

MARIAN UNIVERSITY
— Indianapolis —



MARCH 19, 2022

SENIOR DIVISION

PROJECT LISTING

PROJECT CATEGORIES

- Animal Sciences (AS)
- Behavioral and Social Sciences (BE)
- Biochemistry (BI)
- Biomedical and Health Sciences (BM)
- Chemistry (CH)
- Computer Sciences (CS)
- Earth and Environmental Science (EA)
- Engineering (EN)
- Mathematics (MA)
- Microbiology (MI)
- Physics and Astronomy (PH)
- Plant Sciences (PS)
- Robotics and Embedded Systems (RO)

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ANIMAL SCIENCES (AS)

GRADE 10

Alberto-Lopez, Elizabeth (10-03-07, AS)

Project Submission

Which type of paper makes the most aerodynamic airplane?

" In my experiment, I made 3 airplanes that are made of different materials. I threw them all in the same direction as the meter stick to find which airplane traveled the farthest. As hypothesized, I found the notebook paper traveled the farthest by 209.7 cm averaged."

BEHAVIORAL AND SOCIAL SCIENCES (BE)

GRADE 11

Vashistha, Sneha (11-04-14, BE)

Project Submission

The Trends in Music and Technology: Prospectives and Approaches for Early Childhood Development

" This study aims to collect and analyze data from musically relevant animated films (e.g. Disney) from the last century to analyze the reliance on music and technical aspects to convey emotional turning points. The research question guiding this study was: How has the extent of reliance on music to convey emotions in animated children's feature films (e.g. Disney) from 1930-2020 during emotional turning points changed over time? Findings indicated a decreased reliance on musical elements in films to portray emotional turning points over time. With the benefits of music to improve emotional development and cognizance in children, musical films play a key role in the current ecosystem for early development of children. Given the goal of improved childhood cognizance, there is potential within this field to examine the impacts of changing music-reliance levels and implement strategic methods for improving early childhood development within films."

GRADE 12

Chundi, Sowmya (12-03-18, BE)

Project Submission

An Infoveillance Study on the Opioid Epidemic: Using Machine Learning to Combat Web-Based Misinformation Relating to Opioid Use Disorder

"Since the 1990s, a wave of misinformation surrounding opioid medications has led to widespread misuse of highly addictive opioids, causing 841,000 overdoses across America, 70% of which involved an opioid. An important barrier to combating the opioid crisis is exposure to inaccurate and potentially harmful health misinformation on social media or web-based forums where individuals commonly seek information. Thus, powerful computation tools that can combat opioid misinformation must be designed to flag recently emergent misinformation. Recently, deep learning has made headlines for combating the spread of misinformation as new techniques outperform old models. In this research, generative and predictive deep neural networks were trained to generate and characterize the prevalence of misinformation in social media posts relating to opioid use disorder. For the generative model, a generative adversarial network was trained to produce a wide variety of social media posts relating to the opioid crisis and opioid use disorder. For the predictive model, a deep neural network was trained to classify social media posts as with misinformation or without misinformation. Additionally, the predictive model was trained in conjunction with reinforcement learning to become better at classifying misinformation. For proof-of-concept, a wide data set with millions of social media posts were tested on the model. Results were compared with existing "fake news" and misinformation classifiers. Lastly, unsupervised learning was used to group social media posts containing similar word-related themes into separate topic clusters to analyze common conversations surrounding misinformation. In an ideal world, this study could help inhibit misinformation relating to the opioid epidemic in a top-down model: people would no longer view false claims, pharmaceutical companies would not be able to falsely advertise opioids, and illicit drug dealers would be flagged for marketing dangerous opioids."

BIOCHEMISTRY (BI)

GRADE 9

Bhosale, Rohan (09-01-01, BI)

Project Submission

Accelerated Bio-Chemical Depolymerization of Plastics from Surgical Face Masks: A Proactive Solution to Impending Environmental Pandemic

