

Abstract: Science and Engineering Fair of Houston

1295

Can you beat the House 2.0

Bryan Lucio
Central Middle School

Category

Mathematics

The reason I decided to conduct this project is to help the average person make the best possible bet in roulette in any setting. During this years second attempt on this project, we added 150 spins to collect even more accurate data (AKA 200 spins). The problem this years project tried to solve, was if there was any pattern when betting in roulette to make the best bet. The procedure that I followed was by doing the spins and collecting the one a Google sheet. The google sheet was organized by having 3 columns. Finally I organize the data and made graphs showing the results. After completing my project I could conclude that there was no way to conclude a pattern that there was no way to conclude a pattern when playing roulette. From my findings, the most common variables landed upon are as stated Red landing was the most common landing a 44.7%. And even with a 64.6% finally the most common variables landed upon was red 12 with a 4.4%. In conclusion my project was successful, and contributed to the area of math. So that people can make the most probable bets on roulette.

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Abstract: Science and Engineering Fair of Houston

1296

Does changing the wing size of a cardboard airplane affect its lift and drag?

Kiley Williams

Houston ISD /BCM Academy at James D Ryan - MS

Category

Mathematics

Airplanes have evolved significantly since the Wright brothers' first powered flight, with continuous advancements in design, especially in the optimization of wing size. This study investigates how varying the wingspan of a cardboard airplane impacts two essential aerodynamic forces: lift and drag. Using wingspans of 0 inches (no wings), 4 inches, 8 inches, and 12 inches, I tested how changes in wing size affect the flight distance and lift generated. The hypothesis was that larger wings would increase lift, while drag would have a minimal effect. To test this, cardboard planes were constructed, and each plane was thrown from a height of half a meter. I recorded the flight distance and lift generated, using a meter stick and measuring tape. The results showed that planes with larger wingspans flew higher due to increased lift but experienced more drag, reducing flight distance. Specifically, planes with 8-inch wings flew the farthest, while planes with 12-inch wings, although generating more lift, had higher drag and shorter distances. This experiment confirms that wing size significantly affects both lift and drag, underscoring the importance of optimizing wing dimensions in aircraft design. These findings offer insights into the aerodynamic principles that can inform the design of more efficient aircraft in the future.

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Abstract: Science and Engineering Fair of Houston

1297

Beating the House Isn't as Hard as You Think

Sam Perkey

The Woodlands Methodist School - MS

Category

Mathematics

Risk is an intrinsic part of human life. From using a toaster to driving a car, everything in life comes with some level of risk. While risks are commonly associated with dangerous situations and poor decision-making, taking risks can lead to significant payoffs. This exciting and suspenseful aspect of risks has led to the creation of a popular pastime: gambling. When gambling, gamblers take risks to hopefully make profits. This experiment was designed to answer the question: "How Much of an Advantage is Strategy in Blackjack?" The goal was to test different blackjack strategies in multiple rounds of a 4-deck game of blackjack, and determine which strategy was most effective for the average blackjack player attempting to maximize wins. A Python program was created that simulated a game of blackjack played by four players. Each player was programmed to use a different strategy in order to compare the strategies' win rates. The program was run in ten trials, with each trial consisting of 100,000 consecutive games. The hypothesis was: "If different levels of strategy are tested in blackjack, then more advanced blackjack strategies will have around a 15% higher win rate than basic strategies, because of their level of extra information for the player to use." The data showed that on average, the higher level blackjack strategy tested only provided a 2% benefit to win rate. In conclusion, the optimal strategy for the average player was the dealer strategy, in which a player hits under 17 and stands otherwise.

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Abstract: Science and Engineering Fair of Houston

1298

How Does The Different Types Of Material Affect The Probability Of A Die Roll?

Holden Parker

Conroe ISD /McCullough Junior High

Category

Mathematics

This project was performed by a student researcher who was curious about dice. The student researcher rolled 2 dice, metal and plastic, each 150 times on a dice tower. The results showed that the sides, 1 and 6, were rolled less than the other sides, 2,3,4 and 5. The student researcher concluded that dice are almost fair, but the low ends and high ends of the dice roll less often than the other sides.

