Category **ANIM**   *L01*   Toward Further Understanding in Human Addiction Using C. elegans

Abstract   Objective(s):
-Observe behavior of C. elegans when they must choose between the drug and a substance that they are normally attracted to - NaCl.
-Study the neurotransmitters that may have been responsible for their potential behavior.
-Compare the different mutants to each other and analyze the different patterns that each of them holds.
-Find a connection between the worms' behavior and human addiction

-Mutants include tph-1 and dat-1
-N2 is control
-Dat-1: encodes plasma membrane dopamine transporter; "is predicted to regulate dopaminergic neurotransmission"
-Tph-1 gene encodes tryptophan hydroxylase, which is "the enzyme that catalyzes the rate-limiting first step in serotonin biosynthesis."
-SAM-e: antidepressant; naturally found in human body
-Benadryl: allergy med; drug that reduces anxiety symptoms but causes it in others
-Caffeine: central nervous system stimulant and the world's most widely consumed psychoactive drug
-Nicotine is a stimulant drug and most commonly found in cigarettes
-All drugs will be tested separately, and all of them will be tested alongside a well-known attract to C. elegans: NaCl.

Part 1 - Testing various concentrations of the drugs to determine which is the best to use. Dilute all drugs to 5, 10 and 15 mM concentrations. Only about 1 mL of each is needed. Drugs are made from pill to liquid form using water and sodium azide. Petri dishes are cut into four sections - two for test "T" and two for control "C". Each substance - drugs for test and 100 mM NaCl (for control) are placed onto the plates accordingly. Only N2 worms were used as they were put onto the middle of the plate after the drugs and control had dried in the middle of each of their sections. After one hour (trial time), the number of worms were counted and recorded for each concentration/drug combination, either under "T" for test, "C" for control, "M" for middle, or "E" for elsewhere. Water and 3.75 M NaCl were also used separately as tests alongside the 100 mM NaCl.

Part 2 - Testing mutants against drug concentrations determined in Part 1.
Concentrations found based on most distinctive results: 10 Mm caffeine, 5 mM benadryl, 10 SAM-e, and 5 mM nicotine.
Best timing for chemotaxis - about two hours and recount morning after to ensure accuracy of worms and that they stopped moving
Conduct chemotaxis assay with the new concentrations but now with the mutants, not only the N2 worm. Be sure to put 5-10 worms on the middle on each plate when chemotaxing them.

Part 3 - Pre-exposure of worms to drugs to test if their preference for them, if any, increases.
-Place each mutant/the worms directly on top of the two drops of drug on each plate for 20 minutes.
-Take worms off and transfer them to a plate with only agar for 20 minutes.
-Perform chemotaxis on the worms - similar to that in part 2.

Repeat step 2 and step 3 for a second trial.

Both step 2 worms will be added and step 3 worms will be added.

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Category **BCHM** **L02** Decay Away

Abstract I picked this project is because I recently found out that Mountain Dew has a natural citric acid rather than the other soda companies who use artificial acid. I want to test the effects of the soda on how it changes our teeth.

Materials: Pelletized Limestone (simulated teeth), Eggs (Hard Boiled), Mouthwash, Toothpaste, Coca Cola, Mountain Dew, Faygo Red Pop, Diet Coca Cola, Water

Questions:
1.)How does the soda effect the teeth (limestone)?
2.) Does a mouthwash or toothpaste solution make a difference with the testing of the teeth (limestone)?
3.)How does the same soda effect the staining of the teeth (Boiled Egg)?

Prcedure:
1.) Weigh the Limestone's beginning mass and record it.
2.) Put 1/3 of the limestone in the mouthwash solution for varying amounts of time. Put 1/3 of the limestone in the toothpaste solution for varying amounts of time. Leave the remaining Limestone in water for varying amounts of time.
3.) Re-weigh the limestone and record it.
4.) place the limestone in soda for varying amounts of time.
5.) Weigh the resulting Limestone and record it

Hypothesis:
I believe that the natural citric acid found in Mountain Dew will decay the teeth faster and will also stain the most.

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Category **BCHM** **L03** The Effect of Cooking Methods on the Nutrients in Phaseolus Vulgaris

Abstract This research project studied the effects of different methods of heating on phaseolus vulgaris. The stove and microwave were used to carry out the heating processes. Heating the vegetables had a large effect on the amounts of vitamin C, iron and calcium after they were heated and blended. This experiment was done to know just how good for the human body green beans really were after they were heated. To do this, the green beans were placed in either the microwave, boiled on the stove or steamed on the stove for one minute. After that minute was over, the green beans were placed in the blender with one cup of water, and then placed in a bowl after being liquefied. They were then tested on and it was found that microwaving the vegetables kept the most nutrients, with steaming in second, and boiling in last.

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Category **BCHM L04** Toward Making Extrudable, Water-Soluble Plastic From the Shells of Gulf Shrimp

Abstract As the human population increases at a rate of 3.1 percent (Worldometers 2017) trash and pollution is creating a major problem on a global level. This pollution is causing an increase in greenhouse gas emissions, in the amount of space landfills use to store all of this trash, and in the amount of plastic in oceans. Most of the plastic produced is thrown away, not recycled. Trash in the ocean is collecting at an alarming rate; 14 billion tons are dumped in the major oceans every year (Echo360 2012). This is a serious problem, with very few simple solutions. However, there are some solutions that are easier than others. Gulf Shrimp have been eaten for as long as humans have been aware of them. Their shells, for the most part, have been a waste product. These shells, composed of m mostly chitin, when m manipulated, can be transformed into a biodegradable plastic. The chemical manipulation of the chitin in the shells involves the synthesis of chitosan, which can be altered to form a natural plastic. When this is made, it can be strengthened with lignin, an organ polymer found in plants. When the chitosan and lignin are combined, the polymer becomes fluid, but remains biodegradable. The reinforced chitosan can be transformed into practically anything. This research project may contribute to the current literature on the creation and uses of chitosan and assist in efforts to address global pollution levels.

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Category **BCHM** **L05** Resisting Digestion

Abstract The purpose of this project is to discover if refrigerating starch-containing foods make the starches in those foods more resistant to being digested by the body. In theory, the process of refrigeration creates these resistant starches. A resistant starch is one that is not broken down into glucose immediately upon entering the small intestines. These resistant starches result in smaller blood glucose levels and less of an increase in the body's insulin levels ("Response to Three"). In order to test the digestion process of potatoes as resistant starches, the potatoes will be prepared in two different ways. One potato will be boiled for twenty minutes, cut into three parts and then refrigerated. While the other potato will be cut into three parts and boiled after having been in the refrigerator. One part from each potato will be tested immediately while one will be in the refrigerator for 12 hours and the other for 24 hours. In order to replicate the digestion process in the body, the enzyme diastase will take the place of amylase. Three grams of a 10% diluted potato solution will be mixed with three grams of a 10% diluted diastase solution. The instant the two solutions are mixed a timer will start and every five minutes for two hours the glucose level will be tested using Urine Reagent Strips. The glucose level indicates the amount to which the starch has been digested over a given period of time. Lower glucose levels would indicate that the starches are more resistant. In the data analysis, a line of best fit will be calculated to the data, and the slopes and y-intercepts of the lines of the varying cases will be compared. In the completed section of testing where the potato was cooked first, the 0 hour trial produced the largest slope of 15.592, but smallest y-intercept of 112.9 mg of glucose; the 12 hour trial produced a medium slope of 2.0954 and medium y-intercept value of 192.08 mg of glucose; and the 24 hour trial produced the smallest slope of 1.84 and the largest y-intercept value of 253.2 mg of glucose. These data have many real-world applications including the implications of an alternative method of preparing starches for people diagnosed with diabetes. If refrigerating starches is proven to turn them into resistant starches and cause them to contribute to blood sugar less, then it will be a valuable piece of information that those patients can use.

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Category **BMED**   *L06*   Biocompatibility of 3-D Printed Plastics with Staphylococcus epidermidis in Hy

Abstract   This experiment is to evaluate the biocompatibility of two polymer materials, carboxymethylcellulose and poly(lactic acid) by measuring bacterial growth on the polymer surface in a hyaluronic acid solution. Polylactic acid (PLA) along with the carboxymethylcellulose (CMC) will be divided into six separate pieces and submerged into a hyaluronic acid solution to resemble more of a joint area. Then bacteria will be added to the surface of the plastics. After a few days the bacteria will be swabbed onto new petri dishes and the bacteria colonies will be counted, thus determining which plastic is more biocompatible. The hypothesis was that it is expected that both polymers will exhibit adhesion and proliferation of S. epidermidis on their surfaces. However, due to its already present use in medical technology PLA is expected to grow more bacteria, so PLA will be more biocompatible than CMC, and the hypothesis was supported. PLA grew bacteria in a uniformed way, that also covered most of the petri dish. CMC did prove to be biocompatible but it had a more of a separated growth pattern. CMC also absorbed the hyaluronic acid solution which would not be practical for the long-term goal.

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Singh, D. A., About Dr Arun Pal SinghArun Pal Singh is an orthopedic and trauma surgeon, founder and chief editor of this website. He works in Kanwar Hospital, Hajipur, Hoshiarpur, Punjab.
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Category **BMED** **L07** Using Polymer Hydrogels for Drug Delivery

Abstract The purpose of this experiment is to investigate drug release using polymer hydrogels. This method simulates local drug delivery, which is done by implanting an engineered polymer into the organ or system affected by a disease thus limiting drug side effects compared to systemic drug delivery.

