Michigan Technological University

2025

Undergraduate Research & Scholarship Symposium

Welcome to the 2025 Undergraduate Research & Scholarship Symposium!

Research is about curiosity—asking bold questions, pushing boundaries, and uncovering new possibilities. Today, you have the opportunity to experience that firsthand as Michigan Tech's undergraduate researchers share the exciting discoveries they've made over the past year.

Each student presenting today has embarked on a journey that is both exhilarating and demanding, guided by dedicated faculty mentors who have supported them through the challenges and triumphs of the research process. From late nights in the lab and meticulous fieldwork to analyzing complex data and refining their conclusions, these students have embraced the persistence and creativity that research demands. Their work has the power to spark innovation, deepen our understanding of the world, and shape the future in ways we have yet to imagine.

The projects you'll see today span a vast range of disciplines, demonstrating the incredible breadth of research and scholarship opportunities at Michigan Tech. Many of these students have been supported by programs such as the Summer Undergraduate Research Fellowship (SURF) and the Undergraduate Research Internship Program (URIP), with generous funding from the Copper Shores Community Health Foundation, the DeVlieg Foundation, the Great Lakes Research Center, and the Tech Forward Initiative on Sustainability and Resilience. Their support, along with the guidance of faculty mentors and the encouragement of families, departments, and colleges, makes this work possible.

As you explore the symposium, I encourage you to engage with these researchers—ask questions, challenge ideas, and let their passion inspire you. Whether you're here as a mentor, a peer, or someone simply curious about the world, your conversations today contribute to the learning and growth of these students.

Enjoy the discoveries, the ideas, and the potential that fill this space. The future of research is right here—let's celebrate it together.

Sincerely,

Marika Seigel
Dean, Pavlis Honors College

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101. Patient Care Language Model

Student Presenter: Noah Provenzola, Computer Science
Faculty Advisor: Leo C. Ureel II, Computer Science

Author: *Noah Provenzola*

Introduction:

During the last year, there have been many areas of development for this research project. From data extraction of healthcare provider information with a functional User Interface (UI) to the language model capable of following chain of thought reasoning, this project is close to being a fully functional system. While developing these programs, the main area of testing has been to see the possibilities of statistical models in language generation. With many patients experiencing at home recovery and care, this system can provide a means for patients to inquire about their current health and recommended actions. Having the patient's information being effectively utilized by the model, the response should be accurate and concise. Should the patient need medical attention, the model would be able to provide reasonable guidance on the importance of contacting a medical professional or healthcare provider.

Materials and Methods:

During the production of this educational dialog based system, most of the development was done in Visual Studios with a focus on Python as the primary programming language. There were many libraries used in the development of this system. The following libraries were used:

- "Flask" for front end development on client interface
- Streamlit for Python front end development on provider interface
- "os" for interaction with the operating system
- "random" for variability in the language output
- json for data storage
- NLUMODEL for natural language understanding networks
- spacy for predefined libraries.

Results and Discussion:

With further development of this system, the goal is to improve coherency, accuracy, and user customization. By breaching the gap between the neural networks understanding of user queries and the statistical model's chain of thought reasoning, the model should be able to elaborate on given inquiries and concerns. With utilization of patient information from the database, the model should be able to elaborate on specific inquiries for each patient and their given situation. These technologies have great potential in markets where older populations have difficulties following and recalling physician recommendations. A language model can help to guide unsure patients on their individual needs.

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102. Typical and Atypical Burial Practices in Germany and Michigan

Student Presenter: Victor Wiesen, Mechanical
Faculty Advisor: Stephanie Rowe, Humanities

Authors: *Victor Wiesen, Stephanie Rowe*

Introduction:

In burial there is usually one option given: the typical burial or cremation. These burial types often involve embalming which use chemicals like formaldehyde, phenol, and glutaraldehyde. These are carcinogenic and toxic. Alternatively, atypical methods involve burying without chemicals and using a biodegradable casket. With a lack of information on perceptions of atypical methods, we have questions like “Why are typical methods favored more than the atypical?”. Our goal was to collect and compare viewpoints on these methods, and to help funerary professionals understand, highlight or advocate for the atypical option.

Materials and Methods:

Our Research used qualitative and ethnographic methods. Before researching I looked into various people and companies to reach out to as well as make a timeline. This allowed us to stay on track and have smaller deadlines for our research. As for our main data gathering, we interviewed people through semi-structured interviews. In a semi structured interview we ask questions that are written before the interview as well as thought of during the interview. In order to prepare for these interviews we researched how to conduct, perform, and speak in an interview. This prepared us to keep a professional and ethical atmosphere.

Results and Discussion:

Our research results were split into two general categories, Germany and Michigan, and then compared to each other. For Germany we found that in similarities to America, there are people advocating for things like human composting. Which last we knew was only legal in one of Germany's states. Germany does offer other forms of burial, but because in Germany you cannot be a private person and hold remains; they have to be buried. This law also is for cremation ashes. Unlike in Germany, Americans can hold ashes, and even spread them. As for alternative burials (Atypical) there are actually three types: natural, hybrid and conservation. Natural Burials are only atypical burials, which are burials that are directly in ground with no coffin/casket or embalming. Conservation’s type has two main functions one being an atypical burial site with its second function being land conservancy. Lastly, hybrid's which is a typical site, has tombstones and caskets, with a section for atypical. Overall, there are many differences between us, but what brings us together is that people are advocating for a better alternative to our burial systems and our way of being laid to rest.

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103. Heparin Affinity Chromatography for The Separation of Baculovirus From Vaccines

Student Presenter: Madison Baldwin, Chemical Engineering
Faculty Advisor: Dr. Caryn Heldt, Heldt Bioseparations Laboratory

Authors: *Madison Baldwin, Luis Alberto Mejia, Taravat Sarvari, Lynn Manchester, Justin Sargunas, Dylan Carman, Bradley Priem, Michael Betenbaugh, Caryn Heldt*

Introduction:

In vaccine production, influenza has traditionally been cultured in chicken eggs which carry the risk of allergic reactions to the egg proteins [1]. Additionally, this method has proven difficult to scale up in production because it takes one to two eggs to make a single dose of the influenza A vaccine [2]. When cultured in cells, instead of eggs, the antibodies a patient produces better match the virus and are more effective in combating disease progression [3]. We are designing a process to purify virus-like particles (VLP) grown in insect cells to produce an improved influenza A vaccine.

Materials and Methods:

The cell culture supernatant will be applied to a heparin chromatography column, and we will optimize the method for separating influenza VLPs from baculovirus. 5 mL of the sample will be injected into an AKTA Pure chromatography system with a 1 mL column of heparin resin. We will test loading conditions by changing the flow rate (0.5-1 mL/min). Washing conditions will be different concentrations of salt (NaCl or NaSO4) adjusted between experiments for optimum purity. Finally, elution conditions will be tested with increased salt conditions. Both continuous and step salt gradients will be utilized in the optimization. Fractions will be collected during the chromatography and the initial loading to be analyzed. The samples will be analyzed for VLP titer by MTT assay. Baculovirus concentration is detected by a flow cytometer method that florescent antibodies measure the virus infection [4]. Contaminants in the form of protein will be measured with the Bradford assay from Thermo Fisher. Through quantitative analysis, we will determine the virus purity and recovery for determining the performance of the applied strategies.

Results and Discussion:

This research is still ongoing. As described in the introduction, the success of this project could lead to an influenza A vaccine that is both easier to produce and more effective at combatting disease progression.

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104. An Analysis of Egg Volume Using Narushin's Model With A Comparison of the Relationship Between Egg Storage Methods and Rate of Mass Decay

Student Presenter: Erica Kazin , Chemistry
Faculty Advisor: Loredana Valenzano-Slough, Chemistry

Authors: *Erica Kazin, Loredana Valenzano-Slough*

Introduction:

Eggs are prolate spheroids, ellipsoids with one tapered end. Due to their unique shape, a formula for a standard geometrical shape does not apply. To approximate the volume, the generic formula for volume of an ellipsoid is utilized, with a different leading coefficient to account for the tapered end of the egg, highlighted below. This study uses Narushin's Model to calculate the volume of eggs based on length and breadth and compares the calculated volume to the measured volume. The second part of the project determines how the storage temperature of the eggs can impact the rate of mass decay.

Materials and Methods:

Two dozen Grade A eggs were utilized in the experiment, each egg was measured in length and breadth using a set of calipers. Narushin's Formula was used to calculate volume. The measured volume of each was found using the water displacement method. The calculated and measured volumes were compared to determine accuracy of Narushin's Formula. For the second part of the project, one carton of a dozen eggs was placed in the fridge and one dozen on the counter. The mass of each egg was measured weekly for an 8-week period. The rate of mass decay for each carton of eggs was calculated and compared amongst storage conditions.

Results and Discussion:

For the first part of the project, the average percent error of the measured volume vs. calculated volume was 1.27%. For possible extensions, one could replicate the experiment with eggs of different background, and further apply the method to other areas of research, such as in wildlife biology applications to determine existing correlations between egg dimensions and embryo viability. In the second part of the project, counter eggs lost an average of 0.63 g/week, while fridge eggs lost 0.10 g/week, indicating that eggs stored at room temperature decay at a rate 6.3 times that of fridge eggs. In additional applications, one could perform the experiment with eggs held at a wide temperature range and at smaller increments to find a more precise analysis of how temperature impacts egg mass decay.

105. Living Memorials and Their Potential for Community Connections and Representative Memorialization

Student Presenter: Grace Murray, Policy and Community Development
Faculty Advisor: Dr. Mark Rhodes, Michigan Tech Department of Social Sciences

Authors: *Grace Murray, Mark Rhodes*

Introduction:

Living Memorials, or monuments, memorials, or commemorations which are ecologically rooted, contain unique opportunities to explore biographical history and the potential for deeper community connections. In this study, I focused on fruits and vegetables named after someone who was not involved with the discovery or development of the plant. Living Memorials provide an opportunity to form new relationships with our community, the past, and with ourselves.