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Abstract: Science and Engineering Fair of Houston

1299

How high can it fly

Carlos Guevara

Houston ISD /BCM Biotech Academy at Rusk - MS

Category

Mathematics

Vinegar and Baking soda cause a chemical reaction gas known as carbon dioxide. Many people do this project, but my project is to see how high the balloon flies based on the ratio of vinegar to baking soda. After researching different chemicals and byproducts, the main focus of the experiment was using a variety of ratios to figure out the flight height of a balloon. The main materials used for this experiment were All-purpose Baking Soda, Distilled Vinegar, Balloon, a glass bottle, and a cell phone to record. Testing different ratios of vinegar to baking soda and baking soda to vinegar caused a chemical reaction that formed a gas. Once the balloon was inflated with the gas, it was released to see how high it went. This was recorded on a cell phone. The experiments showed that the ratio of vinegar to baking soda was better than that of baking soda to vinegar because the more solvent you have the stronger the chemical reaction will be.

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Abstract: Science and Engineering Fair of Houston

1300

Against the odds

matthew landry-mclauchlan
Sexton Gaines
Central Middle School

Category

Mathematics

Our projects aims to evaluate and come up with a reliable and consistent data spreadsheet by running multiple tests while organizing this information into spreadsheets and concluded the average odds of three types of gambling;sports betting, slots, and blackjack

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Abstract: Science and Engineering Fair of Houston

1301

To Switch? or Not to Switch?

Ajax Gaalema

Central Middle School

Category

Mathematics

Background: In the classic Monty Hall question the probabilistic answer is not intuitive. There are three doors, one with a fabulous prize, and two with goats. You must pick a door, then Monty reveals one of the losing doors and offers you to switch doors. Should you switch doors? Lots of people thought that the chances of winning the prize were the same whether or not you switched. Question: When given a choice to change your answer what should you do? Hypothesis: Switching will give you a better chance of winning. Methods: We simulated this problem by using playing cards. One card was the Fabulous Prize while two cards acted as goats. One person is playing Monty Hall while the other plays the contestant. Three cards are dealt. The contestant picks one of the three cards without looking at them. Monty Hall looks at all three cards and then reveals to the contestant one of the bad cards and offers them the choice to switch. The contestant switches or doesn't. Then Monty Hall reveals the card, and whether the contestant wins. The initial card choice, if the choice was switched, and if the trial was a winner were recorded. Results: We ran 100 trials, 50 switching, 50 not. Switching resulted in winning the fabulous prize about 2/3 of the time, while not switching, it worked only about 1/3 of the time. Discussion: Our data collection supported our hypothesis that the switching strategy was superior.

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Abstract: Science and Engineering Fair of Houston

1302

Detecting breast cancers using machine learning approaches

Nesandi Jayalath

Clear Creek ISD /Westbrook Intermediate School

Category

Mathematics

This study focuses on detecting breast cancers using machine learning techniques. I studied this because breast cancer is one of the most common cancers in woman. My research question was whether logistic regression or classification tree would be the better technique that can be used to accurately diagnose breast cancers and what variables from cell nuclei would be useful in this diagnosis. I carried out my experiment by first downloading data from an existing database. Then downloading and installing R-studio software and learned R code required for logistic regression and classification tree approaches. Then, I prepared data for statistical modeling. Finally, I trained the model and validated it's accuracy. In conclusion, I found that the logistic regression is a better technique and the significant variables identified in both techniques are texture, area, and concave points measured from the cell nuclei. The future studies that I can conduct is applying these methods for other cancers or similar diseases. Additionally, I plan to investigate some other machine learning techniques that can be used in this type of studies.

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Abstract: Science and Engineering Fair of Houston

1303

Velocity and Motion

Conroy Shackelford

School of Science and Technology, Houston - MS

Category

Mathematics

My purpose of this experiment was to gain more knowledge about the topic itself, and my love for science fiction. My procedure followed a sequence of multiple steps including materials such as an airless basketball, aired basketball, weighted sports ball, air pump, stopwatch, tape measure, sticks, and a notebook. The most important result found was the results of the experiment. I used multiple sources to analyze and gain my data.