To conduct this experiment, 5% green and 15% blue gelatin polymers were made by heating water to 90o C, adding 2 grams and 6 grams gelatin powder, making the solutions, adding 0.75 mL of food coloring to the gels, and chilling them. These gelatin cubes or polymer hydrogel control the release of the color, which represents the drug. Low and high enzyme concentration solutions were prepared by adding 0.1 g and 0.5 g of meat tenderizer to 100 mL of water. The hydrogel cubes were added to solutions with no enzyme, low enzyme, and high enzyme concentration. A UV spectrophotometer was used to determine the amount of drug released by measuring the absorbance.

The hypothesis of this experiment that the gel with higher polymer hydrogel concentration will result in more quantity of drug release regardless of the enzyme concentration is not supported. Adding enzymes to the delivery system increases the drug release except in the 5% control solution. The 5% polymers released more drug than the 15% polymers. So in local drug delivery systems using polymer can be tailored to release a specific % of drug. The higher concentration polymer resulted in slower release because it takes longer to degrade the fibers. While this experiment simulates local drug delivery systems using polymer hydrogels, more research needs to be conducted using real drugs in animals or humans.

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Category *BMEN* **L08**   High-dimensional Single-cell Cytometry Analysis of Cancer Stemness

Abstract   While cancer starts as a single cell, termed cancer stem cell (CSC), the progeny CSCs are not created equal, but exhibit a spectrum of phenotypes of varying renewal capacity, metastatic potential, and drug resistance (1). Understanding this cell-to-cell difference (i.e. heterogeneity) of CSCs holds the key to both scientific and translational cancer research and presents us the opportunity to target and eliminate cancer at its "stem". Unfortunately, we do not currently have the tools necessary to dissect CSC heterogeneity due to multiple limitations (2). First, CSCs are extremely rare, making their isolation parallel with finding a needle in a haystack; Second, not all biomarkers on CSC subpopulations are known; Third, there is currently no single-cell proteomic and signaling analyses of CSCs available; Finally, CSCs are not static, but evolve with interacting symbiotic cells. As a result, our current view of CSCs is "pixelated" and "isolated", keeping us far away from the complete understanding of CSCs.

To overcome some of the limitations mentioned above, we harvested the power of a recent technological advancement in single-cell detection, namely cytometry by time-of-flight (CyTOF) (3). The University of Michigan is among the first to bring this technology on campus. Using CyTOF, I have successfully collected and then profiled the high-dimensional cytometry data obtained from an antibody panel that allows for simultaneous measurement of 27 markers on a single cell at a rate of 1000 cells per second. For the first time, we were able to directly detect breast cancer CSCs. With further antibody panel expansion and data mining, this study will provide the first comprehensive and high-resolution map of the CSC subpopulations at the proteomic and signaling levels. These results will unlock the answers to central questions regarding cancer stemness, which will change the paradigm of current practices in several aspects of cancer medicine, including early detection, monitoring, therapeutics, and ultimately lead to the development of preventative strategies to suppress or even reverse the initiation of cancer.

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Category **CBIO** *L09* Measuring Expression for Novel Variations in Enhancers using STARR-seq Data

Abstract Enhancers, although not translated, help give rise to the variety of unique cell types discoverable throughout the body. Enhancers function through elevating transcription in both the forward and reverse orientations in conjunction with transcription factors. Single Nucleotide Polymorphisms (SNPs) have been statistically linked through Genome Wide Association Studies (GWAS) to Type 2 Diabetes (T2D), although the effect of other allelic differences surrounding such risk alleles has yet to be investigated. As such, data gathered from a modified STARR-seq assay will be used to determine the allelic effects of modifications around a known risk SNP within +/- 10 base pairs of the risk allele to better understand the specific differences in transcription caused by personal mutations around risk SNPs. Specifically, count data from the assay will be used to detect subtle differences in transcription by counting the number of transcripts generated by each enhancer within the input library. After initial QC, the creation of position weight matrices will help highlight the allelic binding preferences of transcription factors to improve the understanding of the significance of specific base pairs in TF binding. Further statistical analyses will then adjust the counts of transcripts to account for random variations and more accurately reflect the transcription levels induced by the enhancers. The project will advance understanding of genomic regulation by helping explore the binding preferences of transcription factors through the analysis of transcript count data and statistical association of transcription levels with allelic differences within the count data.

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Category **CBIO**   *L10*   How does gene expression compare between depression and schizophrenia in the h

Abstract   Why I am interested in this topic: the potential correlation between depression and schizophrenia is not a widely studied field, and I hope to develop on the preliminary findings proposed by this particular study and dataset.

The fact that these brains are post-mortem means that no new environmental implications could be added during the process of study, making the results more indicative of a promising discovery.

To obtain my data, I collected a sample of genes and expression rates from the NCBI GEO database. Then I isolated the genes of interest pertaining to schizophrenia, depression, and a control group. I ran basic data analysis on 20,000 samples from 50 brains (t tests, average, standard deviation, etc.) to help organize the data according to relevance. Then, using the STRING database and further GEO2R analysis, I narrowed down 250 significant genes of interest that were prevalent in both schizophrenic patients and depressed patients but not the control group. The top 3 most relevant genes were then identified and their function was noted.

Accordingly, a genetic correlation between these two anxiety disorders has been established based on the data from 50 brains. It is important to note that this experiment took into account purely genetic correlations, and specific environmental factors were not thoroughly considered, although all the brains were taken from a European caucasian descent of people. Such environmental factors could have a factor in gene expression through the inhibition of the gene or the absence of it altogether.

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L11 Utilizing the WGCNA package in R to Identify Biomarkers for Infantile Spasms

Abstract Infantile spasms (IS) is a seizure disorder that affects children in the first 2 years of life, usually between the ages of 4-8 months. IS has a very subtle appearance making it difficult to recognize and diagnose. Approximately 30% of IS cases are idiopathic. In order to improve current diagnostic methods, my project focuses on identifying biomarkers for infantile spasms. The DMC Children's Hospital Lab collected surgical type brain tissue data from patients with epilepsy, both those with and without IS. They extracted total RNA from the brain tissues of both IS (n=17) and other of epilepsies (referred to as "Non-IS"; n=18) and measured gene expression levels using Agilent Sureprint microarrays. This gene expression data for 35 samples containing 32,080 genes collected by DMC Children's Hospital Lab was used as an input for my project. Since genes operate in networks, I began by analyzing the data using the weighted gene co-expression network analysis (WGCNA) method. The WGCNA package, in the R programming language, was used to construct and analyze the gene networks and to detect modules significant for IS. This was followed by the selection of genes significant for IS and further analysis using the gene ontology enrichment analysis tool. Gene network visualization was done by constructing eigengene heatmaps. A total of 73 modules were detected, out of which 3 modules (#9, #16 and #31) were highly associated with IS.

Within each of these 3 modules, the top 15 significant genes were further investigated using https://toppgene.cchmc.org to research associated terms. In module #31, 3 genes were found significant for IS: KLHL17, PLCB1, and KCNT1. Gene KLHL17 is known to play a major role in actin-based regulation of neuronal function and mutations in this gene can cause West Syndrome, Epilepsy, and X-linked Infantile Spasm Syndrome. Gene PLCB1 is expressed in the amygdala, cerebral cortex, hippocampus, lateral septum, and olfactory bulb and is related to hypsarrhythmia -- a common symptom of infantile spasms. Malignant migrating partial seizures of infancy (MMPSI) are caused by mutations in KCNT1 during early embryonic development. In module #9, one gene NTNG2 was found significant for IS. NTNG2 controls both neuronal circuit formation and neurite outgrowth of axons and dendrites. Using the coregulate-genes analysis website dire.dcode.org, the following transcription factors were predicted to regulate the co-expression of the significant genes in three modules: PBX, PIT1, CIZ, TEF, AIRE, E47, EBOX, PBX1, HMEF2, and XFD2. A preliminary identification of such key genes and the transcription factors provides a starting point in design of new therapeutic drugs to manage infantile spasms. However, additional, detailed in-vitro and in-vivo studies are needed to first validate these targets.

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Category **CELL** *L12* Bacterial Transformation

Abstract The purpose of this experiment was to determine whether it is possible to introduce foreign DNA into a bacteria for which one can transfer other proteins. Bacterial transformation is a process by which bacterial cells take up naked DNA molecules. Of the ways in which bacteria take up DNA from their environment is through their cell wall. Through various heating and cooling procedures, with very explicit guidelines, this project was conducted. E. coli bacteria were used over a three-day period under the supervision of Caitlyn VanGelderen, candidate of a biochemistry and molecular biology at Michigan State University. The plasmid was successfully taken up into the E. coli cells, and the proof is that the colonies grew because if they did not have the plasmid, they would not have been able to grow in the presence of the antibiotics, ampicillin and kanamycin.

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Category **CELL** *L13* "Differential Response to Temozolomide in Patient-derived Glioblastoma Cells

Abstract

Rationale

Over 23,000 malignant tumors of the brain or spinal cord are diagnosed in 2016. Unfortunately, approximately 16,000 people die from their disease. Glioblastoma (GBM), the most common malignant brain tumor is often treated with temozolomide chemotherapy. There is an urgent need to identify the patients who will respond to temozolomide due to its side effects profile. The methylation of the promoter of the MGMT gene which codes for an enzyme critical in DNA repair is shown to be associated with temozolomide sensitivity in patients with GBM. Evaluation of the effect of temozolomide on patient-derived GBM cell lines with varying MGMT methylation status has the potential to provide additional insight on a specific drug's activity ex-vivo. Future application of this approach will allow researchers to experiment on the patient's tumor, not on the patient.