Materials and Methods:

Over the past summer I engaged with my local community in Houghton Michigan through surveys and autoethnography at the weekly farmers market. At the market I gave out seeds, produce, and plant starts of three different living memorials named after women: the Lady Di Runner Bean, the Alice Roosevelt Tomato, and the Evita Strawberry. We gave out optional corresponding anonymous surveys. They were one page long and offered on both paper and on IPads at our booth at the market. Surveys were also offered online via a QR code received with stickers on each receivable. These stickers also displayed biographical information and information about plant care and seed saving. We also offered an optional follow-up survey sent via email three to four weeks after our first interaction with the participant. This survey was also about a page long and asked questions regarding what the individual ended up doing with the plant and any changes in communication or knowledge that the interaction with us may have led to.

Results and Discussion:

My findings indicate that by synthesizing pre-existing connections with food, lived experiences, and with each other, living memorials can create new and deeper community connections and conversations about the past. By the end of the data collection period. I gave out over 150 seed packets each containing between 8 to 10 seeds. I also gave out more than 50 plant starts and 5 produce items. From this we collected 119 corresponding surveys, having approximately a 50% survey return rate. The surveys and journals gave us the data necessary to learn more about how people were interacting with the Living Memorials and to confirm our hypothesis about Living Memorials potential.

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106. Fabrication of Distributed Feedback Laser Based on Superfluorescent Quasi-two-dimensional Perovskite

Student Presenter: Austin West, Physics
Faculty Advisor: Jae Yong Suh, Physics

Authors: *Austin West & Jae Yong Suh (Advisor)*

Introduction:

While research has been conducted on distributed feedback (DFB) lasers that use photoluminescent gain material, little is known about using a superfluorescent gain material. By combining superfluorescent quasi-two-dimensional perovskite with a DFB resonator, light output that is proportional to the square of the number of emitters is possible [1]. Thus, an efficient novel lasing device can be created to improve optoelectronic applications such as LEDs, on-chip lasers, and fiber optic networks [1, 2, 3]. This project aims to fabricate DFB resonators to serve as the basis for these lasing devices via a series of processes, including laser interference lithography, reactive ion etching, and gain material spin-coating.

Materials and Methods:

The manufacturing process for a DFB resonator begins with 1 in. squares of 0.5 mm thick silicon wafer, which are cleaned via sonication. The samples are vapor-coated with a primer to promote the adhesion of a positive photoresist, which is spin-coated. Laser interference lithography (LIL) is used to expose the sample to an interference line pattern from an ultraviolet laser with ~250 nm periodicity. The photoresist that is exposed to the bright lines of the pattern is softened, allowing a developing solvent to strip it away and leave a microscopic periodic trench pattern (grating structure) in the photoresist. Next, deep reactive ion etching (DRIE) is used to etch this trench pattern into the silicon substrate, and the remaining photoresist is removed via oxygen plasma etching. Polydimethylsiloxane is poured onto the silicon to create a reusable mold, and polyurethane is poured onto this mold to produce the DFB resonators. Finally, quasi-two-dimensional perovskite is spin-coated onto the DFB resonators, and the finished products can be tested for lasing and optical properties.

Results and Discussion:

At the time of writing, only preliminary results are available. Scanning electron microscopy (SEM) was used to confirm the successful creation of the microscopic periodic grating structure in the photoresist. The structure is not completely uniform across the surface, but only small (a few millimeters) uniform areas are required to produce results. The periodicities of the structures measured using SEM closely match the theoretical periodicities. DRIE tests have begun, but more testing is necessary to achieve the desired structure depth. Once successful, the remaining manufacturing steps will be followed to create complete DFB resonators. The optical properties of the resonators will be studied using time-resolved photoluminescence (TRPL) and compared with those of the quasi-two-dimensional perovskite. A difference in the radiative decay rates of the DFB resonator and quasi-two-dimensional perovskite will indicate a successful matching of the perovskite emission wavelength and DFB periodicity. TRPL data may also demonstrate evidence of superfluorescence. Finally, by pumping the DFB resonator with a high-power laser, evidence of lasing can be observed. Adjustments will likely need to be made to the periodicity of the DFB resonators, which can be easily accomplished by adjusting the angle of incidence of the laser in the LIL setup.

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107. Understanding thrombosis risk in coronary artery aneurysms and ectasia

Student Presenter: Emily Hyatt, Biomedical Engineering
Faculty Advisor: Dr. Hoda Hatoum, Department of Biomedical Engineering

Authors: *Emily Hyatt, Hoda Hatoum, Simon Lee, John Kovalchin, Mohamad Alkhouli*

Introduction:

Kawasaki Disease (KD) is an inflammatory condition involving systemic inflammation and vasculitis of medium-sized arteries in infants (1-18 months) and young adults [2]. Coronary artery ectasia (CAE) are dilations of the artery that compared to the neighboring artery diameter are 1.5 times larger [2]. These abnormalities can be mild dilation and ectasia or more severe fusiform or saccular aneurysm formation [2]. Coronary artery ectasia has been shown to increase risk of cardiac death or myocardial infarction by three to five times [3]. The World Health Organization estimates that cardiovascular disease (CVD), such as Kawasaki's Disease, claim 17.9 million lives annually and is the global leading cause of death [1].

Z-scores are recommended to assess ectasia severity relative to body size by AHA 2017 guidelines [2]. They are statistical metrics that are based on the diameter of the CAE only. Literature however showed that in addition to diameter, flow dynamics and morphology may also play a significant role in thrombosis risk [2]. Our goal was to generate simple mathematical equations that correlate the hemodynamic parameters that relate to thrombus formation as a function of the CAA and CAE morphology using a combination of computational fluid dynamics (CFD), patient-specific modeling, and response surface method approach. As well as exploring potential therapies.

Materials and Methods:

We started with a design of experiments, using central composite design (CCD), which determined 125 models were the optimal number of models and simulations needed to be performed while spanning the full design space of the 3 most important geometric parameters (neck size, diameter of CAA and CAE, and length. Then, we constructed these models following the dimensions range provided by CCD using SolidWorks 3D Modeling. For the inlets and outlets we added extensions that are 10 times the neck diameter.

We ran CFD simulations for each of the models using ANSYS, and calculated the hemodynamic parameters that correlate with thrombosis as described above: TAWSS, OSI, and RRT. We used a laminar flow model with a mesh element size of 0.3 determined by a mesh independence study. The boundary conditions we used were velocity for the inlet and pressure for the outlet determined from literature [2]. We used the Carreau model for viscosity because the diameter of coronary arteries is small fitting the criteria for when blood exhibits non-Newtonian properties [4].

Once the simulations were complete, we compared the effects of the different diameters and lengths of the CAE models and saw how the results vary depending on neck diameter, aneurysm/ ectasia diameter, and the length of the aneurysm/ ectasia. We first used response surface method (RSM) to generate the mathematical expressions that express each of the hemodynamic parameters as a function of the neck size, CAA and CAE diameters, and length. However, we switched methods to Kriging instead of RSM which gave us better results.

Results and Discussion:

The model statistics for TAWSS and OSI are 0.94604 and 0.90472 respectively for the R^2 value showing promise in a robust predictive model. Figure 1A and 2A both show the actual vs predicted values for TAWSS and OSI. Figures 3A and 4A show how TAWSS and OSI change as the neck diameter is fixed. Figures 5A and 6A show how TAWSS and OSI change as the ectasia/ aneurysm diameter is fixed. Figures 7A and 8A show how TAWSS and OSI change as the length is fixed.

To determine if a pediatric patient should be administered anti-coagulation therapy, only the diameter of the CAE is the determinant in clinical settings up to this day. Having said that, not all centers administer anti-coagulants to pediatric patients. By generating a simple predictive model for thrombotic potential in coronary ectasia that clinicians can implement immediately as part of their management and pre-procedural planning for KD, more insight into whether thrombosis is likely to form or not will be gained, and therefore, whether a patient will be on anti-coagulation therapy will be determined more accurately. We are still in the process of running simulations of the effect of anti-coagulants on the flow of blood.

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108. Impacts of the conversion of northern white cedar swamps to alder cover on cedar peat.

Student Presenter: Ashdon McDaniel, Applied Ecology and Environmental Science
Faculty Advisor: Dr. Rodney Chimner, College of Forest Resources and Environmental Science

Author: *Ashdon McDaniel*

Introduction:

Cedar (Thuja occidentalis) swamps are an important peat forming forest type in the Upper Great Lakes Region due to their large carbon stores. Cedar trees have been historically harvested for their valuable timber, which has resulted in cedar failing to regenerate in some sites. In these sites, alder (Alnus incana) has replaced cedar as the dominant plant cover. Uhelski et. al. (2022) showed that differences in vegetation cover also result in differences in peat quality. The change in vegetation cover could alter the characteristics of the cedar peat and make these carbon stores more vulnerable to carbon losses.

Materials and Methods:

A total of 6 sites were measured in the western Upper Peninsula of Michigan. Two sites for each of the site types. These site types were intact cedar, harvested cedar converted to alder, and intact alder. In each site, one peat core was taken to a depth of 50 cm when possible. Peat cores were then subsequently frozen, segmented, dried, and ground for analysis. CH4 fluxes, bulk density, and loss on ignition were measured to quantify changes to the peat's characteristics. Closed chambered methods were used to measure CH4 fluxes. Peat quality was analyzed with diffuse reflectance fourier-transformed infrared spectroscopy. Four indices, previously used in Uhelski et al. (2022), were created from the DRIFT spectra to quantify peat quality differences. These indices compared relative changes in the composition of lignin, carbonyl, lipids, polysaccharides, carbohydrates, and aromatics. C/N ratios were measured with mass spectroscopy to observe changes in peat composition.