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Abstract: Science and Engineering Fair of Houston

1304

It's Golden

Dylan "Schmorb" Smith
Central Middle School

Category

Mathematics

The math constant Golden Ratio is about 1.618. It has long been associated with harmony and balance in art and design. This project examines how it appears and influences historical artworks, focusing on whether it improves painting aesthetics. This study also examines the compositions of ten great paintings from a given historical period to determine how mathematical ideas relate to artistic beauty. To determine the Golden Ratio's importance in the chosen artworks, essential elements' width and height were measured. The aspect ratio of each picture was measured to determine if it was near to or the Golden Ratio. To verify that the compositions featured Golden Ratio, I employed opaque overlays of several versions. A study was conducted to determine what viewers liked and disliked about the paintings and to compare Golden Ratio paintings to others. This study found that Golden Ratio artworks were more appealing to respondents. This conclusion supports the idea that the Golden Ratio makes art more appealing by boosting its harmony and equilibrium. The study also reveals how mathematical notions like these can dramatically impact how people see the world and what they prefer. In conclusion, the Golden Ratio in art reveals how brilliant artists from the not-so-distant past were with this ratio, linking creativity and mathematics. Expanding the dataset and studying other compositional concepts that enhance these masterpieces could build on these findings.

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Abstract: Science and Engineering Fair of Houston

1305

Crop Efficiency: Cost v.s. Calorie

Allison Steagall

Clear Creek ISD /Seabrook Intermediate School

Category

Mathematics

Farmers have been around for 100 even 1,000 of years as have mathematicians, but what if there was a connection between the 2, what if human kind can figure out something that include the both? Potatoes are a good source of vitamins, minerals and fiber. As a bonus, potatoes are low in calories contain no fat or cholesterol, and are sodium-free. A medium potato, about 5.5 ounces, contains only 145 calories. What is the effect of crop type on cost and calorie efficiency? If crop efficiency analysis is performed on different crop types then the potato will be the most calorie efficient. To test the hypothesis for the experiment a mathematical formula was created and information was inserted from the articles and data bases found, then a summary table was constructed to help analyze the data. Unfortunately the hypothesis was incorrect, the most calorie efficient was sorghum, however over all, wheat was the second best for calorie efficiency and 1st for cost. The hypothesis was most likely wrong because of the lack of knowledge on the topic before the research was conducted. Another thing that would have improved the experiment Is better consistency and trustworthiness of the articles and crop data that was used for the experiment. Farmers have been around for 100 even 1,000 of years as have mathematicians, but what if there was a connection between the 2, what if human kind can figure out something that include the both? Potatoes are a good source of vitamins, minerals and fiber. As a bonus, potatoes are low in calories contain no fat or cholesterol, and are sodium-free. A medium potato, about 5.5 ounces, contains only 145 calories. What is the effect of crop type on cost and calorie efficiency? If crop efficiency analysis is performed on different crop types then the potato will be the most calorie efficient. To test the hypothesis for the experiment a mathematical formula was created and information was inserted from the articles and data bases found, then a summary table was constructed to help analyze the data. Unfortunately the hypothesis was incorrect, the most calorie efficient was sorghum, however over

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Abstract: Science and Engineering Fair of Houston

1306

Let's Make Some Pi(e)

Alexandra Noyes

Clear Creek ISD /Westbrook Intermediate School

Category

Mathematics

I chose to do my science fair project about Pi and explore ways to estimate it. I conducted four experiments to estimate Pi. The first is a Monte Carlo simulation where I dropped pennies in a random manner. I made a circle inside a box and dropped ten sets of 100 pennies from my balcony. I counted how many fell within the circle and how many were in the box. I thought this estimate would be the closest to Pi because I saw a video of this experiment and it looked accurate. The ratio of pennies in the circle to all pennies dropped is equal to the ratio of the area of the circle to the area of the square. For the next two experiments, I filled three spheres and three cylinders with water and measured the volume of water and the diameter of the objects. I also measured the height of the water for the cylinder. I used formulas for volumes of spheres and cylinders to estimate Pi. Finally, I wrapped string around three circular objects. I measured the length of the string and the diameter of the object. I used the formula for circumference of a circle to estimate Pi. The circumference experiment was most accurate with 2% error. The Monte Carlo was the least accurate with 90% error. I did these experiments because Pi is used in everyday life, but not many people know how to estimate it.