Research question, hypothesis, goals, expected outcomes

The purpose of this study is to determine the response to temozolomide therapy in three existing patient-derived GBM cell lines. The hypothesis is that the patient-derived GBM cell lines will mimic the known actual patient response to temozolomide, providing additional insight in the biology of the tumor. The expected outcome of this research is to show that response to temozolomide in the patient-derived GBM cell lines will be the same as in the GBM patient.

Procedures

Three patient-derived GBM cell lines (15-037, 14-015s, 14-104s) will be obtained from the cryo-preserved archives of patient-derived cell lines and tumor fragments. The samples in the archive were previously collected under an Institutional Review Board approved protocol and located in the Translational Neuro-Oncology Research Laboratory at the Karmanos Cancer Institute, Wayne State University School of Medicine, Detroit, MI. The three cell lines will be untreated or exposed to temozolomide (alkylating agent), or CH-223191 (aryl hydrocarbon antagonist). Cell proliferation assays will be assessed by the Vybrant MTT assay (Thermofisher). The GBM patient's response to temozolomide will also be provided in a de-identified manner.

Risk and Safety

Tumor tissues and the resulting cell lines may pose a biological hazard with the risk of infection to exposed individuals. Temozolomide is an agent used for chemotherapy and is known to be cytotoxic. All tumor tissues and cell lines are handled in an annually re-certified biological safety cabinet. Personal protective equipment (gloves, lab coat, safety goggles) will be worn by all personnel performing the experiments. Using these established procedures, there is only a minimal risk of exposure.

Data Analysis

The numeric values obtained by the MTT assays will be analyzed for

statistical significance of differences between control cells and treated cells using Student's t-test or one-way analysis of variance. Results will be statistically significant if $p<0.05$

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Category **CELL** *L14* The Effect of Mechanical Compression on Cancer Cell Proliferation

Abstract Tissues in our body experience a variety of mechanical stimuli that are important in physiological and pathophysiological conditions. Mechanical compression is found in solid tumors and there is conflicting literature in how mechanical compression influences cell growth and proliferation. Compression comes from two forms. One is from the solid tumor directly. Compression can arise from cells in a stiff micro environment of the solid tumor as well as from the migration of a metastatic cancer cell through tight vasculature. How normal and cancer cells respond to mechanical compression is not entirely well understood. My research investigated the mechanical compression on breast cancer cells (MDA-MB-231) and healthy breast epithelial cells (MCF10A) for their growth and proliferation, studied the cellular response to mechanical compression to further understand the progression of cancer development. Different weights were used on agarose pads to simulate different compressive stresses on breast cancer cells and healthy breast cells. Pictures of cells were taken using fluorescence microscope after compression. Images were analyzed using National Institutes of Health ImageJ. Our results suggest that healthy breast cells are stiffer than breast cancer cells, and have a higher threshold for compression; cancer breast cell proliferation responds to mechanical compression faster than healthy breast cells at early compression stage; mechanical compression does not affect breast cancer cells after certain threshold of compression is reached. This research provides unique insight to cancer treatment by taking into account mechanical factors besides the genetic and biological factors. Medical researchers can develop therapy drugs that increase mechanical compression on the tumor to slow down the rate of tumor growth.

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Category **CELL** *L15* Testing the Geometrical and Chemical Structure of
Methylbutenol Synthase: Find

Abstract The purpose of this experiment is to see if changing the chemical
structure of Methylbutenol (MBO) synthase's active site from a
Phenylalanine to a Tyrosine will effect the production of MBO and
isoprene. By finding alternative ways to increase the production of MBO
and isoprene, it will allow for an increase in rubber production and various
uses in biotechnology. It was hypothesized that with the chemical and
geometrical change, a greater production of MBO and isoprene will be
produced because Tyrosine is polar due to the hydroxide group. The
experiment was conducted by using proteins from last year, which went
through a site directed mutagenesis. Next, the proteins underwent a
protein expression was applied by suspending bacterial cells, vortexing,
and then centrifuging the bacterial cells. The supernatant was run
through a western blot. A functional assay was used to color the gel in
order to see the bands of protein. Gas was then extracted from the
protein and cycled through a gas chromatograph. The results showed
that there was little change in the amount of MBO and isoprene
production. The ratio had a slight shift toward the production of isoprene.
This shows that the geometry and the chemistry had an effect on MBO
synthase.

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e>.

Category *EAEV* *L16* The Effect of SAP's on Soil Moisture and Plant Height -Solving The Drought Cri

Abstract In my project, I wanted to demonstrate and develop a viable solution to the drought crisis of countries around the world. I discovered that super absorbent polymers, or SAP's, are substances that have the ability to absorb water up to 300 times their own weight. They have been used for many years in household products like diapers and cleaning supplies. However, more recently, SAP's are being used in the agricultural industry as a method to create an "underwater reservoir" for their crops. However, commercial SAP's are not a viable solution to the drought-infested countries that could benefit from them the most. Commercial SAP's are very expensive and have harmful effects on the external environment and the soil. Therefore, I developed an alternative SAP that is organic, low-cost, eco-friendly, and best of all, made from waste products. Once I discovered that one of the main components in orange peels are polysaccharides, I developed three organic SAP's made from avocado skins and orange peels that can even outperform commercial SAP's. Orange peels contain 60% polysaccharides and when combined with oil from avocado skins, they can produce a strong cross-linked SAP. Each SAP was made through a different series of steps and they each had different effects on the plants. To test their effectiveness against commercial SAP's, I tested their effect on the soil moisture and plant height on the ocimum sanctum plant. I poured 100ml of water on the first day and no additional watering was done for 10 days. The five groups that were tested are as follows: orange peel Solution, orange/avocado Mixture, Orange/avocado Powder, control group (no SAP), and the acrylic SAP (commercial SAP). The Plant Height was recorded using a ruler and Soil Moisture was recorded using a moisture meter once every 24 hours for each group. The orange peel/avocado skin mixture that I made outperformed the commercial acrylic SAP in both the plant height and the soil moisture level by the 10th and final day of the testing period and showed that a cost-effective and viable solution could be developed. I have conducted extensive research on this topic and have a deep comprehension of the processes involved with the formation and utilization of SAP's. Scientists have been researching the question of how to develop organic SAP's for many years and have even undergone testing with alternative SAP's produced from corn and this project further attests to these ongoing scientific studies. My project was awarded the grand prize at my DCMST school science fair and I look forward to sharing it at this regional fair. The organic SAP's I produced are an advancement towards developing a solution to the critical drought crisis around the world. It is most remarkable that a product we would consider to be waste, that we wouldn't even take a second look at before tossing into the garbage, can actually be used to solve one of the biggest and most crucial humanitarian crises that is facing our world today.

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Category **_EAEV_**   **_L17_**   Roof Design that Collects all Precipitation and Natural Fertilizer

Abstract   The purpose of this invention is to utilize the greatest amount of water and natural fertilizer to grow crops using a hydroponic system in areas that do not have the preferred conditions to grow plants. Through this structure, the 795 million people that live in hunger in the world today can be helped because the countries can now grow their own food in many different climate types. By using this invention on top of buildings, the structure would not take up any extra space. The structure can be modified to work in any part of the world: cold, hot, dry, or wet. If it is used in a cold region, heat vents can be opened from the building below. Heat rises, melting the snow, and creating a water source. If the structure is used in a wet area, then overflow spouts can be installed in the first holding tank. The design of this structure naturally draws in pigeons, which act as the fertilizing source. The rainfall then washes the pigeon feces down to the pipes which lead to the holding tank. The water is constantly churning in the holding tanks so the pigeon feces break down creating a nutrient rich solution which then flows through the hydroponic system. The pipes are built at a slight downward angle, so gravity causes the water to flow through the system. No extra energy is required. Once the water makes its way through the system, it flows into another holding tank with a water pump, which then pumps it back up to start the process over again. This way there is not a shortage of water, because the water is being reused.

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Category *EAEV* **L18** Mathematical Modeling of Solar Radiation Management with Sulfur Aerosols

Abstract Along with the increasing presence of greenhouse gasses, climate change is a significant area of concern. In response to this global environmental issue, scientists have proposed geoengineering to find a solution. Geoengineering opts to intervene on a large-scale with the Earth's climate to counter global warming. Geoengineers have proposed a potential technique to obtain climate stabilization through the deliberate injection of sulfur-based aerosols into the stratosphere. Past studies show that atmospheric aerosols already have great capabilities in reflecting solar radiation. Therefore, the utilization of sulfur-based aerosols appears to be a cheap and effective method for solar radiation management. Since sulfur-based aerosols react with atmospheric water vapor to form sulfate particles, this technology appears to be fruitful as naturally occurring sulfur aerosols demonstrate reflective properties on a short-term basis. Climate scientists have conducted small-scale experiments to test the effectiveness of sulfur-based aerosols, however, this research is still premature.

In my study, I use mathematical modeling to gauge the effectiveness of sulfur-based aerosols for solar radiation management. The effectiveness of sulfur-based aerosols for solar radiation management is determined through computing the optical thickness of an aerosol layer, the aerosol's single scattering albedo, and the fraction of the direct sun beam reflected upwards off the aerosol layer. All calculations are made under clear-sky conditions and are based on publicly available data obtained through proper scientific measures. Data needed for mathematical modeling of sulfur-based aerosol performance in reducing the effect of solar radiation- to name a few- includes global average surface albedo, global cloud fraction, and global mean column burden for anthropogenic aerosol constituent. After mathematical modeling is complete, data analyses will determine the significance of the results in this study for potential real-world applications for solar radiation management.