"Number of masks required in the United States alone would be about 7.4 billion, at a cost of \$6.4 billion leading to 84 million kilograms of waste. There are few reported Chemical, Enzymatic and Microbes based methods known to depolymerize plastics. The Purpose of this project is to evaluate additive and synergistic effects of chemical, enzymatic, and microbial process of depolymerization of the plastic from surgical mask. Concomitantly, develop, and test an analytical tool that can measure depolymerization of polymer layer of the surgical mask. Hence, the testable questions were 1. Among Chemical, enzymatic, and Microbial processes, which process of depolymerization of plastic is faster? 2. Can chemical, enzymatic, or microbial processes be deployed in sequence to record synergistic effect? 3. Can we deploy Statistical linear regression based factorial designs to optimize the process? Or 4. Can we measure depolymerization at home? We used Independent Variables such as Concentration of Zinc oxide, white light, UV light exposure, Aeration, Agitation, Temperature, Enzyme concentration, Microbial dosage and Time of incubation and Dependent Variables such as the arbitrary number derived from the quantitative and qualitative data collected from the measurement of NIR spectra as an indicator of depolymerization. I performed experiments in two parts. Firstly, handheld NIR Spectroscope was developed for relative and qualitative measurements. It was made using krypton light where signals were collected using a collimator lens and recorded via attached diffraction grating connected to a web camera which was monitored by open-source software such as Theremino. NIR Spectroscope was used to monitor depolymerization reactions. Near-Infrared (NIR) spectroscopy (1350-1800 nm) demonstrates a unique fingerprint for polypropylene (PP). Change in spectral behavior and

intensity was used as an indicator of depolymerization. Raw spectra were processed to generate quantitative data for relative measurements. Furthermore, I also took Microscopic digital pictures with 10x and 40 x objective lenses to monitor morphological changes. In the second part, I used four set of different experiments to support the proposed hypothesis. In experiment 1, Chemical depolymerization was done using photooxidation of polymer by Zinc Oxide in the reactor alongside mask. The mixture was exposed to radiation by white and UV light for 12 h for over a month. The reactor was placed on Candle warmer, and the temperature was maintained between 60-70°C. In experiment 2, I added an 18-in-1 food grade multi-Enzyme complex to PP. In experiment 3, We used a good mix of probiotic and prebiotic microbes from food grade digestive pills as a source of enzyme. Cutinase ($\hat{1}\pm/\hat{1}^2$ -hydrolase) is the main enzyme known to degrade PP. We tested extract from this blend for its activity against Cutin using enzymatic assay. The mixture was stirred and aerated continuously. Samples were collected every 12 h initially then every 24 h and were monitored using both NIR spectroscope and Light microscope. Literature reports suggest that the NIR spectra of PP typically show classic peaks at 1200, 1400 & 1700 wavelengths. We observed Peak at 1212 for untreated PP. Emergence of new Peak in NIR spectra upon treatment suggest formation of free hydrocarbon molecules. Microscopic pictures indicated that day 8 onwards the morphology of PP changed which was concomitant with the change in the NIR spectra. In experiment 4, I studied the synergistic effect of three processes on depolymerization of PP. Eight Variables were identified as major ones to influence depolymerization. I kept 5 variables fixed and three variables (Enzyme, microbial and Zinc oxide) were studied at two levels for synergy. The DOE reduced the need for doing experiments by 75%. The synergistic effect between microbes and chemicals was observed suggesting that we could deploy two methodologies in sequence for rapid depolymerization of plastics."

GRADE 12

Javeri, Sanika (12-02-17, BI)

Project Submission

Investigation on Mutations in Genes Leading to Heart Diseases - Bioinformatics Approach

"Heart Disease, which can refer to several distinctive forms of heart conditions, is strikingly more dangerous than many presume. Inducing several deaths worldwide and being the number one killer in the U.S., heart disease is also a major cause of disability. In most scenarios, the root cause of the diseases is still unknown, but dietary habits, sedentary lifestyles, and other environmental factors can play key roles in the etiology of the heart diseases. Additionally, hereditary gene inheritance can also be classified as a prominent reason for some of the severe heart diseases. In this project, I did research on genetic etiology of the two predominant heart conditions that many suffer from. Using the NCBI database and search engine, I was able to determine what genes are involved and to determine if expression is taking place. I accomplish this project in three steps. 1. preliminary research on heart diseases. 2. developing methodology to investigate genes using the NCBI search engine and 3., Research on impact and relation the diseased genes have on heart diseases."

BIOMEDICAL AND HEALTH SCIENCES (BM)

GRADE 9

Borneman, Sean (09-02-02, BM)

Project Submission

Machine-learning-based identification of cognitive engagement states in EEG data driven by visual stimulation

"Many actions in everyday life are becoming more automated, but critical tasks continue to require human oversight. Automatic driving systems, for example, have begun to automate repetitive functions through the use of machine learning. However, they rely on a human user to take over

instantly when a critical, often life or death, event occurs. How does an automated system ensure that the human user is engaged and ready to take over? Can machine learning help to solve the problem that it has, in some sense, created?

