2022 Spring MD-DC-VA Section Meeting Student Poster Session

Mathematical Modeling of the Diffusion of Innovation
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Christopher Newport University and Norfolk State University

In the last two decades, the American household has adapted the following technological innovations quite rapidly: color television, cellphone, internet, and social media. In this project, we use the Bass Model and the Gompertz Model in investigating the diffusion of these technologies using published data on their cumulative adoption. Both the Bass and Gompertz models are first-order, two-parameter differential equations that provide analytical tools on understanding the stages of diffusion, on forecasting future behavior, and on investigating the rate of adoption and the acceleration of diffusion. Parameter estimation is performed using least squares method in Excel. We share some insights and implications on using existing diffusion and growth models when analyzing the diffusion of innovations.

Analyzing the Movement Patterns of Notes in Songs
Catherine Fauver
Shenandoah University

Music has always had mathematical reason to it, and many ways to analyze music have been designed throughout the years. In this project, the similarity of songs written on the same scale has been analyzed by using Christoffel words to illustrate the distance between the notes. More specifically, by looking at the half steps between notes. By assigning two half steps up as a, one half step up as b, and their respective inverses as two and one half steps down, distances between notes are mapped as Christoffel words. When a note is repeated, it is denoted by a c. The songs being analyzed are mostly nursery rhymes, with two other songs that are more contemporary, but all are written in the C-major scale. By comparing their overall structure, the patterns are compared in the attempt to see why songs written in the same scale sound similar, or different.

Bitcoin or Gold?
Yang Hsia, Seth Gibson, James Burns
Virginia Military Institute

The purpose of the project is to design a trading strategy that could help investors profit by investing in Bitcoin and gold. Within the model, the decisions are mainly made by tracking the change of the assets' values and comparing with the previous day. By calculating the raising and dropping ratios of the values, the results would suggest the investor to sell, buy or hold certain mounts of the assets. In the end, the model could provide a profitability of 80 times higher than the initial investment.

Using the Coupon Collector Problem to Analyze "Gacha" Games

Royce Lorson
Shenandoah University

The coupon collector problem has not seen many uses in practical problems compared to the potential number of applications it has. Although it is not the most practical problem, this research serves to apply the coupon collector problem to study how long it would take to collect characters in a video game that uses a "gacha" system. For this, we will make use of the reputable services provided by Desmos and RStudio Cloud to program and find results for different variations of the coupon collector problem. Through this, we hope to show the value of the coupon collector problem, and also how arduous a task it is to complete collections in "Gacha" games. In order to do this, we use data from the game Arknights to apply the various variations.

Automated Trading Strategy

Rafael Mas, Nicolas Shier, Nathaniel Light
Virginia Military Institute

Day trading is a fast-paced world of exchanging assets. To some, day trading is a hobby, to others, it is a way of life. Regardless of which reason is the motivation behind day trading, it is a risky game full of patterns that can be exploited to yield a large amount of return. Experts in the field can grow relatively small amounts of money into a fortune. In recent history, the focus of day traders has shifted to trading cryptocurrencies such as BITCOIN.

Our group set out to create a day trading strategy that would follow a simple yet aggressive approach. We initially invested $1000 to daytrade both BITCOIN and gold. Our group decided to trade our assets based on the previous two days of information. We determined three buy patterns and two sell patterns. Compared to a novice strategy of guessing what the trends would do our algorithm is both simpler and more effective. Even though being aggressive can be a weakness, our aggressive model is most effective when it is able to sell almost every share held and then buy back into the market with slightly more shares just a few days later. Day trading for some can be very stressful, but with machine-aided decisions, one could buy or sell with more confidence. This strategy can is not exclusive to the currencies we trade in our project, we believe it can be applied to other currencies.