Results and Discussion:

While the data is yet to be fully interpreted, trends in the data do indicate that the conversion of cedar cover to alder cover, as a result of timber harvesting, has an impact on the cedar peat. Firstly, the results from the C/N ratios suggest that alder litter is contributing to the peat's composition in the top 15 cm in the soil profile. In the converted site C13% was more similar to the organic soil found in the alder site than the intact cedar site at the soil surface. C13% in the converted site's peat then returned to levels found in the intact cedar site peat as you got deeper in the soil profile. Additionally, the presence of alder in the converted site appears to have increased the emission of CH4. CH4 emissions were found to be highest in converted sites, followed by alder sites, with intact cedar sites having the lowest CH4 emissions. However, the significance of the CH4 flux data is limited, likely due to the small sample size used.

109. Adding Nuance to the IPL Immigration Index: Qualitative Methods in Refugee Integration Research

Student Presenter: Erin Loeschmann, Sustainability Science & Society; Anthropology
Faculty Advisor: Dr. Kathryn Hannum, Department of Social Sciences

Author: *Erin Loeschmann*

Introduction:

The Immigration Policy Lab (IPL-12) Integration Index is a twelve-question qualitative metric developed by Stanford University to understand levels of immigrant integration. It is a survey questionnaire that captures six variables of integration: psychological, navigational, economic, social, linguistic, and political integration. (Harder et al. 2018a; Harder et al. 2018b). This project implements a mixed-methods approach, incorporating qualitative interviews alongside the quantitative IPL-12 to understand the barriers to and enablers of successful refugee integration in Southeast Michigan.

Materials and Methods:

The qualitative interview questionnaire was developed by a team of researchers from Michigan Tech, Stanford University, and Global Detroit, a non-profit that works to promote successful refugee integration in Southeast Michigan. Global Detroit connected the research team with refugee agencies (RAs) to receive participant input on the development of this survey, an approach known as Participatory Action Research (PAR) (McIntyre 2007). The RAs additionally assisted our team by connecting us with willing and eligible participants in this study. Participant eligibility was characterized as participants who were at least eighteen years of age, of refugee or similar legal status, and who had lived in the United States for no more than ten years. Interviews were conducted over Zoom and student interviewers used the OtterAI software for confidential transcription, upon consent of refugee participants. Interview transcripts were anonymized andqualitatively coded using the NVivo software and with a codebook developed through a deductive approach to refine the theoretical underpinnings of the IPL-12. Interview transcripts were coded for themes such as national identity, social networks, navigation, and language fluency.

Results and Discussion:

This study is ongoing, and current findings are preliminary. However, through the qualitative coding process, key themes have emerged. One emerging theme is the tapering off of refugee services. Refugee services are fantastic at meeting immediate needs upon arrival. Once the refugee services end, new or unexpected barriers to integration appear and informants find themselves unprepared to face them.

"When I first came, the organization made our appointments so we didn't face any troubles. Then we started making our own appointments… It got harder to book appointments on our own." (2_NA_46).

Additionally, many participants have stated that language is a significant barrier to navigating American systems.

"It's hard for me when I want to make an appointment, cancel an appointment or reschedule the appointment because I do not speak English." (13_NA_39)

A second emerging theme is the idea of nested identities, in which a person may hold multiple layered identities (Herb & Kaplan 1999)).

"I am Ugandan. My native sense remains…For right now, [America] is where I belong. I pay taxes, I work, this is home now." (16_SSAF_48)

Our team will be continuing to explore these emerging themes through a large N panel survey.

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110. Leveraging Machine Learning Algorithms for Drone-Based Snow Monitoring on Solar Panels

Student Presenter: Zoe Mazurkiewicz, Computer Science and Mathematics (one major)
Faculty Advisor: Dr. Ashraf Saleem, Computational Science and Engineering

Authors: *Zoe Mazurkiewicz, Ashraf Saleem*

Introduction:

Climate change is an important topic that affects everything and everyone. It affects our agriculture, the world's ecosystems, and the weather. Climate change also affects how and where we live. Our smallest day-to-day actions have so much effect on our rapidly changing climate. We can see these effects already in Houghton with a decrease in the amount of snow and an increase in temperatures.

The problem with a lot of renewable energies is that they are not always operating at their most efficient level. In snowy climates, the snow can limit the production of energy from the solar panels, especially in Houghton. On the very rare sunny days, it can make a big difference in how much electricity is produced by solar panels. If this is a huge field of solar arrays, then a large amount of manual labor would be needed to maintain them. With technology ever evolving, we can use it to help make maintenance of solar arrays more efficient.

Materials and Methods:

We used the detection algorithm called You Only Look Once (YOLO) as our base algorithm. Before we started to develop the algorithm, images had to be annotated with classes that the algorithm needed to detect. I annotated thermal images with two classes, "solar-panel" and "uncovered-solar-panel". The solar panel class is the solar panel whether it was covered or uncovered. The uncovered solar panel class is the part of the solar panel that didn't have snow covering it.

Once all of the images were annotated they were separated into three categories: training the algorithm, validation of the algorithm, and testing the algorithm. The training class was the algorithm learning the classes that we wanted it to learn, being the solar panel class and uncovered solar panel class. Then the validation of the algorithm is the images that are given to the algorithm and the algorithm will guess and it is told whether it is correct or not. The testing images were images it has never seen before and we give the algorithm the images but not the annotations to see how well the algorithm learned.

Results and Discussion:

At first we tried to segment the images right away. Segmenting images uses the pixels of the image to determine the exact shape of the classification in the image. This did not provide us with the results that we were hoping for. The mean average precision was very low for all classes and the average of all the images.

We then took a step back and decided to have the algorithm detect using bounding boxes on the images. Bounding boxes are a rectangular frame that contains the object the algorithm is trying to detect. When we restricted detection to this, we got significantly better results. Because of these results we moved onto doing this with combined RGB and Thermal images.

I have continued with the project and now we have decided to exclude thermal images because of the average, recall, and precision, not being as high as we would like it to be. But we will be using the RGB results that were done earlier in the year.

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111. Use of Generative AI within the College of Computing

Student Presenter: Rosencrantz Siebigteroth, Computer Science
Faculty Advisor: Briana Bettin and Leo Ureel, College of Computing

Author: *Rose Siebigteroth*

Introduction:

Generative AI such as ChatGPT has had a significant boost in popularity in the past few years. With it being integrated into search engines, chat bots, and study sites, generative AI has become an unavoidable technology. There has also been discourse on how the ability to generate human-looking answers and/or solutions to homework problems could be affecting students. Since this is still a novel topic, there is not much existing research on how generative AI is affecting student learning, how students are approaching the moral dilemma of using AI, and how AI could be disproportionately affecting certain groups.

Materials and Methods:

This study consists of two parts: a review of existing literature on the topic of student generative AI use and a survey. The survey consists of 15 questions about how students feel about generative AI and how they are using it in their studies.

Results and Discussion:

Research is still ongoing as I collect survey responses, but I anticipate the survey will give insight into how students are using generative AI, any challenges they may be facing and who may be more affected by these challenges, and the effects that generative AI is having on student learning. Information gathered could be used to help create guidelines for healthy and effective use of generative AI in a classroom environment.

112. A Preliminary Investigation of Geologic Hydrogen Presence within the Upper Peninsula of Michigan

Student Presenter: Sam Jensen, Applied Geophysics
Faculty Advisor: Radwin Askari, Geological and Mining Engineering and Sciences

Authors: *Samuel Jensen, Theo Asumah*

Introduction:

Geologic hydrogen - a naturally occurring gas found in the subsurface - is a vast resource that remains largely untapped. Hydrogen has the potential to provide a clean and consistent source of renewable energy for people around the world. Technological advances are continuing to reinforce this field of study as fuel cell technology develops. Only a fraction of hydrogen production is trapped to produce pockets of hydrogen which are of economic value. One locality that favors hydrogen production and entrapment is the mid-continent rift system within the Keweenaw Peninsula. The Keweenaw and related faults were explored and surveyed for their hydrogen contents.

Materials and Methods:

Firstly, existing field data was acquired and compiled into a .kmz file. The purpose of this data was primarily to identify the location of the Keweenaw Fault - an ideal geologic structure for any existing hydrogen to escape from the subsurface. After identifying localities to sample, hydrogen stations were created - small, rudimentary pipes that were to be installed in the soil along the Keweenaw fault to effectively "trap" any hydrogen accumulating from the subsurface and allow for easy measurement with a gas analyzer. When discussing hydrogen gas, it is important to note the high diffusivity rates. Hydrogen's molecular structure is very small, so many materials are simply not capable of accumulating the gas. In order to ensure our station concept worked, many lab experiments were performed. Gas of known hydrogen concentration was funneled into a station, turned off, and left overnight. A flowmeter was attached for the purpose of discerning the approximate amount of hydrogen that was used. The station lost much of the hydrogen. Another setup was then experimented and produced marginally better results. After these lab procedures, field experiments resumed. Many stations were placed along the Keweenaw and Hancock faults, and few were placed elsewhere - namely near the Yellow Dog peridotite seen in the Negaunee area. Routine gas analyses of each station were conducted and recorded.

Results and Discussion:

While it is widely known that hydrogen may accumulate in the subsurface, little research on how to identify traps has been conducted within the academic community. The technique of hydrogen monitoring employed serves as a baseline for future research in the field. Specifically, the stations created to monitor hydrogen contents are an effective prototype that require further development and testing. Localities where the Keweenaw and related faults are exposed were identified and monitored, but may require further exploration. Our approach certainly highlighted the need for specialized equipment within the realm of hydrogen content monitoring on the surface. Hydrogen is a very difficult gas to entrap, and as such, materials used in stations must have very tightly-bound molecular structures to minimize hydrogen diffusion. However, the Keweenaw Peninsula's copper mining history possess a unique opportunity for further research. Underground conditions

have proven favorable for other researchers in this field of study, as solid, unaltered rock with little to no deformation may act as a trap for gas accumulation. Historic mines may provide a perfect environment for hydrogen entrapment, which will be explored in the future.