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Category **EAEV**   **L19**   Impact of Road Salt Usage On Atmosphere Concentrations of Cl and Na PM 2.5

Abstract   This work investigates the potential relationship between road salt application and PM concentration in regards to air quality. Over ten million tons of sodium chloride (NaCl) have been dispersed onto US roads annually for seizing purposes. Monitoring data collected by the Environmental Protection Agency was used to determine the composition of particulate matter samples in realtivity to snowfall.

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Category **EAEV** **L20** The Effects of Heavy Metal Contamination on Various Aquatic Organisms

Abstract The Saginaw Bay Watershed has been identified as an area of concern by the U.S. Environmental Protection Agency due to the presence of various metal contaminants. When soil samples in the Bay Region were taken, concentrations of aluminum, arsenic, chromium, copper, lead, mercury, nickel, and zinc were found. This study assesses the uptake and bioconcentrations of heavy metals by aquatic organisms (Daphnia Magna, Ramhorn Snails, Elodea Canadensis, and Freshwater Mussels). The standard solutions were created bearing concentrations of 1 ppm of lead, chromium, and aluminum. The uptake of the metals was analyzed by measuring changes in solution concentration using a PerkinElmer Atomic Absorption Spectrophotometer. The hypothesis was supported. Exposure to heavy metals caused an increase in the heart rate of Daphnia Magna. The Ramhorn snails were able to uptake more than twenty-five percent of the metal contaminant, the Elodea Canadensis was able to uptake more than fifty percent of the metal contaminant and the freshwater mussels were able to uptake more than seventy percent of the metal contaminant. Because of such high uptake levels by the Elodea Canadensis, it may be a potential source for phytoremediation.

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Category **MCRO L21** Mechanism by Which Holy Basil Protects Human Cells Against Pneumonia.

Abstract The herb Basil is known for its medicinal properties (1-2). For the past four years, I have been studying the antimicrobial properties of basil. Last year, I found that basal protects human lung cells from K. pneumoniae, a gram negative bacteria. This year, I will be testing to see if basil can protect lung cells from S. pneumoniae, a gram positive bacteria. My results, from my project last year, showed that although the basil did not kill all of the bacteria, it was still able to keep almost all the cells alive. Therefore, I will also be studying the mechanism by which basil protects the cells. I expect that basil will protect cells from gram positive bacteria equally as well as a gram negative. I also expect that the basil will protect the cells by facilitating the release of protective substances and inhibiting harmful substances. I will conduct my experiment by pretreating the lung cells with a 1% solution of organic basil powder and incubating for 24 hours. Following this, it will be infected with bacterial suspension (1000 cfu). I will then analyze the viability with trypan blue dye. I will also collect the media that had contained the cells, and examine the changes in levels of proteins such as cytokines using ELISA. A scientific report which connected pneumonia related mortality to increased levels of proinflammatory cytokines prompted me to select cytokines.(3) At the end of my project, I expect the results to show that basil protects gram negative, as well as gram positive bacteria and that it will increase the levels of anti inflammatory cytokines and/or decrease the levels of proinflammatory cytokines.

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Category **PLNT** *L22* Growth of Green Onions in different soil types

Abstract I wanted to demonstrate that plants can grow in many ground types. To prove my demonstration I planted green onions in sand, soil, pebbles, and just water. I also wanted to test which type would produce the most amount of growth. To do this, I measured the change in height.

The data I needed to prove my demonstration was the growth of each plant from each type of ground type. I need to measure each green onion from where they were cut and the growth before they where planted and after they where planted.

I noticed that the green onions that were planted in the sand had the highest growth. The highest growth of the sand was 23.5, highest for soil was 23, the highest for pebbles was 11.8 , and the highest for just water was 10.8. I planted three green onions in every soil type to ensure that my results were valid. From my results, I concluded that the sand provided the best growing conditions for the green onions.

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The Effects of Copper Sulfate on the Health and Growth of
Dracena Sanderiana

Abstract   The purpose of this research project was to determine if an increased level in copper sulfate in bamboo grown as hydroponics would increase the plants overall height and health. There was a total of four experimental groups set up with 17 bamboo plants in each group. In group A the water used had no copper added to it, therefore it was the control. Group B had 15 ppms of copper sulfate and Group C had 30 ppms of copper sulfate. Finally Group D had a level of 45 ppms of copper sulfate.

 Every other week the plants were measured for growth and each was graded on a scale from 1-4 , four being the healthiest and least healthy. Data was collected for a total of seven weeks from October 9th till November 27th. Through my results it was concluded that the plants grown in group C had the highest average growth with a mean of 0.5588 inches and group B had the lowest growth with a mean of 0.382 inches. All of the plants at the beginning of the project began with an average rating of four, meaning they were all healthy. By the end of the project the healthiest was group A and the least healthy was Group C. From this data it was determined the effect that copper sulfate has on each plant's health and growth.

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Category *CELL*   *L24*   Detecting Dust & Dander Allergens in IgE Sensitized Individuals Using a ...

Abstract   Detecting Dust and Dander Allergens in IgE Sensitized Individuals Using a Capillary Tube Precipitation Test: A New Non-Intrusive Antigen/Antibody Reaction Test

The purpose of this research was to determine if a new non-intrusive allergy test can detect dust and dander allergens in IgE sensitized individuals using a capillary tube precipitation test without the associated risks in currently available tests. Eleven samples of saliva were gathered from individuals with known allergies to cats, dogs, both or neither; along with fur from two cats and five dogs. The dander from the fur from each animal was extracted using water and in another trail using acetone. Cat saliva was also used in one of the trails. One milliliter of saliva was put into each test tube along with one milliliter of antigen solution. There were six different trials with a total of 138 tests. Results indicated that this non-intrusive test detected reactions in several of the samples (see Table 1). Further research is needed using a commercially available antigen Can f 1 solving both the concentration and PH issues allowing for more consistent and reliable results. There is no way to truly avoid dog and cat antigens one hundred percent of the time, so hypersensitive people need to be able to quickly, efficiently, and reliably diagnosis exactly what they are sensitive to. This test would make this a reality for millions of people. (Contains five tables and five figures).

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Category *CHEM* *P01*   Do Essential Oils Work

Abstract   Do essential oils work? How do they work and what can they be used for? These are some of the questions explored in this science project. Essential oils are compounds, complex chemical substances and have been used for thousands of years to fight bacteria and mold. Experiments were performed to test essential oils with both bacteria and bread mold. This was done to determine whether certain essential oils have antibacterial and/or antifungal properties.

Certain essential oils were made to be tested on bacteria and bread mold. These consisted of the same kinds as the ones which were purchased from Whole Foods Store and a pharmacy. They were basil, cinnamon, clove, lavender, lemongrass, nutmeg, and vanilla. After these essential oils were made, all of the oils the homemade and the store-bought ones were tested on agar plates swabbed with bacteria. Some essential oils were also tested on bread mold swabbed on agar plates. The bread mold was only tested with cinnamon, clove, lavender, lemongrass, and vanilla. None of the store-bought essential oils were tested with the bread mold.

The homemade essential oils mostly worked better; preventing the growth of bacteria on agar plates, while the purchased ones generally did not work as well. Some essential oils performed better than others. Lavender essential oils worked well on both mold and bacteria. The growth of mold was also somewhat prevented by the lemongrass essential oil.

Some essential oils have antifungal properties which can help with infections caused by fungi, which have become hard to treat with medicine. The antibacterial and antifungal properties of essential oils can allow them to be used instead of medicines such as antibiotics when these medicines cannot be used.

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Category *CHEM* *P02*   The Effect of Concentrations of Citric Acid on the Leakage of
                           BPA From Plastic

Abstract   The purpose of this research was to determine if increasing the
            concentration of citric acid also increases the leakage of Bisphenol A
            (BPA) from plastic. This experiment is important to study because people
            will know if BPA will leak into their beverages depending on how high the
            concentration of citric acid is. They will be aware that citric acid levels
            affect BPA. Therefore, they will take it into consideration. If people realize
            what problems it causes, then they would try drinking from a glass at
            home or carrying beverages in a refillable steel container instead of
            plastic. Eight experimental groups and one control group were set up.
            Each experimental group received different concentrations of citric acid-
            10, 20, 30, 40, 50, 60, 70, and 80 millimoles. The control group received
            500 milliliters of tap water without any citric acid. The qualitative
            measurements- BPA being present were collected using an indicator,
            iron (lll) chloride. Data was collected for four days after 19 days of the
            bottles sitting in the cabinet. All the experimental groups resulted with a
            yellow and green color, and the control group turned out to be a brown
            and orange color. The hypothesis was not supported because the
            concentrations of citric acid got higher as it went from the first
            experimental group to the eighth experimental group. When they were
            tested, they resulted in the same yellow and green color as the lower
            concentrations of citric acid. For BPA to be present, a color other than a
            yellow and green color, and a brown and orange color was supposed to
            appear.