Human consciousness is defined as the ability to perceive and model the environment, which is represented as neural activity. This project assesses a variety of Machine Learning algorithms to identify the features of conscious neural response to visual stimuli. Data was taken from EEG measurements (brainwaves) of deaf singers while watching two sets of videos; one, displaying a signer signing different sentences, and two, the same videos played in reverse. These two stimulus conditions were then equivalent in temporal parameters; but only one condition (forward signing) was comprehensible. The peak correlation between the video's motion (optical flow) and the singer's EEG was passed into machine learning algorithms as input parameters. The machine learning algorithms were then trained to classify which video the participants were watching based on the correlation between the EEG brainwaves and the optical flow of the videos. This analysis shows that it is possible to classify a person's brain state between comprehension and non-comprehension."

GRADE 10

Zahrn, Sama (10-02-06, BM)

Project Submission

What is The Best Mask Against COVID-19?

"The purpose of my experiment is to find out which design of a mask is the best in protecting others against pathogens. The transmission of pathogens across a fabric was evaluated using by measuring the distance the aerosol travels through a cloth mask made of different materials. The thickness of each material was measured using a digital caliper. My problem statement is which design of a mask is the most effective to protect from pathogens? I experimented on six different fabrics in which four of them were made of polyester. Mt results show the K-N95 mask is the best design to protect against pathogens. The K-N95 mask is the least breathable

and has the lowest transmission at 0.0 in. My results show that the K-N95 mask and surgical masks were the most effective since they both had the lowest repeatability and lowest transmission rate of 0.0 in."

Huang, Bolong (Alan) (10-06*-10, BM)

Yang, James (11-06*-10, BM)

Project Submission 2

Identification of X-linked Candidate Disease Genes through Trio Analysis of Family Pedigree

"With thousands of Mendelian-inherited diseases, new bioinformatics technology such as WES has been implemented to identify causal genes and variants within patients. Even with modern technology, analysis of WES sequencing remains difficult for researchers as an individual's exome spans over 30,000 variants with many complex variants. Many variants in X-linked diseases lead to developmental disorders (DD) associated with the brain. In support of using WES to analyze DD-associated Mendelian diseases, a software called Exomiser can be implemented. Exomiser contains multiple filtering, prioritization, and ranking algorithms, making it the ideal software for my partner and me to identify disease-causing variants within-patient(s). We applied Exomiser to a DNA trio (two parents and their child) extracted from CEPH family 1463. The CEPH reference panel serves as the CEU (Central Europe) population of the HapMap project for the generation of a haplotype map of the human genome, making it the ideal basis of research for my partner and me. We have successfully identified multiple DD-associated candidate genes expressed by both the father and son in the trio through Exomiser analysis. Through Exomiser's combined score assessment of 0.95+, we identified five critical genes in relation to DD-associated diseases, including STAG2, IQSEC2, TAF1, NLGN3, and ARSD. Through minimum ranking assessment, we then narrowed down the causal genes to the three top candidate genes STAG2, IQSEC2, and TAF1. All candidate genes identified were expressed in the brain, passed through x-linked inheritance, and ranked as the top causal gene in each patient."

GRADE 11

Yang, Grace (11-02-12, BM)

Project Submission

Computational Modeling of Cell Type Specific Metabolic Rate of Glucose Flow and Glutaminolysis in Cancer Microenvironment

"Glutaminolysis has been considered a major carbon and energy source in cancer. Recent studies report that immune cells tend to use more glucose while cancer cells use more glutaminolysis for ATP production. However, I suspect the observations only made on cell lines or limited mouse orthotopic model do not reflect the general metabolic changes in real cancer tissue. In this study, I comprehensively estimated the metabolic flux and distribution of glycolysis, pentose phosphate, DNA synthesis, lactate production, TCA cycle, and glutaminolysis in both multiple cancer types and normal tissue, by using tissue and single-cell transcriptomics data. My analysis confirms the increased glucose uptake and upper part of glycolysis and the decreased upper part of the TCA cycle in all cancer types. However, increased lactate production and the second half of the TCA cycle were only seen in certain cancer types. Moreover, I did not see that cancer tissues have shifted glutaminolysis compared to normal tissue samples. Even though cancer cells have the highest glutaminolysis rate compared to stromal and immune cells in the tumor microenvironment, I did not observe stromal and immune cells have higher glucose consumption than cancer cells. Further analysis illustrates that immune cells may have a higher potential in glucose uptake (by glucose transporters), while their downstream consumption of glucose is much lower than cancer cells."