113. Investigating the Impact of Design Choices on Agrivoltaic System Performance

Student Presenter: Marcus Wu, Electrical Engineering
Faculty Advisor: Anna Stuhlmacher, Electrical Engineering Department

Authors: *Marcus Wu & Anna Stuhlmacher*

Introduction:

Agrivoltaic systems combine energy generation and food production by planting crops under solar photovoltaic (PV) panels. This practice can substantially increase land use efficiency and reduce land use competition between agriculture and energy production. However, the overall performance of an agrivoltaic system is highly dependent on design factors such as row and column spacing, site location, and solar panel mounting types. In this work, we simulate and analyze the impact of these design choices on PV electricity production and the irradiance received by crops, accounting for PV and crop shading.

Materials and Methods:

To evaluate the performance of an agrivoltaic system under different design choices, we develop a simulation in MATLAB to determine the solar irradiance reaching the PV panels and the field. This model allows a wide range of inputs to modify the system parameters, such as panel dimensions, spacing, mounting types, panel quantity, solar irradiance, and sun position. We estimate the electricity production and amount of sunlight useful for plant growth reaching the crops (i.e., photosynthetically active radiation (PAR)) given the time-varying inter-row and cropland shading factors. We define the inter-row shading factor as the percentage of the panels' surface area shaded by adjacent panels and the cropland shading factor as the percentage of the cropland shaded by PV panels. To calculate the shaded area, a ray-tracing method is used to project the vertices of a PV panel onto neighboring panels and/or the ground. We run year-long simulations of the agrivoltaics system under different design choices to evaluate the longer-term impacts of design choices. Last, we perform a sensitivity analysis on agrivoltaic system performance given different design choices.

Results and Discussion:

We found that dual-axis PV systems experience the highest level of inter-row shading compared to fixed-axis and single-axis configurations. This is due to the sun-tracking mechanism of dual-axis panels, which minimizes the incident angle to receive more direct beam irradiance but can cause more shading on adjacent panels. However, we note that inter-row panel shading predominantly occurs during the early morning and late evening hours. Although this shading can lead to a larger shading factor, its overall impact on power generation is minimized due to the limited solar radiation available around sunrise and sunset. We also observe that the dual-axis system in our case study produces 11.3% more energy than the fixed-axis system despite the panel shading. As expected, inter-row shading decreases with greater PV row spacing, while intra-row spacing has little effect. This is due to the north-south orientation of the PV rows in our case study, where panel shading only occurred between rows around sunrise and sunset when the sun is at low altitudes. This simulation tool enables researchers to evaluate how design parameters influence energy generation and crop yield, providing greater insights into the trade-offs within agrivoltaics systems.

114. Investigating Correlation between Atrial Fibrillation and Stroke Patients Using Computational Fluid Dynamics

Student Presenter: Hailey LaBonte, Biomedical Engineering
Faculty Advisor: Hoda Haotum, Biomedical Engineering Department

Authors: *Hailey LaBonte, Ahmad Bshennaty, Ghasaq Saleh, Mohamad Alkhouli, and Hoda Hatoum*

Introduction:

Atrial fibrillation (AF) impacts nearly 33 million individuals in the world, because of an irregular and rapid heart rate [1]. AF occurs when the left atrium contracts in a fast and irregular beat which commonly causes blood to pool and clot [2]. If blood clots travel into the brain, ischemic stroke may occur. This research aims to include more patient-specific flow dynamic parameters that help individualize stroke prediction. These parameters are time average wall shear stress (TAWSS), relative residence time (RRT), and oscillatory shear index (OSI). Analysis of these parameters provides clinicians with predictive data of patients who are at risk of undergoing an ischemic stroke, aiming toward personalized medicine.

Materials and Methods:

Computed tomography (CT) scans of 49 patients who underwent AF with a stroke, without a stroke, and a stroke without AF were acquired from Mayo Clinic under an Institutional Review Board (IRB) approved study. These CT scans were imported into Mimics Research 23.0 (Materialize, Belgium) where patient-specific 3D geometry was extracted through segmentation. The segmented models were then be exported into 3-Matic (Materialize, Belgium), where the exterior geometry was smoothed. To prepare the models for the computational fluid dynamic simulations (CFD), the model was then be imported and meshed in Ansys Workbench (Canonsburg, PA). Boundary conditions for each patient were obtained from their echocardiographic waveforms from Mayo Clinic. As previously mentioned, our simulated endpoints are contour plots reflecting the distribution of TAWSS, RRT, and OSI within the heart. Flow dynamic parameters were assessed to evaluate the correlation between thrombus development causing AF, and ischemic strokes. Note that all 49 patients' geometries were extracted however only 4 patients had their simulations completed and their post-processing finalized so far. We expect to have all the patients simulated and post-processed by the end of this semester.

Results and Discussion:

The anticipated outcome of this research is to find a correlation between the flow dynamic parameters calculated and evidence of thrombosis in both atrial fibrillation and stroke patients through 3D-modeled contour plots. Patients who are at risk of thrombus formation are shown to have a low TAWSS, high RRT, and high OSI [3]. Circulatory and oscillatory flow within the left atrial appendage (LAA) are characteristics that lead to elevated OSI and RRT parameters which may result in thrombosis [3]. TAWSS denotes the wall shear stress applied on the arterial wall over the cardiac cycle, low velocity in the LA causes TAWSS to decrease (<0.4Pa) [4]. Individuals who have experienced atrial fibrillation are more likely to experience thrombosis and therefore ischemic stroke when thrombi travel to the brain. The findings of this study will validate the hypothesis of the correlation between hemodynamic parameters and the occurrence of stroke in AF.

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115. Evaluating stroke risk in atrial fibrillation with amyloidosis and hypertrophic obstructive cardiomyopathy using flow dynamics

Student Presenter: Grace Hoeppner, Biomedical Engineering
Faculty Advisor: Dr. Hoda Hatoum, Biomedical Engineering

Authors: *Grace Hoeppner, Hoda Hatoum, Brennan Vogl, & Ahmad Bshennaty*

Introduction:

Atrial fibrillation (AF) affects over 6 million people in the U.S. and significantly increases stroke risk due to irregular blood flow and clot formation. Cardiac amyloidosis and hypertrophic cardiomyopathy are additional conditions known to contribute to thromboembolic events, but their combined effects with AF remain unstudied. This research analyzes blood flow dynamics in patients with AF alone, AF with cardiac amyloidosis, and AF with hypertrophic cardiomyopathy to identify differences in stroke risk factors. Understanding these flow abnormalities can lead to improved risk stratification and personalized treatment strategies, ultimately enhancing patient outcomes and stroke prevention efforts.

Materials and Methods:

Computed tomography (CT) scans of six patients (two with AF, two with AF and cardiac amyloidosis, and two with AF and hypertrophic cardiomyopathy) were acquired from the Mayo Clinic under an Institutional Review Board (IRB) approved study and a data use agreement (DUA). Each group was matched by age and sex. The scans were imported into Mimics Research 23.0 for segmentation, followed by 3-matic for surface smoothing. The 3D models were then meshed and the computational fluid dynamics (CFD) were performed in Ansys Workbench using patient-specific echocardiographic waveforms. ParaView 5.12.0 was used to analyze the CFD simulations and assess key hemodynamic parameters: time-averaged wall shear stress (TAWSS), oscillatory shear index (OSI), and relative residence time (RRT). Low TAWSS, high OSI, and high RRT correlate with an elevated risk of thrombosis. By comparing these parameters across patient groups, this study aims to identify how each condition contributes to altered blood flow dynamics and stroke risk. Statistical comparisons between groups will determine whether amyloidosis or hypertrophic cardiomyopathy further exacerbate AF-related thromboembolic risk. These insights could lead to better stroke prevention strategies tailored to specific patient populations.

Results and Discussion:

This study aims to quantify differences in blood flow patterns between AF patients with and without additional cardiac conditions. This study has not yet been completed, however, we anticipate that patients with AF and cardiac amyloidosis or hypertrophic cardiomyopathy will exhibit higher OSI and RRT, along with lower TAWSS, indicating a greater propensity for thrombosis. Specifically, amyloidosis may contribute to increased atrial stiffness, worsening blood stasis, while hypertrophic cardiomyopathy's structural changes may disrupt normal flow patterns, exacerbating thromboembolic risk.

By comparing these parameters, we hope to establish a clearer understanding of how these conditions interact to influence stroke risk. If significant differences are found, the results could support the development of personalized risk models, guiding clinicians toward more tailored

stroke prevention strategies. These findings could influence treatment decisions such as anticoagulation therapy intensity, procedural interventions, and risk stratification for patients with AF and coexisting cardiac conditions. Additionally, this research could lay the groundwork for future studies on other structural heart diseases and their impact on thromboembolism. Ultimately, this study has the potential to enhance AF management by identifying at-risk subpopulations, improving early detection, and optimizing patient-specific stroke prevention strategies.

116. Economic Development and Educational Strategies for Michigan's Western Upper Peninsula

Student Presenter: Marguerite Goldman, Finance
Faculty Advisor: Jonathan Leinonen, College of Business

Author: *Marguerite Goldman*

Introduction:

Overcoming the economic, educational, and geographic challenges in Michigan's Western Upper Peninsula (U.P.) is crucial for long-term regional stability. Historically dependent on resource-based industries, the Western U.P. now faces economic decline due to automation and global shifts. With educational attainment lagging, residents without college degrees struggle to access well-paying, stable jobs. Geographic isolation and harsh winters further limit economic mobility and workforce development. Addressing these issues through targeted educational initiatives, expanding access to higher education, and fostering industries that offer local job opportunities can help break the cycle of underemployment, improve financial stability, and drive economic growth for future generations.