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Abstract: Science and Engineering Fair of Houston

1307

Shuffle it up

Sarai Angulo

Clear Creek ISD /Seabrook Intermediate School

Category

Mathematics

This experiment was done to answer the question, which method of shuffling shuffles cards the best? At the beginning the one that was guessed would be the best one was the automatic shuffler. First, the cards would be labeled 1-52. The cards would be shuffled and then put back in the order that it was when it first came out of the box. For the hand shuffles, that would be done 1 more time for a total of 2 times. Then, it would be shuffled 2 times by 4 other people to have a total of 8 trials. But, for the machine shufflers they would be shuffled by the same person a total of 10 times each shuffle. Finally, the order of the cards would be entered into excel so that the R-squared value could be calculated. The overhand shuffle ended up being the one that ended up being the most shuffled at a mean of 0.070444. This was surprising because this one was thought to be the worst one, while the automatic shuffler, thought to be the best one, had a 0.26666 mean. In conclusion, the hypothesis was wrong, because the automatic shuffler was not the best one, it was the overhand shuffle. The automatic shuffler had a mean of 0.26666, and the over hand shuffle had a mean of 0.070444.

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Abstract: Science and Engineering Fair of Houston

3286

ArCADia; Investigation of Matching Method for AI Aided CAD Development Prompting Tools

Anushka Polapally
Tompkins - HS

Category

Mathematics

ArCADia is an innovative platform designed to revolutionize traditional CAD workflows by integrating AI-driven real-time design suggestions. By analyzing 3D models through a process called shape signature generation, ArCADia identifies critical design features and matches them to a comprehensive proprietary database of prior designs. This database is populated through automated web scraping of open-source design data and licensed repositories, ensuring a robust and diverse collection of geometric identifiers. The system employs deep learning to categorize designs and provide designers with accurate, context-aware recommendations, reducing redundant editing tasks and enabling greater focus on creativity. Initial validation of ArCADia's processes demonstrated the effectiveness of automated shape signature generation, with error rates below 5%, and confirmed the feasibility of deep learning models for design categorization. The platform's efficiency is projected to improve CAD workflows by at least 26%, echoing the transformative impact of AI in software development. With applications spanning industries such as architecture, aerospace, and consumer goods, ArCADia has the potential to accelerate innovation, reduce development timelines, and drive progress in hardware design. By empowering designers to focus on ideation and problem-solving, ArCADia fosters a new era of creativity and efficiency in product design.

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Abstract: Science and Engineering Fair of Houston

3287

Die Hard NFL Fan

Christopher Creedon

Clear Creek ISD /Clear Creek High School

Category

Mathematics

Many professional sports leagues have recently expanded their teams, while college football conferences have seen significant realignment. These trends sparked my curiosity about whether it's possible to watch every NFL team play a home game in one season. Questions arose, like where to start, if it's feasible during the regular season, and how short the journey could be. In 2021, the Guinness World Record for the fastest time to attend every NFL team's home game was set at 74 days, 7 hours, and 35 minutes. When I saw this record, I was determined to find a possible route faster than 74 days with the 2024-2025 schedule. So, I wanted to create a mathematical solution to complete this task for the NFL 2024-2025 schedule given human variables and some restrictions to see every NFL team play a home game once in under 74 days. For the experiment, I created a mathematical solution using Python code by simplifying scheduling hand calculations and the "nurse scheduling problem" algorithm to conclude the fastest possible route to see all NFL teams play a home game once. I achieved a route of 76 days 3 hours and 30 mins, thus not breaking the world record and proving my hypothesis false.