Sriram, Raghav (11-03-13, BM)

Project Submission

Characterizing Pathogenic Enhancer Activity at Single-Cell Resolution to Study the Mechanism of Limb Malformation Disorders

"The ZRS enhancer, a regulatory sequence found in numerous organisms, plays an important role in early embryonic limb development. ZRS controls the expression of the Sonic Hedgehog gene (Shh), and

therefore early limb development in an organism as Shh has been shown to control the width of the limb bud by stimulating mesenchyme cell proliferation due to its ability to regulate the anterior-posterior length of the apical ectodermal ridge. Several transcription factors, acting as repressors or activators of the Shh gene, coordinate this limb development process in tandem with the ZRS enhancer. While the significance of normal ZRS activity is evident, this study looks deeper into the effects of pathogenic changes to the ZRS enhancer and the development of associated limb disorders such as preaxial polydactyly (PPD) by focusing on several aspects of ZRS regulation and its relation to Shh expression. This was accomplished by characterizing the expression of Shh and mCherry, an introduced luminescence gene regulated by ZRS, through single-cell RNA sequenced cells from a developing limb bud of a mouse embryo. Additionally, this study characterized specific transcription factors as potential repressors or activators of ZRS by determining TF enrichment or depletion in highly expressive Shh and mCherry cells. Classifying such TFs is vital in identifying the regulatory elements that control the formation of limb malformation disorders such as preaxial polydactyly and aid in the development of future therapeutic interventions.”

CHEMISTRY (CH)

GRADE 9

Rimawi, Danya (09-03-03, CH)

Mohammed, Nafisa (09-03-03, CH)

Project Submission 2

Are there chlorophyll and pigment varieties within leaves and petals?

"se, we all know they look green, but in fact, there are multiple pigments within leaves, each serving a different purpose. If it is a smaller leaf, do they need more of one pigment to sustain itself, if it is a different colored leaf or flower petal, will pigments turn out as different colors? There are three types of pigments within leaves, chlorophyll a, chlorophyll b, and carotenoids. All of these serve different functions to make

glucose; however, now we want to figure out what the variety within different leaves means. We used chromatography, a method in which you can separate different components in a mixture solution, using paper and acetone, to break down the leaf and find out what colors are inside. In the end, we found out that the size of the leaf did not affect the amount of pigment inside, and other results as well.”

GRADE 12

Imoudu, Jessica (12-04-19, CH)

Project Submission

Which is better at removing stains on a white fabric 'Liquid soap or detergents?

"For my experiment, not so much was needed. I tried to keep it as simple and straightforward as possible. I got my detergent (Gain) and liquid soap from Walmart, and the pieces of white was from a t shirt I owned. My experiment took me a day to complete. I tested my hypothesis out by pouring the same amount of stain/food substances on each shirt. I left the shirts for an hour to allow the smudge dessicate on it, and then after that, I examined both the detergent and liquid soap by applying both on each clothing; I measured the liquid soap in a cup, and added the same amount of water on both, since I knew I was going to be adding water to the detergent also, and I used the same amount for the detergent by mixing it in the same cup, and then I poured both mixtures in the two separate buckets. After that, I washed both the fabrics at the same time duration, for two rounds and then left it to dry.”

COMPUTER SCIENCE (CS)

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EARTH AND ENVIRONMENTAL SCIENCE (EA)

GRADE 9

Flores, Gloria (09-04-04, EA)

Project Submission

How do different methods to clear icy roads affect the pH of our waterways?

“In my experiment, I was testing the change of water’s pH after chemicals used for the icy roads are dissolved in the water. I thought that the chemical in the salt would affect the pH more than the rest. I was surprised when the chemicals all were around the same range of pH. I chose this project since it deals with water pollution and it isn’t a topic often researched about. This also is something that relates to many people’s lives and that indirectly affects the planet.”

ENGINEERING (EN)

GRADE 10

Paraboschi, Matthew (10-01-05, EN)

Songirkar, Siddhesh (10-01-05, EN)

Project Submission 2

Use of OCR Application to Allow Rapid English to Braille Conversion

“Our project focuses on using Optical Character Recognition (OCR) to engage in outside world translation of characters directly into braille via a camera. We recognized that a lot of information in the world is written, whether that be on signs, pamphlets, posters, or cards. This puts the blind at a disadvantage, considering these displays either have no braille translation on hand or cannot have braille, such as shop signs. The program will look for words in a video feed and segment them into letters. These letters will be processed into motor signals and sent to a microcontroller (Arduino with an HC-06 Bluetooth module), which dictates the motion of 6 servos, raising pegs into the user’s arm via a crank and

slider mechanism capable of converting rotary motion to linear motion. These pegs will act as output for the braille. The design will be structured as follows: a band on the forearm, with one container on the inside of the wrist that will house the servos, and another on the outside that will house the Arduino. Wires will run along the band between the two housings, surrounded by sheaths for protection. A second group of wires will run between the battery, located in a fanny pack on the hip, and the Arduino, supplying power to the whole system. This will be worn on the same hand holding the cane, with the other one holding the phone and engaging the program.”