Materials and Methods:

This report relied on secondary data obtained from various online sources, including internet sites, public media platforms, and government websites, such as those from state and federal agencies. These sources provided statistical data and reports relevant to the Western Upper Peninsula's economic landscape. Public media websites, such as news outlets and industry reports, were also consulted to gather current information on regional economic trends, industry performance, and local challenges.

Data on industry trends, employment patterns, and regional demographics were gathered from publicly available reports and press releases. Where applicable, online databases provided historical data to track economic shifts. The information was synthesized to provide a comprehensive view of the current economic challenges and opportunities in the Western Upper Peninsula.

Results and Discussion:

The Western Upper Peninsula (U.P.) faces economic challenges due to the decline of traditional industries, a shrinking workforce due to an aging population, and limited economic diversification. Historically reliant on resource-based sectors like mining and logging, the region has seen job losses due to automation and global shifts, leaving many residents without college degrees struggling for stable employment. Additionally, low educational attainment, particularly in rural areas like Baraga County, limits access to high-paying jobs in growing fields such as technology and healthcare.

Given the remote geography, another challenge facing the area, tourism, renewable energy, healthcare, and remote work offer key opportunities for growth. Expanding outdoor recreation, such as hiking trails, could boost tourism, while investments in wind energy and specialty manufacturing could create new jobs.

To address these challenges and capitalize on potential opportunities, the region must focus on education, workforce development, and infrastructure. Expanding access to higher education and trade programs, improving broadband access for remote work, and fostering renewable energy and digital industries can drive long-term economic growth. By diversifying its economy, the U.P. can create sustainable, well-paying jobs, retain young talent, and build a more resilient future.

117. A combinatorial approach to a congruence for partitions into two part sizes

Student Presenter: Eli DeWitt, Mathematics
Faculty Advisor: William Keith, Department of Mathematical Sciences

Author: *Eli DeWitt*

Introduction:

In number theory and combinatorics, an integer partition is a way of writing a positive integer n as a sum of positive integers, where the order of the addends, or parts, doesn't matter. Dr. William Keith showed that if n = 16j + 14, then the number of partitions of n with exactly two part sizes is always a multiple of four. However, his proof relied on modular forms, which, though powerful, obscure the combinatorial nature of the problem. This work introduces the first elementary proof of the result, offering deeper insight into the combinatorial structure of these partitions.

Materials and Methods:

The primary method of mathematical research is using mathematical reasoning to derive and prove various statements. Since avoiding highly specialized methods is what motivated this project, we appeal only to elementary number theory and combinatorial methods of proof.

Many computational experiments were performed using Python to guide intuition about how to develop methods of proof. These experiments were designed to detect patterns and guide the development of conjectures, which were then rigorously proved through mathematical reasoning and formal proofs.

Results and Discussion:

This research was successful in producing a combinatorial proof of Dr. Keith's theorem; there remain similar theorems that would benefit from combinatorial proofs. In fact, Dr. Keith used modular forms to prove the same result for n following many other arithmetic progressions such as 36j+30, 72j+42, 196j+70, and 252j+114. However, the proof methods discussed here do not immediately translate to these other cases.

118. Energy Sources for Food Webs in Regional Lakes

Student Presenter: Drew Schlaff, Environmental Engineering
Faculty Advisor: Dr. Noel Urban & Dr. Judith Perlinger, Civil, Environmental, and Geospacial Engineering

Author: *Drew Schlaff*

Introduction:

Lakes in the Houghton area receive carbon from aquatic (autochthonous) and terrestrial (allochthonous) sources, but their relative contributions to food webs remain uncertain (Carpenter et al. 2005; Lau et al. 2014). Understanding these sources is essential for assessing energy flow and contaminant pathways. This study utilizes stable isotope analysis to distinguish between sources, clarifying dominant carbon inputs. It examines how trophic state and carbon sources influence carbon dynamics in northern lakes. The findings will explore how energy flow influences food webs and contaminant dynamics, with potential implications for fisheries management and public health.

Materials and Methods:

Six study lakes were selected representing different trophic states (eutrophic, mesotrophic, and dystrophic). From each of these lakes, samples were collected for dissolved organic matter (DOM), seston, macrophytes, and zooplankton. Large-volume water samples were purged with nitrogen gas to remove dissolved inorganic carbon (DIC), and freeze-dried to isolate DOM. Zooplankton and seston were collected via net tows and filtration respectively. Macrophytes were sampled from nearshore areas. Stable isotope ratios (δ13C and δ15N) were measured using isotope ratio mass spectrometry (IRMS) at Michigan Tech's LEAF laboratory. Isotope values were then compared across sample types to assess the relative importance of allochthonous (algal) and autochthonous (terrestrial) carbon sources in lake food webs. Supporting measurements including Secchi depth, total phosphorus, and DOC were measured to confirm the trophic state. Data was then analyzed statistically and through the use of a mixing model to identify patterns in carbon source utilization across lake types.

Results and Discussion:

Initial findings from physical and chemical lake measurements show clear differences in trophic state, with dystrophic lakes showing higher dissolved organic carbon (DOC) levels and low Secchi depth. This research is still ongoing; however, once stable isotope data δ13C is obtained from the LEAF lab and analyzed, we aim to determine whether dystrophic lakes rely more on allochthonous carbon sources such as DOC and macrophytes, or if autochthonous production plays a larger role (Carpenter et al. 2005; Lau et al. 2014). Similarly, we seek to clarify that eutrophic and mesotrophic lakes primarily derive their energy from autochthonous sources, such as phytoplankton (Taipale et al., 2016). Determining these carbon inputs will help assess whether dystrophic lakes with greater terrestrial carbon inputs have lower contaminant bioaccumulation. This may be due to shorter food webs (Vander Zanden & Rasmussen 1996) and differences in contaminant retention influenced by the lake ecosystem characteristics (Schindler et al. 1995). Both factors contribute to PCB and mercury bioaccumulation. These findings will improve our understanding of how carbon sources influence energy flow and contaminant dynamics in northern aquatic ecosystems, potentially informing fisheries management and pollution mitigation strategies.

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119. Antiviral Efficacy and Interaction Mechanism of Green Surfactants with Enveloped Viruses

Student Presenter: Grace Wallis, Chemical Engineering
Faculty Advisor: Dr. Caryn Heldt, Chemical Engineering

Authors: *Grace Wallis, Vaishali Sharma, Caryn L Heldt*

Introduction:

Virus clearance is crucial and is required to ensure the safety of biopharmaceutical products. For a long time, Triton X-100 has been the gold standard for virus clearance in detergent-mediated virus inactivation. Due to toxic byproduct formation created in the breakdown of Triton X-100, the European Union has mandated its replacement in all biopharmaceutical manufacturing processes [1]. This research aims to explore sustainable alternatives and investigate how modifications in the physical properties of surfactants impact virus inactivation.

Materials and Methods:

Amino-acid-based green surfactants were tested for their ability to inactivate an enveloped virus, suid herpesvirus (SuHV). The surfactants were prepared in varying concentrations relative to their critical micelle concentrations (CMCs), ranging from 0.05x to 2.0x CMC, in a sodium bicarbonate buffer at pH 8 [2]. Virus samples were incubated with surfactants at 4°C for 60 minutes. Viral titers were determined using a tetrazolium salt (MTT) cell viability assay [3]. Optimal surfactant concentrations were identified based on maximum log reduction values with minimal cytotoxicity. Dynamic light scattering (DLS) studies measured changes in viral particle size after surfactant treatment to better understand the inactivation mechanism of virus particles by surfactants. In the future transmission electron microscopy (TEM) will be done to confirm the morphological changes introduced to the virus particles after surfactant treatment.

Results and Discussion:

The study demonstrated that all three amino-acid-based surfactants—undecanoyl L-tert-leucine, undecanoyl L-iso-leucine, and undecanoyl L-nor-leucine—successfully inactivated SuHV at an optimal concentration of 0.25x CMC. This concentration achieved significant log reduction values (LRVs) of up to 3.10, indicating substantial viral inactivation with minimal cytotoxicity to host cells. Inactivation kinetics revealed rapid efficacy, with notable viral inactivation occurring within one minute of surfactant exposure and peak performance observed at five minutes. DLS measurements indicated that undecanoyl L-tert-leucine and undecanoyl L-nor-leucine reduced viral particle size, suggesting virus envelope solubilization, while undecanoyl L-iso-leucine increased particle size. The surfactants tested share the same tail length, with differences only in the surfactant head group. Notably, undecanoyl L-iso-leucine is the only naturally occurring amino acid among them, which may contribute to its unique effect on virus size.

These findings highlight the potential of green surfactants as eco-friendly, effective alternatives to Triton X-100 for viral inactivation in biomanufacturing. These surfactants could reduce the environmental and regulatory concerns associated with traditional surfactants. Future research will focus on validating these findings with other enveloped viruses and exploring the inactivation mechanisms in greater detail.

120. StoryMapping Detroit: Recording and Preserving a History of Resilience.

Student Presenter: Aidan Johnson, History (BA)
Faculty Advisor: Laura Rouleau, Social Sciences Department

Author: *Aidan Johnson*

Introduction:

This project was conducted as a continuation of the four StoryMaps created by Michigan Technological University students in Detroit last spring using ArcGIS. The research was entirely focused on the Jefferson Chalmers community of Detroit. The work aimed to preserve the history of the region and advocate for change that needs to occur for the people of the neighborhood. I was allowed to produce a fifth StoryMap over the last year and the work has culminated into a beautiful public history project. I focused my work on the late Photographer Hugh Grannum and his impact on the community.