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vents/publichealthfocus/ucm064437.htm

Category **CHEM** ***P03***   Direct measurment of pH of Atmospheric Aerosol Particles

Abstract   The impact of highly acidic aerosol particles in the atmosphere affect, not only climate change but human health as well. Atmospheric aerosols impact climate by scattering or absorbing solar radiation. These particles can also go through chemical reactions that lead to the formation of secondary organic aerosols. The formation of SOA particles is dependent on aerosol acidity. But, determining the exact pH of atmospheric aerosol particles has proved to be a tough task, due to the microscopic size of aerosol particles. Previous experimentation includes the use of equations, thermodynamic equilibrium models, and Raman microspectroscopy in relation to relative humidity, yet these methods came along with many limitations. In this study, a variety of different methods and instruments were used to test the pH of atmospheric aerosols. The testing was done on six bulk solutions made from various mixtures of salts and acids that resembled atmospheric aerosols particles. The methods in this experiment included the use of a pH probe and pH paper that were dipped inside the six bulk solutions,titrations used for a pH equation, and image processing using a Matlab script generated from the pH strips. A nebulizer was also used to impact aerosol particles onto pH paper. The results of the experiment yielded the conclusion that the best instrument used to test the pH of atmospheric aerosols was the pH probe. Though image processing was relatively effective when compared to the titration calculations, the pH probe most accurately matched the desired pH of the six bulk solutions.

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Category **EBED** *P04*   Real Time Heart Rate Variability Analysis

Abstract   Electrocardiogram(ECG) is commonly used for diagnosis of cardiac rhythm. Variation in the heart rate and beat to beat interval is indicated by Heart Rate Variability (HRV) analysis, which plays an important role in the diagnosis of cardiac status. Patients in intensive care require continuous monitoring; however, it is impractical for a human to analyze such a large quantity of data for the diagnosis. An embedded system for real-time HRV analysis is desired for a more efficient and accurate diagnosis. This study used a Shimmer wireless body sensor platform to detect ECG signals from the human body. A nonlinear energy method was used to detect the R peak of QRS, and HRV analysis was performed based on statistical measures. A MATLAB program was developed to compute R peak and HRV indexes. The proposed embedded system can be used for real time HRV analysis.

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Category **EBED**   *P05*   Canine Whisperer

Abstract   Every day, dog owners must make sure that their dogs get enough food and water that maintains the dietary needs. A yearly checkup is also required to make sure dogs stay at their healthiest. Sometimes more than a yearly checkup is needed to keep a dog active and athletic. Unfortunately, a dog owner has no way of easily knowing if their dog has become ill. Thus, this project creates an efficient system for monitoring your dog's health. It achieves this by dispensing a specific amount of food and water at preset times throughout the day and puts them on a regimented schedule. Though this simplifies the process of managing a dog, it does not directly make sure a dog stays healthy. To identify if the dog is becoming sick, the system keeps track of all food and water the dog consumes and compares it to prior information of the dog's eating habits by looking for either an increase or decrease in food or water consumption which is a common indicator of illness in dogs. If the program detects that the dog might be falling ill, it will send the owner an email with the changes it has detected in the dog's eating habits along with a graph of the past 30 days of food and water consumption. This will allow the owner to know if the dog has had a change in diet and when exactly that change happened. Overall, this complex system will increase the ease in management of a dog and improve the health and comfort of a dog's life.

Bibliography   https://docs.python.org/3/https://learn.sparkfun.com/tutorials

Category **EGCH** **P06** Solar Hydrogen Home

Abstract The purpose of this experiment is to determine if it is possible to adequately fulfill the power needs of a home in Michigan through the use of a solar powered fuel cell. It has been proven that this is possible in places with more sun exposure, but never in Michigan.

My project is composed of two major parts. The first part is running multiple, five minute trials at different times of day and in different conditions. It is important to note that the act of splitting the water into hydrogen and oxygen is done because hydrogen is a more effective way to store energy than batteries. It has the highest energy density of any gas or liquid fuel. The idea behind this experiment is that during the summer months, where there is more sun exposure, any electricity that was not used by the house could be used to break down water, storing the energy as hydrogen. During winter or at night, when little solar energy is being produced, the hydrogen would go through the fuel cell, recombining to make water and electricity.

The second part of my project is to determine if the amount of energy produced is sufficient to power a home twenty-four-seven three-sixty-five. We can use our electricity bill to determine our monthly average usage. I will use the mean of my measurements with measurements simulated as summer.

Bibliography https://www.scientificamerican.com/article/hydrogen-house/https://www.technologyreview.com/s/518516/an-inexpensive-fuel-cell-generator/

Abstract   BACKGROUND

The current generated by a single solar cell is highly sensitive to the
angle, the intensity, and the color of the light incident upon it. In this
project, I want to investigate whether this property can be utilized to
design an "intelligent" solar panel that can "predict" the position of a light
source incident upon it (and, possibly, also its distance and its color). A
potential application of such an "intelligent" panel would be as a solar
tracker, facilitating the determination of the position of the Sun and
feeding positional data to the tilting control unit.

HYPOTHESIS

My hypothesis is that if an array of solar cells can be properly designed,
then the electrical response of each cell in the array will be different for
different locations of an incandescent source of light pointed towards it.
These electrical response values can then be read by a computer using
proper sensors. The latter data, along with the positional information of
the light source can then be used to train a supervised Machine Learning
algorithm. The generated model can then be used to predict the position
of any incandescent light source pointed at the array.

EXPERIMENT:

1.Use Ruthenizer-535 synthetic dye to create dye-sensitized solar cells
(DSSCs). I choose to use DSSCs because I can produce them at home.
Moreover, DSSCs are environmentally friendly, cheaper to manufacture
than their silicon-based counterparts, and work in low-light conditions.

2.Use 6-9 such DSSCs to create an array so that each cell responds
differently to an incandescent light source pointed at the array.

3.Connect each cell to the ADC input of an Arduino.

4.Read the voltage-drop on a 560-ohm resistor connected to each cell
using an Arduino program.

5.Record the position of the light source in a 2-dimensional / 3-
dimensional unit.

6.Use MatLab programs to train a Machine Learning algorithm and
generate a model for light-source-position prediction.

7.Test the correctness of the model by placing the light source at an arbitrary position around the panel, recording the voltage values from each cell, feeding the data to the model, and checking whether it predicts the position correctly.

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Category **EGCH   P08**   Testing the Electrical Energy Production Capability of Microbial Fuel Cells

Abstract   The purpose of this project was to test the capability of microbial fuel cells (MFCs) to generate electrical energy. If the MFCs generate an electrical current, then the maximum voltage reading will be approximately 100 mV without resistors and 5 mV with resistors for each MFC. The MFCs were assembled by using a guide found at Science Buddies, but the actual measurements were acquired without a guide. The types of data that were collected included voltage measurements with a resistor attached to the MFCs and the voltage reading without a resistor attached to the MFCs. Voltage measurements were also taken at different times of the day over a period of fourteen days. Power readings were calculated from the voltage readings of the MFCs with the resistors attached. As the experiment progressed, the voltage readings for when the MFCs did not have a resistor attached increased steadily until reaching a peak a voltage of around 380-395 mV. This same trend was also observed in the voltage readings for when the MFCs had resistors attached; however; the peak voltage was around 10-12 mV. Power generation also experienced a similar trend as the voltage readings. The results from the experiment showed that the hypothesis was wrong in predicting the maximum voltage of the MFCs. Instead of a maximum of 100 mV, the MFCs achieved a maximum of four times the predicted maximum. With resistors, the MFCs had 5-7 mV more than the predicted maximum.

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Category *EGPH* **P09** Clean Electricity from Wastewater: Implementing and Improving Hydrokinetics

Abstract As the population of the Earth increases, so does the demand for energy. Therefore, the damage being done to the environment is exacerbated. This is because the most prevalent methods of obtaining usable energy involve sources such as oil, coal and natural gas which are harmful to the atmosphere. These resources are also finite, so forward-thinking methods of generating energy should be employed. By implementing new renewable energy projects, or improving the efficiency of existing renewable technology, the environmental and energy crisis can be offset.

Specifically, this project will explore and demonstrate potential applications for hydrokinetic technology by generating clean electricity from the potential energy of rainwater and storing the electricity into energy-efficient capacitors. I will design the set-up using the Autodesk software MAYA, and I will construct a hydropower generator to be applied for use on the school campus.

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doi: 10.3390/en4091258

Do Fish Hold the Secret to Hydrokinetic Energy Harnessing?

Abstract   Rationale: In the Spring of 2015, at the Niagara Falls aquarium, I noticed that when a school of fish changed speed, fish adjusted their relative position to maintain a regular formation. I observed that fish left behind struggled to catch up. Soon after, I read a 10-year long DOE-Harvard-MIT study that investigated the movement of fish behind a cylinder. It was proven that fish used less energy and flexed their bodies only slightly when swimming behind a cylinder in a current. Could a machine be designed to harness hydrokinetic power efficiently using fish kinematics. I was so fascinated by this that, I contacted the Marine Renewable Energy Laboratory (MRELab) at the University of Michigan. They study harnessing hydrokinetic energy using cylinders in flow-induced vibrations (FIV) in water currents. I proposed to use two cylinders and change their spacing – like fish do - to study the impact on harnessing hydrokinetic energy. They agreed and I joined the team as intern in September 2015. The test-results were phenomenal, showing an increase in converted power by a factor of 2.6-7.5 when two cylinders are in synergistic FIV compared to a single isolated cylinder. Ever since, I have been working in the MRELab to optimize this converter. Its power-to-volume density is 60,000 times that of wind farms. Its potential is immense from a renewable energy standpoint and it is harmless to the environment, since it mimics fish kinematics.
Hypotheses: Based on results I collected and processed for Science Fair 2016 using two cylinders in synergistic FIV, my hypotheses pertaining to the power output of three cylinders are: (a) Three tandem cylinders in synergistic FIV can harness more hydrokinetic energy than three isolated cylinders. (b) Per cylinder, three tandem cylinders can harness synergistically more hydrokinetic energy than two cylinders synergistically. (c) The power converted by three cylinders in tandem can be optimized with respect to the harnessing damping.
Testing: All tests were conducted in the Channel of the MRELab using three oscillators consisting of cylinders suspended horizontally by linear springs in steady flow. Constants: Cylinder diameter, length, mass, spring stiffness, cylinder spacing. Variable: Flow speed ≤1.35m/s. Parameter: Harnessing damping. Testing time: 15 hours.
Data analysis: The displacement history of each cylinder was post-processed to calculate amplitude and frequency of oscillation, and harnessed power. Laser flow visualization with high-speed camera helped understand the interaction between cylinders and wakes.
Results: All three hypotheses were confirmed. Specifically, (a) The energy harnessed by three cylinders in synergy was 3.4-7 times the energy harnessed by a single isolated cylinder. (b) Per cylinder, three cylinders produced 10% more power than two cylinders. (c) By adjusting harnessing damping power can be optimized.