Yang, Jonathan (10-05-09, EN)

Project Submission

Development of a Magneto-Optical Kerr Effect System

“Organic electronic devices demonstrate promising applications in new generation devices research. Spin crossover molecules exhibit binary stability between high spin and low spin states and the transition between two states can be controlled using different stimulus such as temperature, pressure and light. Magneto optical Kerr effect (MOKE) shows the interaction of light with magnetic materials and the photon polarization rotation is proportional to the magnetic moment of the sample. Studying the spin crossover molecules using MOKE apparatus is advantageous due to the surface sensitivity. We have developed a homebuilt MOKE device in order to study the magnetic field effect on spin crossover transition temperature. Both the instrumentation development and experimental data on spin crossover molecules will be presented.”

GRADE 12

Akin-Olukunle, Deborah (12-01-16, EN)

Project Submission

Fruit-Energy Generation

“The experiment was aimed at discerning the power generation capacity of grapes and blueberries. Preliminary expectations were that the grapes would produce more power than the blueberries. The topic

was selected because of a drive to know how fruits could contribute to electricity generation. The experiments were conducted in a science classroom and outside the school (IMSA North) building. The experiment took a week to complete.”

MATHEMATICS (MA)

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MICROBIOLOGY (MI)

—

PHYSICS AND ASTRONOMY (PH)

GRADE 11

Mo, Lucca (11-05-15, PH)

Project Submission

Utilizing the Swift UVOT Data to Improve the Classification of Gamma-Ray Bursts through Color-Color and Color-Magnitude Diagrams with Color Indices Based on Temperature

“Gamma-Ray Bursts (GRBs) have been classified into two recognizable categories designated as short-hard (Type-I) and long-short (Type-II). However, the possibility of newer classes of GRBs have been debated and speculated due to the current methodology of short vs long GRBs. Therefore, I present a further discrimination of the classification of GRBs through color diagrams to further research on newer GRB classification techniques. I utilized the SWIFT dataset to form two classification graphs based on the Burst Alert Telescope (BAT) and the X-Ray Telescope (XRT). With BAT being separated by the traditional dividing line of $T_{90} = 3$ and XRT having the dividing line at early flux = 50 keV. Subsequently, I observed the relationship between the V filter of UltraViolet Telescope (UVOT) to short and long GRBs

from XRT and BAT. This allowed for the identification of the burst power range of short and long. Following the V filter comparison graph, I created color-magnitude diagrams (CMDs) to find the color through specific filters while comparing the colors together by using color-color diagrams (CCDs). This methodology led to the results of most GRB values clustering at the center of the CMD and CCD graphs. This would indicate that many of the values were hard to identify as short and long. As a result, the color will not be able to further discriminate the classification of all GRBs due to the irregularity and variability of GRBs. But color will confirm the GRB class if the T_{90} and early flux align with one another in the same category. Through color, the possibility of aligning the color of GRBs to temperature has been found possible. This would further lead to the investigation of temperature from color being an influence on the classification of Type-I and Type-II. Through utilizing the dataset of SWIFT, BAT, and XRT, the values identified that temperature may be used for future GRB identification. However, further works need to be done on temperature and GRBs effects.”

PLANT SCIENCES (PS)

GRADE 10

Akinkuehinmi, Ayomikun (10-04-08, PS)

Project Submission

Does how you treat a plant affect its rate of growth?

"In my experiment I was trying to test if how plants get treated has any affect on their rate of growth. I wanted to study this because I wanted to find out the best method for planting plants. This would be an experimental project in the Botany category since I am experimenting and studying plant behaviour.”

GRADE 11

Akin-Olukunle, Felicia (11-01-11, PS)

Project Submission

Energy Conversion with Berries

“The experiment was conducted to deduce if berries could generate power. The topic was chosen to ascertain if fruits would be suitable materials to use in generating electricity for future experiments. It was anticipated that the blackberries used would produce greater power than the raspberries. The experiments were conducted in a science laboratory, a conference room, and in the IMSA North compound. The experiments lasted a week and all findings were recorded.”

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