Materials and Methods:

To conduct this research I was required to deploy various methods of information gathering. I employed the method of Archival Research, using photos of historic documents from the Detroit Free Press and the Detroit Public Library. The majority of the information used for this project came from incredibly personal one-on-one interviews with the Grannum Family; This allowed me to fully develop and understand the crucial skills needed to conduct Human Subject research. I spent over 50 hours of the project coordinating with Carolyn Grannum and Blake Grannum to make sure the project went exactly how they wanted it to. I coordinated my efforts on this project with community members from the Jefferson Chalmers neighborhood in Detroit. The StoryMap website production required me to fully understand and utilize all of the various GIS methods required for a spatially focused public history project. ArcGis was the main software I employed to complete the StoryMap portion of the project.

Results and Discussion:

This Project has been released publicly to the community of Jefferson Chalmers through the Jefferson Chalmers W.A.T.E.R Project website. The research conducted proved to be crucial in preserving the history and heritage of the Jefferson Chalmers community. I was able to produce a StoryMap that preserves the work of one of the community's most notable figures, while also directing the community to resources that will assist them in understanding the origins of the issues they face and plans to rectify the situation. This work will be preserved on the internet for as long as the W.A.T.E.R project website is active, and the family of Hugh Grannum will be able to access the work indefinitely due to having the direct link. There is still room for public history work to be done in Jefferson Chalmers, but the community now has more comfort knowing their problems have been heard and their cultural heritage is being preserved. This work will stand for years to preserve the strength and perseverance of the Jefferson Chalmers community, while also functioning as a commemoration of one of Detroit's most impactful artists.

121. Optogenetic Activation of the Subthalamic Nucleus for Treatment of Depressive Symptoms in a Parkinson's Disease Model

Student Presenter: Nikolas Johnson, Biological Sciences
Faculty Advisor: Dr. Chunxiu Yu, Biomedical Engineering

Authors: *Nikolas Johnson, Jacob Jackson, Ethan Plummer, Evan Jackson, & Dr. Chunxiu Yu*

Introduction:

Parkinson's Disease (PD) is a progressive neurodegenerative disorder characterized by death of dopaminergic neurons in the Substantia Nigra1. Depression is a common comorbidity and, along with other non-motor symptoms, often precedes PD diagnosis2. Excitatory optogenetic stimulation of the Subthalamic Nucleus (STN) has been shown to effectively treat motor deficits in the 6-OHDA rat model of Parkinson's Disease3. As the STN is involved in emotional and cognitive circuits as well as motor4, this research seeks to examine whether excitatory optogenetic stimulation of the STN has an effect on the non-motor symptoms of this model of PD.

Materials and Methods:

A hemiparkinsonian phenotype is created in the rat model by injection of 6-OHDA in the left medial forebrain bundle. This depletes dopaminergic neurons in the Substantia Nigra pars Compacta on this side, mimicking PD pathology. This allows for establishment of the disease model while offering a control (the healthy side) within the same animal. First, the difference in performance in our behavioral tests between rats with this treatment (TPD) and wild-type (WT) control rats was assessed. Then, we performed long-term optogenetic excitatory stimulation of the Subthalamic Nucleus (STN) of the TPD animals. Behavioral tests were conducted weekly to assess depressive symptoms. A long-term study involving weekly behavioral tests was performed with TPD and WT animals as well.

Optogenetic stimulation was accomplished by injection of an AAV vector loaded with the CamKII-Chronos-GFP complex, which allows for cell-specific and spatially localized expression of light-sensitive Na+ channels. These channels open when they absorb light at 473 nm, enabling targeted activation using a fiber optic cable. Behavior testing consists of the Plus Maze, a test used to assess exploratory behavior, and the Sucrose Consumption Test (SCT), which measures anhedonia (a symptom which is likely more tied to PD-derived depression than general depression5).

Results and Discussion:

The first round of testing showed a clear difference in performance in the Plus Maze between TPD and WT groups. This was determined by single-instance testing using the Plus Maze. Not enough data was collected to confirm a phenotypic difference in the SCT results, but initial data suggest that PD individuals show deficits similarly to how they are seen in the Plus Maze results.

The long-term testing with PD and WT groups (no stimulation) was to determine if repeated exposures to the behavioral tests changed rats' results. Though only two WT and two PD rats were used, from this sample it is clear that the PD rats symptoms' related to Plus Maze performance persisted through time. SCT results were inconclusive, which, similar to the single-instance testing, suggests larger experimental groups are needed.

Long-term excitatory stimulation with weekly testing also provided inconclusive results so far. Two rats have been tested, and two more are about to begin testing. This portion of the project is set to continue for the foreseeable future.

122. From Pressure to Prediction: Machine Learning-Powered Force Sensing

Student Presenter: Chethan Magnan, Computer Engineering
Faculty Advisor: Dr. Jin Choi, Electrical and Computer Engineering

Authors: *Chethan Magnan, Karsten Kempfe, Sawyer Dunbar*

Introduction:

The ability to detect subtle force changes has critical applications in automotive safety, healthcare, and aerospace. Existing pressure-sensing devices are limited to basic on/off detection, lacking the resolution needed for advanced applications. This research explores the use of a Force Sensitive Resistor (FSR) mat with 160 sensor cells to collect high-resolution force data. By integrating supervised machine learning, we aim to improve force pattern recognition; enabling real-time posture monitoring and motion detection. Potential applications include alerting drivers of unsafe seating positions, monitoring patient posture in hospitals, and measuring a baby's breathing rate.

Materials and Methods:

The FSR mat used in this study consists of 160 force-sensitive cells arranged in a grid, connected to a central controller, and interfaced with a power supply. The mat records force distribution by measuring voltage variations across sensor cells. Current data collection involved seating participants in four distinct positions—Slouch, Fancy, Right, and Left—while recording force data over 10-second intervals. A TensorFlow-based supervised learning model was trained using Edge Impulse to classify these positions based on force distribution patterns. Heat maps were generated to visualize force variations, and accuracy was evaluated by testing the model’s ability to distinguish between different postures and detect motion.

Results and Discussion:

The machine learning model achieved a 95.8% classification accuracy, successfully differentiating between sitting positions and detecting movement. These results demonstrate the potential of FSR mats for real-time posture assessment and motion analysis. Future work over the next month will focus on developing an embedded device to do classification in real-time as well as on a larger data set. The implications of this research extend to automotive safety systems, healthcare monitoring devices, and ergonomic assessments, with exciting potential in embedded AI applications.

123. Aqueous Two-Phase Extraction Systems for Continuous Purification of Influenza Vaccine

Student Presenter: Abigail Ruthenberg and Elizaveta Korolkov, Chemical Engineering
Faculty Advisor: Caryn Heldt, PhD, Chemical Engineering

Authors: *Abigail Ruthenberg, Liza Korolkov, Taravat Sarvari, Lynn Manchester, Caryn Heldt*

Introduction:

Influenza is a respiratory virus with significant clinical and economic impacts, yet the vaccination coverage in the US remains suboptimal at just 51.8%. Therefore, resolving the barriers to vaccine production and increasing accessibility is crucial. Continuous processing can lower manufacturing costs by minimizing downtime, reducing plant footprint, and decreasing processing time. One continuous-processing method is purifying vaccines through aqueous two-phase systems (ATPS), which partitions the viral product and impurities into two different liquid phases. Here, we investigated the potential of ATPS for the purification of influenza A virus-like particles as a cost-effective and scalable alternative to traditional chromatography methods.

Materials and Methods:

During the first stage of ATPS, viral stock was mixed with sodium citrate salt (citrate), water, and polyethylene glycol (PEG) polymer and centrifuged to separate the two phases. The virus was salted out of the citrate-rich phase and partitioned into the PEG-rich phase. This serves to purify the virus since the impurities remain in the salt-rich phase. During the second stage of ATPS, the virus-laden PEG was mixed with fresh citrate salt and water. The virus is then partitioned into the salt-rich phase, which has a lower viscosity and eases further processing. This experiment explores reducing the settling time for the two phases to separate in both batch and continuous modes. Sodium chloride and sodium sulfate at different concentrations were mixed with first-stage citrate, and the effects on settling time were studied using sedimentation and coalescence curves. For preliminary trials, this process was tested with herpes simplex virus (HSV) because reliable analytical methods were previously developed and readily available.

Results and Discussion:

Previous batch-ATPS experiments allowed us to choose the best condition. This condition yielded recoveries >100% based on HA and qPCR results. Such high values of recoveries stem from PEG and citrate interference in our analytical methods. The Bradford and PicoGreen assays determined 99% protein removal and 97% DNA impurity removal, respectively, in our best-condition ATPS samples. ATPS purification can lead to the purification of IBV with acceptable virus recovery and impurity removal. The process is simple and fast and easy to scale up or use in continuous mode.

We have found that adding 0.25 M NaCl salt into the ATPS system reduces settling time from 6.5 minutes to 5.5 minutes with no significant effect on HSV's partitioning. We are now evaluating the effect of different concentrations of sodium chloride and sodium sulfate salts to determine the best conditions for ATPS settling in batch mode. We will then select the best salt conditions for settling in batch mode and evaluate the performance in continuous mode using a novel settling device.

124. Brain Stimulation Treatment in the 5XFAD mouse Model of Alzheimer's Disease

Student Presenter: Miles Cornils, Biomedical Engineering
Faculty Advisor: Dr. Chunxiu (Traci) Yu, Biomedical Engineering

Authors: *Miles Cornils, Dr. Chunxiu (Traci) Yu*

Introduction:

Alzheimer's Disease (AD) affects 6.5 million Americans every year with 55 million people worldwide, resulting in an estimated economic burden of 335 billion dollars. Following diagnosis, a patient typically lives around 5.8 years. Presently, there are no cures or preventatives available. However, recent studies employing deep brain stimulation (DBS) have shown a promising improvement in cognitive function for afflicted individuals.