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Category **EMNC** **P11** Raspberry Pi Autonomous Cars Driving and Interacting

Abstract As the automobile industry starts to shifts towards autonomous cars, the safety and effectivity of driverless cars become more valued. In my project, I am demonstrating the communication between autonomous Raspberry Pi powered cars with computer vision capabilities. The cars use a combination of UDP protocol communication and OpenCV computer vision to recognize street signs and cross a four way intersection safely.

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Category **EMNC** *P12* Electronic Tap Board

Abstract The purpose of this project was to create a portable tap board that creates loud, good quality sounds. The board was able to amplify the sound using piezoelectric sensors, which took in the vibrations from the board and transmitted electrical signals. Those electrical signals then went to an amplifier which projected the sound much louder. The board was made portable by adding wheels. The tap board worked and the volume ranged in relation to the distance of the vibration and the piezoelectric sensor. In the future a few things could be improved, such as the wheels, and cushioning. Overall, the Electronic Tap Board worked well with the Piezo Electric Sensors, which picked up the vibrations made by the taps and were amplified through the speaker.

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Portable Practice Flooring. O'Mara Sprung Floors. https://sprungfloors.com/portable-dance-floors-for-home.html. Accessed October 9, 2016.

Category *EMNC* *P13*   Wind Noise Reduction Device for the Hearing Impaired

Abstract   The research goal was to provide a device that reduces discomfort due to wind noise experienced by hearing aid users while riding a bike. The device reduced the noise while allowing important surrounding background sound such as cars, sirens, and other motor vehicles to be heard. Three testing methods were configured; a bike rig with a false head and a microphone in the ear, a wind tunnel with a microphone in a false ear, and finally a wind tunnel where the microphone was placed above the ear, as it exists in behind-the-ear (BTE) hearing aids. The third method was then used to draw data, results, and conclusions from, as the first two failed at producing conclusive results. Sound was recorded for a minute for each combination of test parameters. Each test condition was repeated with a whistle noise to replicate an emergency vehicle siren. Various materials were then used to block sound but still allow for the siren-noise replica to pass through. These included: a control group with nothing blocking the ear, blue high density foam, a replica of a preexisting product Cat Ears, kitchen sponge foam, and speaker foam. Three fan speeds were also used: low, medium, and high. The head was oriented at three angles: forward, toward the ear (left), and away from the ear (right). An open-source program, Audacity, was used to analyze decibels as a function of time, and then decibels as a function of frequencies (hertz). These were plotted based on the microphone's reference sound and then replotted on the a-weighted curve of human hearing. There was no difference found in the left and right facing data, so that was disregarded when analyzing and only front-facing data was used. Though all materials were effective to some extent, it was determined that the speaker foam worked the best across all three fan speeds allowing for necessary sounds to pass through but blocking wind noise. The control group with nothing blocking the ear performed the worst. The research goal was met due to the success of the materials used in reducing air turbulence around the microphone.

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Investigating Tuned Magneto-Rheological Reservoirs, Compression Systems, and S

Abstract The prevention of concussion and sub concussive injury in helmeted activities are of great military, commercial, legal, and medical interest. A Summation of Tests for the Analysis of concussion Risk, is defined by mapping actual on ice impact data to pendulum-modulated impact conditions at different energy angles, locations, and accelerations. As defined by Virginia Tech STAR equation $\sum(L=1)^4 \sum(\theta=1)^3 [E(L,\theta) \times R(a,\alpha)]$. Linear(a) and rotational(α) acceleration are the only potentially modifiable risks in this equation. For this experiment, a four meter pendulum was closely replicated so interventions can be mapped back to actual player impact data. This year a multitude of protective systems were designed to potentially improve helmet safety. Interventions for this year include a threaded, compression spring design, and tuned magnetorheological systems along with the following Shear Thickening Fluids interventions (1) Calcium Carbonate/Water, (2) Fumed Silica/Polyethylene Glycol, (3) Colloidal Silica/ Polyethylene Glycol, and (4) Polyethylene Glycol(comparator). Helmet constructs were tested for their potential to decrease mean peak linear and rotational acceleration. The internal or external location of Shear Thickening Fluids were explored and confirmed to be an important factor in mitigating mean peak acceleration. When compared to the neat(control) helmets, interventions engineered in this experiment including shear thickening fluids, spring systems, and magnetorheological reservoir designs all significantly out perform ($p<.01$) a neat helmet. These findings point to a likelihood of a reduced concussion risk as a function of linear(a) and rotational(α) head acceleration values, when using these interventions.

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Category **ENEV** **P15** Reducing Carbon Emissions From A Coal Burning Plant

Abstract The purpose of this project is mainly focusing on finding a better alternative for catching the carbon emissions emitted by a coal burning plant. Right now there are limited options for doing this so finding one that performs better that can be implemented on a wide scale would be helpful to the world. The way this will be tested is by simulating a coal plant with a grill that would be burning bituminous coal. The gases emitted will then be pumped through an air compressor to have pressure behind it. The gases will be pumped and filtered through buckets that are full of calcium hydroxide solute, sodium hydroxide solute, soybean oil. The Carbon will be measured in two spots, right before entering the compressor and after being filtered through the 2 buckets. The Soybean Oil performed much worse than the Sodium Hydroxide and Calcium Hydroxide. It caught no Carbon Dioxide and the PPM of CO_2 stayed the exact same. The sodium hydroxide dropped the CO_2 PPM a lot. There was a 77 Percent decrease between the beginning and final amount of Carbon Dioxide. Then there was a 81 Percent decrease between the Beginning and Final Amount of Carbon Dioxide. The Hydroxides has a drawback however seeing as the Hydroxides solute has to be changed out when it all binds with the carbon dioxide. The sodium hydroxide was suppose to create Sodium Carbonate in an Aqueous Solution. Then Calcium Hydroxide was suppose to produce Calcium Carbonate in an Aqueous Solution. It is believed that it did happen but for the Byproduct to be useful, the water and the chemical has to be split.

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Category **ENEV** *P16* The Construction of a Water Purification System

Abstract The purpose of this project was to construct a water purification system using solar distillation. Solar distillation is the evaporation of water and the condensation of the water into purified water. This is very applicable and useful for people struggling to obtain safe drinking water around the world. The apparatus was constructed of poly methyl methacrylate, acrylic mirror, plastic pipe cement, and hinges. The apparatus was built into a rectangular shape with an angled covering. A container was constructed and placed into the apparatus to collect the purified water. A hole was cut in the back of the apparatus and a 12 volt cooling fan was placed in the hole. The fan was attached to a 12 volt battery to supply the fan with energy. The 12 volt battery was connected to a solar panel on the side of the apparatus so that the battery could be resupplied by solar energy. Two heat lamps were placed on the sides of the apparatus to provide heat to the apparatus and allow for evaporation. The fan allows for the temperature to decease in the apparatus allowing for the relative humidity to reach 100%. Around 22.7 liters of water with a purity of 233 parts per million was placed into the apparatus. The purity of water was determined using a total dissolved solids concentration meter. This meter determined the total amount of dissolved solids in the water. Ideal drinking water is between zero and fifty parts per million is obtained using distillation. The system gained heat until condensation started to occur on the cover of the apparatus. Once this occurred, the fan was turned on for an hour. After an hour, the fan was turned off and the system was allowed to regain heat for six hours. This was repeated every day for two weeks. After two weeks the distilled water was extracted and measure to be around 156 mL with a purity of 25 parts per million. This is in the range of acceptable drinking water and is 90% more pure than the contaminated water. This shows that the water purification system is successful and can function without any energy besides solar energy.

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Category **ENEV** *P17* Testing Biodegradable Compounds in Rubber Tire Formulations

Abstract Coffee chaff and eggshells were examined as potential bio-fillers for carbon black due to carbon black's health risks to the average consumer. Different compounds within the coffee chaff were examined and TGA and FTIR analyses were run on the different components of the coffee chaff and eggshells to compare and contrast physical properties between the compounds. Coffee chaff was also incorporated into a rubber formula in order to examine its effectiveness at replacing carbon black. After the ingredients for each rubber sample were run through the Banbury, plaques were made of each sample and tested for their hardness and thickness values. These values were compared to a control (rubber tire formula without coffee chaff) to examine differences and similarities between coffee chaff and carbon black.