De Bruijn Sequences

Devin Teri
Randolph-Macon College

Can you create a cyclic sequence of 0s and 1s that contains 000, 010, 101, 110, 111, 011, 001, and 100 exactly once? How many such unique sequences are there? In 1944, Posthumous originally proposed the conjecture that the number of such unique sequences containing all possible strings of length n is $22n - 1 - n$. In 1946, De Bruijn was able to prove this conjecture. My poster explores this proof, looking at the applications of these sequences in various fields.

Catching Coattails: Modeling and Investing in Gold and Bitcoin

Mariah Woods, Erik Tolley, Daniel Walsh
Virginia Military Institute

An investor has tasked this team with creating a mathematical model to automate the purchase and sale of bitcoin and gold in order to maximize profits over a five-year period. The model should only use the past stream of daily prices to determine each day if the trader should buy, hold, or sell their assets in their portfolio. The model may trade between gold, bitcoin, and cash, and can only look at previous data to make decisions about new trades. Our group used a technical analysis approach to develop a model that gives the best daily trading strategy based solely on the price data up to that day. The term "diverse portfolio" can be used to describe these investments, as gold tends to follow consistent and predictable trends, while bitcoin is risky and rewarding. We considered whether or not to diversify, and how to prioritize safe investments and returns as well as riskier investments with more rewarding returns in our model. We have been given a five-year span ranging from September 2016 until September 2021 to use as our data range and the time allotted to produce returns. This mathematical model was built using MATLAB and makes trading decisions in two veins of opportunity: small gains and big gains. These are done by selling twice a year after the first and second trimester, respectively, while spending 100on stock options every ten months using. We decided to sell larger holdings of Bitcoin after the second trimester of purchase to allow for a longer duration of stock to build.

Trading Strategies

Junzhe Yan, Noah Birthisel, Zachary Branner
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Traders utilize mathematical software and processes to profit off the market. When a trader should buy, hold, or sell is where the art of assets-trading resides. It is in being able to make risk managed trades that render the most profit. And the more profit there is to be had, there is an equal chance at a loss. This is risk. Our model needs to be able to detect any type of trend, including downward trends and react accordingly in order to minimize the losses that could be a result. In this project we have a portfolio made from low-volatility gold and high-volatility bitcoin. Bitcoin's volatility shows promise of rendering great profit or crushing loss. Meanwhile gold offers more stable but humbler earnings. We worked to find a middle ground that hedged bets between these two assets for a moderate investment strategy. We constructed trade transaction and portfolio modeling infrastructure that will track the movement and amount of cash, bitcoin, and gold, in our portfolio, as well as simulating the daily price changes of assets. This tracking infrastructure is modeled after most common trading interfaces such as RobinHood or Webull. Using this infrastructure, our goal is to create a model that will rival that trading tactic by promising a stable upward trend in the portfolio, regardless of market conditions, bear or bull. We created three distinct trading strategies that are parameterized based on common trading strategies, these are then combined to produce a singular trading algorithm. Our hope is to utilize this algorithm for any particular stock with upward projected performance.

How Asteroid Mining Can Impact Global Equity

Emma Zhou, Carter Jefferson, Boudabbous
Virginia Military Institute

With space exploration becoming the new centerpiece of technological innovation, the future will almost certainly involve efforts to profit from space ventures. One likely avenue for this reality is in space asteroid mining. We have been tasked with modelling our definition of global equity, and seeing how asteroid mining in the future will benefit global equity per our model and definition. The goal of our project is to determine how the revenue from space mining can impact global equity and the kinds of limitations on space mining we should expect, along with defining a mathematical reality behind this new endeavor. We have come up with a combination of two models that helps us scale a variety of countries based on their potential to both sustain the capabilities to conduct space expeditions and sustain their respective economies on Earth. The first model uses an economic freedom index data set to determine which categories best influence a country's Gross Domestic Product (GDP) through predictor importance, then ranks each country accordingly. The second model represents the revenue collected from mining asteroids and is to be used to feed into the first model. The combination of these two models aims to broadly paint a mathematical reality of what asteroid mining in the future looks like.