Materials and Methods:

Twelve 5XFAD mice and six wildtype mice will undergo a series of behavioral tests. One group (n=6) of 5XFAD mice will be injected with AAV5-syn-Chronos-GFP and fiber implanted into MTN. The second group 5XFAD mice (n=6) will serve as control without any treatment for evaluating behavioral deficits. Six wild type mice will be used as naïve control to demonstrate normal learning and memory behavior.

Results and Discussion:

Currently, we only have the preliminary results on the behavior differences for the wild type mice with the 5XFAD mice coming in later this month. However it appears that WT mice are acting as expected with the exploratory nature of the mice being very evident. Assuming the 5XFAD mice follow the results we expect, we should see more random behavior. The exploratory nature of the WT mice is shown with the mice always picking the a new/unknown object and side instead of a known object/side. The results we SHOULD see in the 5XFAD mice is that both new and known object should have the similar relative time of interaction as well as areas being chosen to be more random and less predictable.

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125. Statistical Analysis of the Heart-Brain Connection Using Magnetic Resonance Imaging and Clinical Records

Student Presenter: Aili Toyli, Statistics
Faculty Advisor: Weihua Zhou, Michigan Tech Medical Imaging and Informatics Lab

Author: *Aili Toyli*

Introduction:

Every year, cardiovascular disease takes an estimated 17.9 million lives worldwide [1], and nearly ten million new cases of dementia are diagnosed [2]. To effectively address these public health issues, it is crucial to understand the structural and functional links between the heart and brain and the interactions in their pathologies. In 2023, Zhao et al. [3] published a large-scale study in which they found associations between the heart's and brain's phenotypical parameters. My research sought to validate the results of this study and identify further correlations between Alzheimer's disease (AD) and cardiovascular disease (CVD).

Materials and Methods:

In this project, I analyzed individuals from the UK Biobank with cardiac magnetic resonance imaging (CMR) data and two types of brain imaging features: volumetric MRI and diffusion tensor imaging (DTI). First, I assessed the reliability of CMR traits in repeat imaging using intraclass correlation (ICC) [4]. Next, I performed linear regression to identify significant associations between heart and brain imaging features after adjusting for covariates, repeating the analysis separately for males and females to examine sex differences in the heart-brain connection. To further explore these relationships, I conducted canonical correlation analysis (CCA) to identify multidimensional associations between brain and heart imaging modalities [5]. I then performed a mediation analysis to assess whether CMR features mediate the relationship between known cardiac risk factors and brain MRI traits. Finally, I calculated the odds ratio for Alzheimer's disease (AD) given different subtypes of cardiovascular disease (CVD) diagnosis.

Results and Discussion:

Aorta and ventricle traits exhibited the highest ICC values, indicating strong reliability in repeat imaging compared to other cardiac features like ejection fraction and distensibility. Regression analyses between CMR and volumetric MRI traits identified 116 significant pairings. An additional 246 significant associations were found between CMR and DTI variables. Notably, subcortical structure volumes strongly correlated with cardiac wall thickness, and significant associations emerged between left ventricular myocardial mass and DTI tracts. Pairwise regression results were largely consistent across sexes, though females showed stronger associations between DTI and wall thickness traits than males. No strong canonical correlations were detected between CMR and volumetric MRI traits, but the aorta and whole brain volumes were primary contributors to the strongest correlations. DTI traits exhibited slightly higher canonical correlations, although with few distinct patterns in coefficient weights. The only significant mediation effect after p-value correction linked diastolic blood pressure to optic chiasm volume, with 79% of the effect mediated by CMR features. Most CVD diagnoses were associated with increased odds of AD, with hypotension presenting the highest risk. Our findings highlight numerous notable connections between heart and brain health. To fully interpret them, we will have to consult with clinical collaborators.

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126. Impacts of housing availability and accessibility for high-need, low-visibility populations in Keweenaw, Houghton, and Baraga Counties

Student Presenter: Marielle Raasio, Policy and Community Development
Faculty Advisor: Kelly Kamm, KIP

Author: *Marielle Raasio*

Introduction:

Housing is widely referenced as a social determinant of health and wellbeing. Housing is also an indicator of economic and social mobility. However, the intangible results of these physical housing pathways that disproportionately affect vulnerable populations are not well understood. We know that housing instability is linked to negative health outcomes, financial insecurity, and homelessness. This study will be an actionable foundation for new policy work and community action. Establishing a foundational knowledge about local housing challenges is critical to implementing actionable solutions for positive public health outcomes.

Materials and Methods:

The research design process involved gathering information on local affordable housing stock and key community stakeholders to inform data collection. This information was used to craft interview templates for each target population and community knowledge keeper. Semi-structured, qualitative interviews serve as the primary data collection method, allowing for the capture of subjective perspectives essential to the research question. This approach is particularly valuable for amplifying the experiences of vulnerable populations.

Interviews are conducted with three representatives from each identified population, supplemented by interviews with key information gatekeepers such as Community Health Workers, Social Workers, or Shelter Workers. In preparation for the interviews, a literature review and interview guide were developed and refined to ensure clarity and effectiveness.

Data from transcribed interviews will undergo thematic analysis to identify patterns related to housing conditions, access, affordability, and availability. Findings will be compiled into datasets and shared with community stakeholders and local planning commissions to inform housing policy and advocacy efforts.

Results and Discussion:

The anticipated outcomes of this research include an increased understanding of the challenges high-need, low-visibility populations in Keweenaw, Houghton, and Baraga counties experience. This study aims to identify key barriers to housing access, affordability, and stability among these groups. Potential implications include insights that inform local policymakers on targeted interventions to improve affordable housing access. Additionally, these findings will help equip local organizations to better advocate for housing initiatives and funding opportunities.

Finally, this project will raise public awareness of the lived experiences of low visibility groups and the effects of housing insecurity in Michigan Tech's broader community. Overall, this research is expected to contribute to practical solutions aimed to improve housing conditions for underserved populations and provide a basis for further academic discourse.

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127. Utilizing Machine Learning to Diagnose Alzheimer's Disease

Student Presenter: Sean Phelan, Statistics & Mathematics - Business Analytics
Faculty Advisor: Weihua Zhou, Applied Computing

Authors: *Sean Phelan, Weihua Zhou, Qiuying Sha, Chen Zhao*

Introduction:

My research is important in achieving better outcomes for those diagnosed with AD. Current treatments are for preventing further brain decay and are extremely effective when deployed early. I am working on a staged method where clinical, imaging, and genetic variables are utilized with a staged approach, allowing doctors to diagnose cases and be confident in recommending further testing. Machine learning as a tool for diagnoses will reduce the burden on doctors and allow them to consult for a quick second opinion, possibly guiding the future plan of care.

Materials and Methods:

First, I downloaded a lot of data from the UK BioBank. I have several sets of predictor variables grouped into imaging, genetic, and clinical factors. I also have a list of every patient diagnosed with Alzheimer's Disease. I preprocessed the data by removing zero variance predictors, encoding categorical variables, and imputing missing values. Next, I performed model selection for each stage (1: Clinical, 2: Clinical & Imaging, 3: Clinical, Imaging, & Genetic) by training hundreds of iterations of hundreds of classification models. The models I investigated were SVM Classifiers, Decision Trees, and Boosting Algorithms. The SVM Classifier and some Boosting Algorithms cannot handle missing values and were trained on the predictors without using imputation. After model training and validation, I selected our best models for each stage to test on unseen data. I aim to find the model with the lowest false negative rate while maintaining a relatively good overall accuracy.

Results and Discussion:

I found models with false negative rates of <5% for stage 3. I also plan to integrate blood samples to test if blood neurobiomarker data will improve performance. I am interested in modeling which stage is best, and seeing if on a low confidence diagnosis from stage 1, our model can recommend which test, blood, brain scan, or genetic, will be most likely in improving the confidence of our Alzheimer's diagnosis. I am still training stage 1 and 2, and have to make some sample stratification and size adjustments to ensure we can be confident in the results. The sample is extremely unbalanced, and I have to fine tune the repeated stratification so that the whole population is used and each model can be trained on multiple unique stratified samples of our large population. These findings could improve accuracy and efficiency of the Alzheimer's diagnosis process and would be utilized in a hospital by doctors.

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128. How do long-term drainage, altered hydrology, and the encroachment of trees affect dissolved organic matter composition and redox status in northern peatlands?

Student Presenter: Nora Sullivan, Ecology & Evolutionary Biology
Faculty Advisor: Evan Kane, College of Forest Resources and Environmental Science

Author: *Nora Sullivan*

Introduction:

Peatlands are carbon dense ecosystems that store about 30% of soil carbon globally while only occupying 3% of the land area, yet this carbon is vulnerable to oxidation as a result of climate change or drainage. Peat carbon generally stays locked up under cool and saturated conditions but the carbon is at risk of being released back into the atmosphere if the peatlands are drained or decomposed. This long-term drainage results in a more degraded peat and therefore we expect that changes in the dominant enzyme systems in response to drainage will alter the quality and quantity of redox-reactive charge sites in organic matter.

Materials and Methods:

I assessed DOM character with absorbance and fluorescence spectroscopy, as well as oxidation-reduction potential, in a full-factorial experiment in peat with: i) contemporary drainage (long-term low water year vs. average water year), ii) long-term drainage (sites drained in the 1930's vs. "pristine" peatlands), and iii) the presence or absence of trees. I harvested water for analyses from existing piezometers with sampling capability at 20 and 40 cm. Sample campaigns included maintaining the treatments, beginning after green-up (June). Water was sampled and filtered (0.45 m) and analyzed for indices of aromaticity, molecular weight and oxidation. I analyzed the DOM composition using a Horiba Aqualog fluorometer (and Aqualog software, and custom R script), and Eh using a Hach probe and closed flow-through cell apparatus.