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Abstract My project is a Mat Innovation that is used for mounting ceramic substrates in automotive emission control devices.

A catalytic converter is made up of a substrate, mat and metal shell-housing. The mat has to provide enough holding force to counter the back pressure and acceleration forces the substrate will experience while not exceeding the isostatic strength of the substrate.

In a previous project I had designed an automotive particulate filter that had lower back pressure than the filters in production today. Prototype sample testing confirmed the benefits of my innovation. Use of this filter design could save millions of gallons of fuel each year.

However, my triangular cell filter innovation could not go into production due to its strength limitation. This filter has lower isostatic strength and cannot withstand the canning process.

This was the motivation of my Mat Innovation project. I decided to invent a support Mat that provided the holding force at much lower peak canning pressures, thereby avoid crushing the weaker substrates. I first researched the properties and performance characteristics of the existing mats in the market. Using the force balance, I calculated the holding force required for a hypothetical filter. Then using the peak pressure curves of available mats, calculated the pressure the substrate will experience to achieve the desired holding force.

Out of the 16 mats that I investigated, only 5 mats passed the hypothetical case study which was purposely less severe than the actual requirements otherwise no existing mat would have passed. The mats failed either due to high peak pressure or insufficient holding force.

Next, I identified all the critical common features of these down selected mats. I concluded that polycrystalline non-intumescent low binder mats and hybrid mats with low vermiculite performed the best.

High coefficient of friction also allows achieving the required holding force at lower peak pressures. I decided to increase my mat's coefficient of friction by adding fine silica on the surface of the mat and by providing a texture to the mat during manufacturing.

I created a prototype mat design with the identified desirable features. In this polycrystalline non-intumescent hybrid mat I decided to keep the vermiculite on the ceramic side so it heats up faster and fixed the 200 micron fine silica using an adhesive. 3M provided technical support in making the prototype sample.

Testing showed that the peak pressure data of the novel mat was marginally lower than the currently available mats. Due to the optimization of binder, vermiculite etc. I had expected significantly lower peak pressures. However, the coefficient of friction was significantly higher as expected. Using this information I recalculated the safety factor and peak pressures and this novel mat out performed all currently available mats.

This novel mat will provide sufficient holding force for the real world pressure and acceleration forces without crushing the innovative filter and other thin wall substrates. My mat innovation will allow low back pressure substrates to go into automotive production saving millions of gallons of fuel!

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Category *ENEV*   *P19*   The construction of a price reduced 3D printed turbidity meter

Abstract   Turbidity is an underestimated concern when it comes to water quality. Turbidity, how much sedimentation is in water(measured in NTU), is a severe problem when it comes to killing of plants, illness in wildlife, and potential illness to humans. Build up can commonly form from a storm, construction, and natural disasters. The sedimentation in water can be from a variety of different sources: clay, silt, algae, organic material, inorganic material, and other microscopic organisms.

Turbidity is most harmful due to its link of over nitrification of aquatic plants, most commonly algae. When water has high turbidity, sunlight is blocked from reaching plants under the water. This causes plants to die over time from lack of sunlight, which causes the dissolved oxygen level of the surrounding area to decrease drastically. Then the surrounding animal life and plant life die as well. Without an average amount of dissolved oxygen, surrounding life cannot support itself.

Humans can also be affected by high turbidity water. Sedimentation can shield viruses from being filtered. Chlorine and other water cleaning agents cannot kill viruses that surround themselves in turbidity. According to water.nscu.edu,"If the water you are filtering is above the safe amount of turbidity(5 NTU) then the water is not suitable to drink." This can cause an increase in microbial growth and disinfection.

The engineering goal of the project is to code a fully functioning 3D turbidity meter using C++ that gives plus or minus five NTU readings. This means the meter's goal is to be able to read samples accurately, reliably function, and run without any bugs in the code. The researcher believes he will be able to reach his engineering goal.

The procedure of the project will be quite complex. The turbidity meter, electrical board, and casing will be designed and built. The code is built, then tested on the meter. If the readings are what are expected from a commercial meter, then the engineering goal is supported. This procedure happened multiple times due to code being unpredictable and new versions
being made to create the best version possible.

As the results show, the turbidity meter was successful. The range was about plus or minus three NTU. The code was successful after two prototype versions of it. The code also left opportunity for consumers to make their own versions and add things to the board. Arduino is an open environment and all parts used are unlocked so all individuals can make their own modifications. There is also code made for SMS messaging, that was unable to be finished in the time given, but will be worked on and tested.

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Category *ENEV*   *P20*   Comparing the Electricity Output in Microbial Fuel Cells by Bacteria Type

Abstract   This experiment tested the voltage generated by different types of bacteria in microbial fuel cells. Microbial fuel cells are an alternative energy source to fossil fuels and they use organic waste to generate electricity. This is done using bacteria that consume the organic waste and energy and electrons. However, microbial fuel cells are not efficient enough for practical use as the amount of electricity they generate changes over time and the soil bacteria that are commonly used in these fuel cells aren't always easy to obtain in isolated samples. This is why four other types of soil bacteria were used in this project. The types of bacteria that were used were Rhodospirillum rubrum, Clostridium beijerinckii, Pseudomonas putida, and Mycobacterium nonchromogenicum. R. rubrum is facultatively anaerobic and due to the versatility in the ways that it gets energy from food, it was hypothesized that this bacteria would generate the highest voltage.

A different type of bacteria was added to nutrient broth in the anode chamber of each microbial fuel cell. There were three trials, or three microbial fuel cells for each type of bacteria. A multimeter was used to record the voltage generated by each trial for three days. With an overall average of .0707 volts, R. rubrum generated the highest voltage and the hypothesis was supported. The data shows that the voltages generated were low, so in the future an electron- extracting mediator can be tested to improve voltages. This data can help improve the efficiency of microbial fuel cells by providing data on more easily obtained bacteria that can be used in microbial fuel cells.

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Category **MATH   P21**   Bayesian probablity technique to estimate Schziophrenia genes

Abstract   First I will take pre-existing samples from NCBI, which is the National Center for Biotechnology information. The data will be analyzed with Geo2R based on the samples containing Schizophrenia and the samples not containing it. The software will give me the top 250 genes with the highest levels of expression. This will happen for the samples from the superior temporal cortex and the samples from the anterior prefrontal cortex. From that database, I will also take more data sets for laboratory animals. I will take these genes and insert them into String Db to better see the connections in Homosapiens and other species. I then want to use probability distribution techniques like Bayes Theorem to find out if by combining probabilities that come from prior known proteins and current observations in other species, I can predict the proteins and genes that are downregulated or upregulated in humans.

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Strong Matching Preclusion of the Generalized Petersen Graph

Abstract The world wide web, cell phone lines and other technology networks depend on the strength of their networks to connect millions of people daily. Supercomputer networks are used frequently as one of the most powerful computing tools in the world. In the computer science field, it is important to detect the reliability of an interconnection network because the speed and cost of a network often depends on its design.

Graph theory allows for complex networks and processes to be modeled and examined using edges and vertices. The idea of strong matching preclusion within graph theory assists with fault diagnosis, as it can specifically be used to simulate the propagation of outside interference on these large computer networks and to design optimal strategies to protect them from a real-time malware attack. The strong matching preclusion number of a graph is the minimum number of vertices and edges whose deletion results in a graph with neither perfect matchings nor almost-perfect matchings. The Petersen Graph is a strongly regular graph which provides many counterexamples to graph-theoretic statements. One can extend the Petersen graph to a variety of graphs that have many similar properties; these are known as the Generalized Petersen Graphs P(n,k). In this project, the robustness of P(n,k) was shown by proving that the graph will always be strongly matched under specific conditions.

Rather than induction, the principle of casework based on parity was used to investigate the graph due to the infinite amount of base cases necessary. This more technical approach is direct and efficient; it provides insight towards other methods applicable to a related set of problems. Furthermore, the greedy algorithm was used to optimize our solutions.

The class of Generalized Petersen Graphs can be extended to a 3D network which can be used for parallel computing. As shown in this project, this type of network is one that is extremely stable and efficient, even during node or connection failure. The findings in this project will allow for more effective high speed parallel and quantum computing.

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Category **MATS** *P23* Optimization of Electro Pulsing on 3Y-TZP Ceramic Water Filter Sintering

Abstract This project includes the utilization of electro pulsing to optimize the production of ceramic filters, specifically Yttria-Stabilized Tetragonal Polycrystalline Zirconia (3Y-TZP). Due to the versatility of this ceramic, pore sizes can be controlled to filter out particulates, bacteria, viruses, and other pathogens. However, current ceramic sintering processes require long sintering times and extensive energy costs when heating furnaces at high temperatures. Furthermore, current ceramic water filters are unable to attain the miniscule pore sizes required to filter viruses. This study sought to shorten sintering time, reach a target pore size of 20 nanometers, and achieve full density. The sintering process was optimized by varying voltage, duration, and electro pulsing frequency. At 40V, 10 microsecond pulses, and 70 Hz at 1400°C for 3000 minutes, the microstructure data showed that the pore size did achieve 20 nanometers and full density. Activation energy of space-charged clouds increased to slow the grain growth, which allowed full density at a smaller pore size. In addition, the sintering time was decreased from 7200 minutes to 3000 minutes, making the process very cost-effective. The use of electro pulsing to produce ceramic water filters is an efficient method and allows for potable drinking water to be more accessible.