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Abstract: Science and Engineering Fair of Houston

3288

Utilizing Wavelet Transform and Fourier Transform to Detect Cardiac Arrest Through Electrocardiogram Analysis

Caleb Foo

Conroe ISD /AST: Academy of Science and Technology

Category

Mathematics

There are over 400,000 accounts of Sudden Cardiac Arrest (SCA) recorded each year with over 90% of SCA accounts being fatal. The current detection system used to detect cardiac arrest, MEWS (modified early warning system) is limited because of their rudimentary detection variables and their tendency for false positive alerts. In this project, wavelet transform, a relatively new signal processing method, was used to detect frequency features within electrocardiogram (ECG) signals. The aim of this model was to accurately detect abnormal ECG signals correlated to cardiac arrest. ECG signals from both patients with cardiac arrest and the control group were collected from an open source database. All signals were then preprocessed using filters to compress noise and decomposed using Wavelet Transform. A t-test were used to calculate the significance of the analysis between the control and the experimental group. The analysis found the difference to be statistical significant proving that the wavelet transform is a viable method for detecting indicators of cardiac arrest. Improving this model's feature extraction and eliminating confounding variables such as interpolation can lead to a greater number of significant results and improved efficiency in detection. The end goal of this project would be to create a revolutionary real time detection device of cardiac arrest for patients in an out-of-hospital setting that utilizes this signal processing model.

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Abstract: Science and Engineering Fair of Houston

3289

Optimizing the Creation of Electronic Filters through the use of Meromorphic Functions

Sahil Kulkarni

Conroe ISD /AST: Academy of Science and Technology

Category

Mathematics

Electronic Filters are pieces of technology that block out certain electromagnetic frequencies while letting others pass through, a technology ubiquitous today, in every electronic device worldwide. There are multiple types of filters, but this project will specifically focus on notch filters, which out of the possible input frequencies, filter out the middle frequencies. These filters can be modeled with functions on the x-y plane, a relatively simple process for real-valued filters. However, in cases with two independent input frequencies a complex filter is needed, and the need to graph complex functions. And with notch filters specifically, the four-dimensional equivalent of a rational function is needed: a meromorphic function. This project attempted to optimize the analysis and creation of these notch filters by better modeling their graphs using these meromorphic functions. More specifically, when analyzing functions, certain traits make working with functions much easier, including fast differentiation, factoring, integration, and solving for roots, but also factors such as the number of asymptotes and where they are located, and the number of terms in both the numerator and denominator. To achieve this, this project first wrote a program that can not only graph these functions using a technique called domain coloring but the program was specifically designed to calculate the time it took to calculate these key attributes for each function. Various types of meromorphic functions were used including $1/x$, and others such as $1/x^2$ etc. The computer data was combined with human intuition for the most optimal function.

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Abstract: Science and Engineering Fair of Houston

3290

A novel method for approximating area under the curve using ellipses: an alternative to 150-year-old Riemann sum method.

Saisha Verma

Nusrat Hossain

Bhardwai Home School - HS

Category

Mathematics

Isaac Newton invented Calculus in 1665 while trying to determine the speed of a falling object overtime through derivatives and summation, which is considered the "Fundamental Theorem of Calculus". Exact method of determining the area under a curve (AUC) with definite integrals is the cornerstone of Calculus. While this 'Exact method' uses integration, Riemann's sum method approximates the area using rectangles and is a simpler method invented much later in the 1800s. In this project, we wanted to derive a novel method of calculating the AUC, and hypothesized that ellipses can be used for the estimation. Using the Desmos graphing calculator, we graphed multiple different quadratic- and cubic- functions by fitting an ellipse that matched the curvature of the graph to approximate the AUC. To then calculate the area, we formed a rectangle between two x-values, the AUC and the x-axis, and subtracted a quarter of the area of the fitted ellipse between these two x-values. We then compared the area of the Exact method with definite integrals, Riemann's Sum approximations (Left, Right, and Trapezoidal Rule) as well as our method using ellipses. We calculated the Riemann Sum approximations and Exact areas using definite integrals, repeating these comparisons for a large number of curves of various sizes. Lastly, we evaluated if the measurements created by these three different techniques produced similar results by performing multiple statistical tests and plots. In support of our hypothesis and as expected Paired t-test revealed no statistically significant difference between the areas calculated by the Exact method and our ellipse-based method. Additionally, we uncovered that our method yielded much better approximations than Riemann's Sum approaches. A scatter plot between the Exact area and the area calculated using ellipses showed a linear relationship. In conclusion, we would like to report the ability of ellipses as a novel method of AUC approximation.

