immune system cannot subdue COVID-19 in the first week or so, the virus usually becomes a lower respiratory infection as it moves down into the lungs. Fluid and mucus build up to make it harder for blood to get oxygen. As pneumonia settles in, it begins to prolong the recovery time from someone who has COVID-19. While the immune system could potentially respond to different parts of the virus, it's the spike proteins that get the most attention. Immune cells recognize the spike proteins as a foreign substance and begin producing antibodies in response. Our research project attempts to address the following questions:

How does the immune system affect the growth of COVID-19 cells in the body? To what extent does age, gender and size affect the immune system's ability to suppress and/or eradicate COVID-19 from the body? What effects do preventative and/or therapeutic measures have on the immune system's ability to suppress and/or eradicate COVID-19 from the body? To address the research questions above, we develop a system of differential equations which tracks the growth of COVID-19 cells in a human body and the number of antibodies being produced by an immune system. From here we can analyze the behavior of the system to predict the immune system's ability to suppress/eradicate COVID-19 from the body.

**Jade Thompson** (Simpson College)

*The Existence of Photons and its Probabilistic Nature* (Talk)

With new advancements of technology throughout the past decades, the use of quantum theory has become more prevalent in sciences. Beam splitting is an operation that separates a beam of light into multiple beams of light. Looking at beam splitting quantumly, photons are sent into two different directions, reflected off or transmitted through the beam splitter. By using quantum mechanics, calculations can be done to find the probability of a single photon being reflected or transmitted. When testing the probabilities, the existence of photons can be proven by showing that light cannot be made of classical waves.

## POSTERS

**Zach Geery, Lara Kallem, and Sam McCoy** (Simpson College)

*Using a Speech Recognizer to Help Patients Recover with the Well-Spoken System* (Poster)

Speech therapy can be an intensive process for people with brain injuries, especially due to limited speech therapist availability. We have created a program to assist people during their speech recovery process. This system utilizes an automatic speech recognizer, allowing people to practice speaking without the presence of a speech therapist. To improve motivation, the program includes elements of gamification. The system logs the user's interactions and classifies their errors into different categories so that immediate feedback can be given to the user. A statistical model of simulated patients is used to validate the accuracy of the error classification. The user interface is written in Python and uses the data analytics and graphing capabilities of R to display and highlight the user's progress. Based on the results of the error analysis, the patient and therapist can view different charts and graphs of the user's progress and their type of errors. The idea is not to replace traditional speech therapy but to supplement it.

**Tim Hornback** (Simpson College)

*Client Choice and Network Demand on Preventive Health Care in Des Moines* (Poster)

The goal of my research is to expand upon an article from Zhang et. al. regarding how client choice impacts preventive healthcare facility design. The original article applies their model to a real-world example of distance to mammography screening locations in Montreal. I intend to use a model presented in the original research and apply it to the Des Moines area for other relevant preventive healthcare, such as COVID-19 in-person testing locations. This will be achieved by replication of results concluded from the original text, gathering and processing relevant data regarding preventive healthcare facilities in the Des Moines area, and modifying given mixed integer program (MIP) optimization to determine how limited resources can be best distributed throughout the area.

**Marc Medici, Noah Nelsen, and Keara Schmitt** (Simpson College)

*Classifying Histological Images Through the Application of Multiparameter Persistent Homology* (Poster)

Analyzing and classifying histological images of cells based on composition is an essential practice to diagnosing various types of cancer. However, medical professionals must contend with the time spent and variability introduced when classifying the images by hand. We use persistent homology, a tool in topology data analysis, to automate the classification process. Persistent homology methods of classification were explored in previous studies using stain normalization and single parameter persistent homology to classify histological images. Utilizing an open-source data set of histological images of colorectal cancer, this project evaluated six different forms of image preprocessing, single parameter persistent homology, and multiparameter persistent homology to understand pixel composition. Using k-nearest neighbor clustering on the outputs of the persistent homology functions, we were able to classify images of colorectal histological images with an accuracy of 80.58.

**Laura Nielsen** (Simpson College)

*Food Pantry Accessibility in Iowa* (Poster)

My project looks at whether there is a difference in food pantry accessibility for English speaking communities versus Spanish speaking communities in Iowa. In order to do this, I determine food assistance deserts using Python and Excel Programming in 25 counties in Iowa, half of which have high Spanish speaking populations and half of which have low Spanish speaking populations. I then compare these communities to determine if there is a difference between these two groups. The second part of my project consists of cultural research on how Latinx citizens are affected by the hunger issue as opposed to white americans. This includes access to federal food assistance programs, poverty rates, and the difficulty of finding Latin American food supplies in pantries.

**Miguel Sanchez** (Simpson College)

*Budget Management: Building an iOS app* (Poster)

Managing one's finances and budget can be easy, fast, and organized with the help of a computer. Existing apps allow the user to track previous transactions and show data based on this information. This iOS app will help the user to manage transactions in the future. The app, built using Apple's Swift programming language and SwiftUI, provides the user with the ability to visualize current and future transactions and provides useful information about the user's balance on any date now or in the future. Some other key features of the app include the ability to set recurrent transactions, see relevant information for each transaction, and have a calendar view for easy access to the balance up to a certain date. This is a user-friendly alternative to managing one's finances on paper or using a spreadsheet..