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Category **PHYS** *P24* Tharsis Montes:The Search for Palagonite and Its Implications for Martian Life

Abstract The Tharsis Montes are a group of three shield volcanoes located near the equator of Mars, centered around 332°E, -40°N. This region has been described as having glacial and volcanic activity during the Amazonian Era. These glaciovolcanic interactions could have created habitable aqueous environments in the late history of Mars.
Palagonite is an alteration mineral that is often formed from volcanic glass. Researchers believe that palagonite on Earth is often biogenic in its origin. One goal of this research was to find if palagonite exists on Mars. Investigators have not yet found palagonite on the surface of Mars. The spectrum of palagonite is hard to distinguish as it closely resembles the spectra of other hydrated silicates. So, another research goal is to create a set of criteria to distinguish palagonite spectra from its look-alikes.
A total of 364 HiRISE images were examined for indicators of ice-volcanic interactions, such as inverted terrain, ice cauldrons, and glaciovolcanic edifices. These areas were then analyzed using online spectral libraries and spectra from the CRISM instrument to find possible spectra of palagonite in the given area.
Out of 40 spectra examined, 3 putative palagonite spectra were found in three different areas in the Tharsis Region as a result of this research. Along with this discovery, an algorithm was set to determine palagonite from look-alikes so future researchers will have a more streamlined process when searching for palagonite. This algorithm includes looking at the overall form of a certain spectrum and its major absorption bands in relation to the spectra of palagonite and its mineral associates.

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Category **ROBO** *P25* Intelligent Stock Investing

Abstract The purpose of this study is to use machine learning to write and test a strategy that will be implemented in a program that can intelligently invest in the stock market using five different stock picking strategies. The final goal is a strategy that will profit even during changes in the stock market, by using different methods for picking stocks. This study uses stock data from 1950 up to and including 2016, as well as Corporate bond data, and formulas for value, growth, income, GARP, and Dogs of the Dow stock picking strategies. Profit will be calculated by percentage of original money. This study will provide information regarding the field of machine learning in computer science, as well as providing information regarding investment strategies for the stock market.

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Category **SOFT** *P26* Random Student Selection

Abstract   Teachers always have cups full of popsicle sticks placed on their desks that help them pick on students. "To call on students randomly or equitably, some teachers use cards or craft sticks with students' names on them." Not all teachers take advantage of these utensils anymore. Nowadays, everything is done on computers and displayed on electronics.

Currently, there is an application that helps teachers select students. The application is called Popsicle Sticks: Teacher Picks. The application also helps place the students into groups. This process is done randomly. The only concern with the application is, "does the application meet the teachers' needs?" The teachers who used this application, informed the researcher that it does not exactly help in the best way possible. The main problem with the current application is that it only fulfils the minimum needs. For example, the application limits teachers to create only five groups that students would be placed in. When teachers need more groups, they will have to purchase the privilege to assign more groups.

The researcher of this project plans to make a better application. The education of children is important to many people. An easy way to keep children engaged and alert is to select their names randomly. In this practice, students should be paying attention at all times. For this action to happen, the teachers would give the students attention to show the students how important paying attention is. When students see other classmates participating, they will feel more encouraged and comfortable to share their ideas.

A better application that allows teachers to work freely in their classrooms will help them out to positively impact their students' learning. Using the improved application, teachers will find a big difference in their students' learning trend. Staying in contact with students helps teachers determine where their students stand academically. At that point, teachers will plot a detailed plan to improve their teaching skills.This strategy would help students to develop stronger background and enhance their way of thinking.

Technology plays an important role in students' educational career, especially in the era of technology. The researcher hopes that the improved application will benefit teachers and students comparably. The improved application is created through a website that helps create apps; it is called MIT App Inventor 2. This website is the best choice because it is easy to use compared to other websites and many new features to create an application are found on App Inventor. The researcher took the teachers' concerns in consideration as the application was in the process of being created. The teachers provided qualitative feedback via survey after they tested both applications, the original application and the improved application.

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Category **SOFT** **P27** An Integrated Approach to Novel TSP-Based Clustering
Algorithms

Abstract Clustering is a concept that involves creating or finding structure within
unstructured data. Given an arbitrary set of data points, clustering
algorithms have the goal of organizing these points into sets, with
different algorithms trying to accomplish different tasks. DBSCAN and K-
mean clustering are the two most common, with DBSCAN clustering
attempting to find clusters based on radial distance from core points, and
K-mean clustering forming sets using the least distances to the K-center.
Main issues with clustering algorithms include timeliness as many are NP-
hard and the arbitrary nature of the data set and conditions make many
variations of algorithms.

The traveling salesman problem is a problem where a salesman must
travel to all the cities presented exactly once and arrives back at his
starting point. The solution is the path that is of the least length, and this
type of linear optimization problem is considered NP-hard.

For my project, I have combined the ideas of TSP and clustering
algorithms. Using Java, I wrote a program implementing the greedy
algorithm, specifically nearest neighbor, of constructing TSP solutions.
That method is combined with the DBSCAN method of clustering
algorithms to find the number of clusters that will be formed given a
maximum tour. The K-means clustering algorithm is modified to find the
optimal method of clustering data points to minimize the average tour
length. These methods are proven to work and compared to the status
quo using random data, and empirical is given to prove the superiority.
This algorithm is very useful in fields involving shipping and networking,
in which there may be one agent for a cluster of clients, so it would be
useful in finding how to assign such agents to clients. Additionally, I have
programmed it so that it is very easily modifiable and can be used in multi-
dimensional analysis.

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Category *SOFT*   *P28*   Eco-Friendly Lithium-ion Battery Reuse via Intelligent Energy Harvesting

Abstract   Battery is an electrochemical cell for providing electric power as needed, and rechargeable battery is a secondary cell that can store excess energy from renewable energy sources. Based on a study performed by Navigant Research, the worldwide revenue of one common type of rechargeable batteries, Lithium-ion (Li-ion) cells, is expected to reach $26 billion US dollars in 2023 due to its wide applications. However, there have been numerous concerns with respect to the availability of Lithium, an element crucial to the production of Li-on batteries. The current processing activities at recycling facilities are limited to the cell destruction for recovering chemical elements in batteries with three shortcomings: a) restricted accessibility: only few facilities available worldwide for element recovery; b) economic non-viability: element recovery cost higher than mining the elements; and c) waste of resources: undifferentiated destruction of both good and bad cells.

In this project I uncovered a brand-new method that can be used to sort 18650 Li-ion batteries in large quantity and in real time for harvesting used cells with enough capacity for battery reuse. After a large number (about 170) of battery cells were collected from a battery recycling facility, internal resistance and capacity tests of these cells were conducted as a reference point for comparison with a novel degradation-based method based on X-ray radiographic scanning and digital image contrast computation. The test results indicate that the sorting accuracy of test cells is about 81% with composite indices and 87% with machine learning. The execution time of my algorithm is at a level of 100 milliseconds, making the method a real-time solution for harvesting the remaining energy in good used cells with a potential multi-million-dollar market. This method will potentially be a breakthrough to the lithium battery recycling process and the energy conservation of our eco-system through the sorting process that reduces the need to produce new Li-ion batteries.

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Category *SOFT* *P29* Cloud-based Data Preparation for Medical Observational Research

Abstract The future of healthcare lies in endeavors such as precision medicine where treatment options, clinical decisions, and preventive techniques are tailored to patients based on their exact characteristics. For these advancements to be made possible, clinical data collected from the health records of patients in medical facilities must be obtained for analytics and observational research.

Electronic health records (EHRs) are the optimal source of data for medical observational studies, but, unfortunately, current practices for retrieving relevant EHRs lack automation and efficiency. Clinical data mining is a complex endeavor due to the lack of standardization and structure in the natural text comprising health records. In addition, stringent patient privacy requirements at various organizational levels further complicate procedures for preparing data for observational studies.

An autonomous, decentralized, privacy-enabled architecture incorporating a novel semantic similarity algorithm is created for automated EHR retrieval in this project. The semantic similarity algorithm has high values of precision and recall, indicating that clinical records relevant to an observational study's specifications are retrieved. Furthermore, the addition and removal of data-contributing medical facilities does not impact data retrieval at other nodes. Sensitive information present in the EHRs such as a patient's social security number and name is identified and removed before retrieval via an ontology-guided approach. This project promises to reduce the time required for data preparation for observational research from months to minutes.

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Category **SOFT** *P30* One For the Road: A Texting Management App to Promote Safe Driving

Abstract In 2015, the U.S. Department of Transportation reported that of 30,057 fatal crashes in the U.S. during 2013, 411 were involved cell phone use as a driver distraction. This accounts for 14% of all distraction-related fatal crashes. The principal problem of cell phone distraction is its use as a medium of communication; upon operating a motor vehicle, many drivers, as evidenced by the DTS compiled accident data, do not cease their use of cellphones. Two key solutions come to mind to combat this problem: either deactivate cell phone use temporarily while the vehicle is under operation, or introduce a way for the phone itself to notify people sending messages to the user that said user is driving. The latter solution has yet to be attempted; thus, the purpose of this project was to create integrated cell phone software that allows a phone to detect when it is being used in a moving vehicle and subsequently alert those in communication with the driver that the person in question is operating a vehicle. The app will be designed in Java to seamlessly run in the background of a phone's operating system (Android OS only) upon being started, measuring movement speed via the phone's accelerometer and triggering a conditional response should the phone's speed exceed a set limit. Thus, those in communication with the driver would be dissuaded from texting them, reducing distraction and potentially saving lives.

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