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3291

Forecasting NFL Draft Pick Potential Through a Machine Learning-Based Approach

Sandul Manage

Conroe ISD /AST: Academy of Science and Technology

Category

Mathematics

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Abstract: Science and Engineering Fair of Houston

3292

The Effect of Excessive Iron on Human Lifespan

Lucas Cheney

Conroe ISD /AST: Academy of Science and Technology

Category

Mathematics

Excessive dietary iron has been proven to be a cause of cardiovascular disease, which is responsible for 1/3 of all deaths. Iron is also in a wide variety of foods, from tortillas to cereal to bread. This project tested this damage in an objective way by comparing the mean iron intake of each age range for both men and women per year to the life expectancy of that year. Information regarding iron intake was taken from NHANES in order to not violate any health regulations. The data was compared to the lifespan between 1999-2018 which found that men consistently ingested over double what they should and lived 5 years less. The US Government passed regulations in 1980 that caused companies to fortify their foods to battle malnutrition, right before obesity rates took off in America. One of these fortifications was iron. In order to eliminate malnutrition for everyone, the Daily Value, which is presented on nutritional labels, was raised to the highest level of RDA, 18 mg for menstruating women. However, the RDA for men is only 8 mg. Due to the Daily Value, however, men end up ingesting 18 mg, which means that they intake over double the amount that they should. While iron is not the sole cause of the lifespan disparity, it almost certainly plays a role. Due to the findings of this project, it can be recommended that the idea of the Daily Value be reconsidered to make sure its recommendation doesn't accidentally hurt people.

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Abstract: Science and Engineering Fair of Houston

3293

Infinite factorization in power mean polynomials of finite variables

Aditya Sarkar
Seven Lakes - HS

Category

Mathematics

The ascending chain condition on principal ideals (ACCP) is satisfied when there is no infinite strictly ascending chain of principal ideals of the given type (left/right/two-sided) in a ring. In this paper, we explore whether the ACCP acted upon the family of rings $PM_n[I]$, or the polynomial ring of n variables containing all power mean polynomials and the factorization properties implied by this. The family of rings discussed here have not been studied extensively in modern literature, and the findings in this research may lead to important cryptographic discoveries based in commutative algebra systems. Since this family of rings is not widely discussed, this research defines the family of power mean polynomial rings along with their group presentation. This research also claims that the ACCP does not hold in the power mean ring of 1 variable, and that the ring of elementary symmetric polynomials of n variables $SYM_n[I]$ is injective onto $PM_n[I]$. This research uses a novel technique, symmetric degrees, to prove that the given family of power mean rings satisfies the ACCP for any n not equal to 1. Finally, this research has some important applications in creating instances of infinite factorization in the RSA cryptosystem (the most widely used interface to encrypt data) to potentially doubly secure data, through making it virtually impossible to detect specific prime factorizations.

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Abstract: Science and Engineering Fair of Houston

3294

A Novel Optimizer Equation to Predict KI67 Scores from Breast Cancer WSIs

Sana Kale
Tomball ISD /Tomball HS

Category

Mathematics

Breast cancer is a serious health concern worldwide, and the accurate scoring of KI67, a critical biomarker for tumor proliferation, forms the basis for effective treatment. However, the process of calculating and scoring this biomarker can be tedious, so to aid in this task, I created a model. Initial attempts at training using standard optimizers resulted in high loss values, prompting the need for innovation. Knowing the limits of the existing methods, I developed a new optimizer equation and did several proofs to test its behavior. Early iterations looked promising but failed to reduce the loss effectively when tested on my model. After refining my approach and creating a final equation, the model achieved substantial improvements, with a notably low loss by the 10th epoch. My work demonstrates the potential of custom optimizers in enhancing applications for medical imaging.

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3295

Utilizing Bayesian Statistics: Applying Demographic Characteristics of Suspected HIV Patients To Help Determine Posterior Possibility of Infection

Rudra Sharma

Conroe ISD /AST: Academy of Science and Technology

Category

Mathematics

Nearly 1.2 million people in the US are living with HIV, but nearly 13% are unaware that they have contracted this disease. This is because of the stigma that has become attached to this sickness due to the way that people catch HIV/AIDS which is usually through sexual contact or drug usage. This often leads people to become scared to confirm their diagnosis potentially opening up the possibility for this deadly pathogen to take hold of their host's body. Therefore, the student researcher utilized the statistical software R to breakdown the Ryan White HIV/AIDS Program Services Report 2022 into 4 key categories: Age Group, Race/Ethnicity, Gender, and Transmission Category. Next, Bayes Theorem in Statistics is employed to help the student researcher create a curated, personalized posterior possibility of contracting HIV/AIDS through these demographic characteristics. This model of diagnosis was statistically proven to be more accurate than the standard status quo of just using the frequentist method. This was tested out through the Log-Likelihood Ratio Test where the Naïve Bayes classifier (full model) has a higher LLR score of 33.19; Since $LLR > 0$, this means the full model provides a better fit than the null model. To help display these specifically curated statistics to each individual, a UI was also developed to help concisely convey the findings.

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3296

CardioSynthesis: A Novel Multi-Omics Drug Discovery Pipeline Using Artificial Intelligence for De Novo Drug Design and Identification of Congestive Heart Failure Biomarkers by Targeting Mitochondrial Dysfunction, Chronic Inflammation, Myocardial Fibrosis

Category

Mathematics

Congestive Heart Failure (CHF) is a progressive multifactorial syndrome prevailing in 64 million people worldwide and 4.1 million people in India alone. Regarding the fact that approximately 50% of patients die within five years of diagnosis, it is crucial to prevent progression into later stages by ensuring effective first-line medication. Current drug design methods overlook multi-omics data, lack general protein inhibition and activation capability, and engage with unintended molecular targets which can lead to adverse side effects. As a result, 90% of drugs produced fail clinical trials, wasting \$23.4 billion for every 10 drugs created. This engineering study presents a novel, cost-effective in silico pipeline for de novo drug discovery, leveraging machine learning techniques and AI to design original CHF medications targeting four unexplored protein targets—PGC-1 α , Yes-Associated Protein, Transforming Growth Factor-Beta, NLRP3—involved in key heart failure pathways. First, a graph neural network was programmed to identify hub genes. Then, 3D homology models of protein structures were created and simulations were run to test the stability and binding sites. In post-cryptic pocket identification, small molecules (ligands) were screened and the binding affinities were scored. Toxicity prediction and ADMET profiling were performed to test the molecules. To predict the biological activity of the lead compounds, a QSAR model was created to validate them, concluding that 80% of candidates had high bioavailability and low toxicity. Ultimately, this in silico program improves the standardized drug development process by reducing development time by 98% and lowering costs by 97%.

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3297

Fourier Transform and Statistical Methods in Heart Rate Variability Analysis

Sai Balaji

Conroe ISD /AST: Academy of Science and Technology

Category

Mathematics

This study explores the application of Fourier Transform and statistical methods to analyze Heart Rate Variability (HRV) data, focusing on coherence frequencies and their relationship with emotional states. Utilizing a dataset of 1.8 million HRV biofeedback sessions from the Inner Balance app, the most common coherence frequency was identified at approximately 0.1016 Hz, achieved by a 10 seconds breath cycle. Coherence frequency refers to the specific heart rhythm frequency where optimal physiological synchronization occurs, promoting emotional stability and cognitive function. The Fourier Transform was employed to convert time-domain Inter-Beat Interval (IBI) data into frequency-domain insights, revealing significant patterns in physiological rhythms. Statistical analyses, including ANOVA and t-tests, demonstrated that positive emotions such as "Excited" and "Happy" were associated with higher coherence scores and more stable frequencies, while negative emotions showed greater variability and dispersion. This variability indicates a less consistent physiological state during negative emotional experiences. The study highlights the critical role of mathematical techniques in uncovering patterns that enhance the understanding of physiological and emotional well-being. By identifying key coherence frequencies and their stability, this research provides a foundation for developing targeted HRV biofeedback interventions. These findings emphasize the potential of HRV biofeedback to promote self-regulation and improve emotional and physiological health. The insights gained contribute to the broader field of biofeedback, offering valuable implications for clinical practices, educational programs, and workplace wellness initiatives. Future research could further explore the long-term effects of HRV coherence training and its applications in diverse populations, ultimately advancing the integration of biofeedback techniques into everyday health practices.

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