Results and Discussion:

The results of my experiment show that the presence of trees in northern peatlands does affect the dissolved organic matter character. By comparing HIX (humification) and BIX (biological) indices we see that the higher the level of organic matter maturation, the lower the level of autochthonous contributions to the dissolved organic matter. The more oxidizing conditions occur with the lowering of the water table result in less aromatic, lower molecular weight compounds.

129. A Cross-Case Comparison of Celebrated Women as Living Memorials

Student Presenter: Ila Swier, Sustainability Science and Society
Faculty Advisor: Mark Rhodes, Social Sciences

Authors: *Ila Swier, Mark Rhodes*

Introduction:

The Living Memory Lab at Michigan Technological University looks at the relationship between memory and plant-based foods. I first did background research on the origins of the plants, and for SURF I took this a step further. To do this I shared plant starts, raw seeds, and did surveys on the memorial plants. The lab worked in the Keweenaw over the summer, while I conducted a comparative case study downstate. My research looked at three heirloom varieties named after diverse celebrated women and explored their ability to shift a predominantly masculine memorial landscape.

Materials and Methods:

Firstly I did background research, developed surveys for people to take at the markets, and grew plants to share. To gather data I went to farmers' markets and shared information on the varieties I grew through conversation and informational labels that were attached to seeds and plant starts. I then conducted both written and digital surveys. I also gathered data through field notes, making observations on myself, my surroundings, and interactions. I recorded the exact amount of plants and seeds I dispersed. We sent out a follow-up survey to gather more data on people's perceptions and experiences with the plants. Throughout the summer I compiled my findings and analyzed them. I came to conclusions through my own data, and then to look deeper I met with the other team members in the Keweenaw. We have compiled the information that we collected from the surveys and conversations from all locations for cross-comparative empirical analysis. I have been looking to inform my relationship with the food landscape as a female farmer sharing prominent female stories through seeds, explore how those women fit into the two communities, and what impact this work has on people's perceptions.

Results and Discussion:

I found that through my survey that very small number of people had knowledge of the person and history. From my field notes I recorded that even though few people had knowledge, they were very interested to learn. After many weeks of markets, people would continue to tell me how this inspired them, how they shared the information, and their investment in the plants. Showing that the connection of the person to the plant impacts the way that people view the plant. I found that women and older people were more likely to do the survey and have an interest in the project. The demographic questions showed the common age group and the scale of interest results were found through my field notes. When I explained the project women would engage more and were more likely to continue to do the survey. As for the older generation, they seemed to have more knowledge of the person the plant was named after and showed more interest in the historical side than younger people. With this, I did look at market demographics in the cities I went to, and there are typically more women and older people at the markets to start.

130. The Hybrid Path to Explainable Artificial Intelligence

Student Presenter: Nate Pongtankul, Computer Science
Faculty Advisor: Leo C. Ureel II, Department of Computer Science

Author: *Nate Pongtankul*

Introduction:

This project aims to address the gap in explainability between classical AI and modern ML by developing hybrid systems that leverage the strengths of both paradigms; integrating the explicit knowledge representation and reasoning capabilities of classical AI with the pattern recognition and predictive power of modern ML. We propose to create enhanced XAI tools that can provide users with understandable, transparent, and meaningful insights into the decision-making processes of AI systems.

Materials and Methods:

We explore the intersection between old and new AI approaches, combining the two to develop innovative new hybrid algorithms. We do this by integrating problem solvers such as those in Forbus and De Kleer's "Building Problem Solvers" with ML models to enhance explainability.

Results and Discussion:

The results are still ongoing, and are inconclusive at this moment. The implications, however, would be beneficial in not only better understanding the logic produced by these models, but also better improve confidence in their logical reasoning.

131. Utilizing wastewater based surveillance to monitor Borrelia sp. for the detection of Lyme disease in a non-endemic region of the United States

Student Presenter: Jacob Schmidt, Environmental Engineering
Faculty Advisor: Ishi Keenum, Civil, Environmental, Geospatial Engineering

Authors: *Jacob Schmidt, Aimee Marceau, Ishi Keenum*

Introduction:

Tick-borne pathogens (TBPs) like Borrelia sp., the causative bacteria of Lyme Disease, are a major public health concern because of their variable occurrence and limited existing monitoring methods.1 Traditional TBP surveillance methods use clinical surveillance monitoring human cases after symptoms present. Data is then distributed to public health officials. This model, while effective, inherently creates a lag in reporting.1,2 Wastewater based surveillance has emerged as a way to monitor pathogen concentrations.3-9 This project aims to expand existing efforts to monitor TBPs. TBP surveillance via wastewater has never been conducted and could provide a revolutionary way to understand disease burden.

Materials and Methods:

Weekly 24-hour composite influent wastewater samples were collected (grab samples were collected when a composite sample was unavailable), from March 2024 - December 2024 following sterile sampling protocols, from the Portage Lake Water and Sewer Authority wastewater treatment plant in Houghton. Wastewater samples were filtered, in triplicate on 0.22 micron filters.

DNA was extracted from the filtered samples using the FastDNA™ SPIN Kit for Soil. DNA was eluded to a final volume of 100 µL. Digital droplet PCR (ddPCR) was used to capture variations in Borrelia prevalence. Targeted assays for A. phagocytophilum and Ba. microti sa1 (M1b Assay B. burgorferi s.l. fliD)10 in addition to Ba. microti 18S and Borrelia 16S (M3 Assay Borrelia 16S rDNA)10 were used to amplify specific genetic markers associated with known tick-borne pathogens. Associated limits of detection for the selected assays are 3-20 copies.10 Genomic DNA standards and no-template controls were used for data validation.

Data visualization is being conducted with R studio using the ggplot2 package. Statistical analysis is being conducted using spatial autocorrelation methods and Bayesian regression models to compare Borrelia detection in wastewater with reported cases of Lyme disease by the Michigan Department of Health and Human Services (MDHHS).

Results and Discussion:

We have successfully measured Borrelia using two assays in 39 samples, though further analysis is ongoing. Digital droplet PCR results for wastewater samples show consistent positive results for both grab and 24 hour composite influent samples – validating method feasibility for detection using WBS. Collected data is being analyzed as gene copies per milliliter of wastewater looking for trends over time. We will also normalize samples to the human fecal indicator (HF183). The collected wastewater surveillance data is currently being compared to Houghton County Lyme Disease cases, as reported by the Michigan Department of Health and Human Services, with significant correlation found with public health data lagging approximately eight weeks behind

wastewater data. Further analysis is needed to assess possible correlations between wastewater data and citizen collected ticks.

The successful implementation of TBP monitoring using wastewater surveillance will enable proactive public health interventions and control measures. The potential to shift the procedures for TBP monitoring processes allows public health officials to focus on implementing risk assessments, prioritizing resource allocation, and guiding policy development – greatly improving the public health response to TBPs and beyond.

132. Exploring Microbial Community Growth Dynamics on Deconstructed Mixed Plastics

Student Presenter: Adrian Noecker, Biochemistry and Molecular Biology with a Biology focus
Faculty Advisor: Dr. Lindsay Putman, Biology Department

Authors: *Adrian Noecker, Lindsay Putman, Sulihat Aloba, Rebecca Ong, Stephen Techtmann*

Introduction:

Plastic is used as a result of its stable structure, this quality is what also makes plastic a pollutant of concern because it is difficult to degrade and is persistent in the environment [1]. Chemical and biological methods of plastic degradation have been found to speed up this process and produce usable byproducts [2, 3]. Chemically deconstructed plastic monomers were successfully metabolized by a microbial community in our lab [4]. The difference in community dynamics between cultures grown on a mix of plastic monomers compared to monomers derived from one plastic type is needed to better understand how to make this process more efficient.

Materials and Methods:

Cultures grown on chemically deconstructed polyethylene terephthalate (PET) and a mix of chemically deconstructed polyethylene (PE), PET, and meal-ready-to-eat bags (MRE, made of polyolefin, polyamide, polyester, and aluminum) were both grown in bioreactors. Growth in bioreactors was assessed using spectrophotometry to measure the optical density of the cultures at 600 nm. These cultures were each used to source the microbial community used for experiments to assess comparative degradation as measured by a Micro-Oxymax respirometer and high performance liquid chromatography (HPLC) samples taken at the beginning and end of the experiment.

The PET culture and the mixed plastic culture were sequenced using shotgun metagenomic sequencing to assess differences in community composition and metabolic potential. Metagenomic sequencing samples were trimmed, assembled, and annotated for analysis. Differences in taxonomy were assessed using phyloFlash and Kraken and differences in metabolic genes were assessed using the KEGG mapping resource.

Results and Discussion:

The mixed plastic culture was found to grow at similar rates to the culture only fed PET monomers both in the bioreactors and the respirometer experiment. This was confirmed by the difference between the final and initial monomer concentrations measured by HPLC and by the rate of carbon dioxide production detected by the respirometer. Taxonomic assignment of 16S rRNA reads of each metagenome are fairly similar at the phylum level, however, the mixed plastic community has a higher relative abundance of organisms from the Bacteroidetes and Firmicutes phyla. Community differences at the family and order taxonomic levels are in the process of being analyzed, which will provide insight into which microbes are best able to grow in the mixed plastic culture. Genes related to plastic monomer degradation will be identified if present within each metagenome to compare the different metabolic pathways each community may be using. This information will help to explain taxonomic differences between the two cultures as well as any differences in metabolic processing of monomers. The ability of the microbial community to degrade a mix of plastic monomers is significant with regards to the ability to biologically degrade plastic waste at a large

scale, as this would alleviate the need for sorting different plastic types without loss of metabolic efficiency.

133. Lake Superior Mapping and Archaeological Exploration Using Uncrewed Technology

Student Presenter: Jenna DeVries, Mechatronics
Faculty Advisor: Timothy Havens and Travis White, Great Lakes Research Center

Author: *Jenna DeVries*

Introduction:

The Great Lakes Research Center is leading an Autonomous and Intelligent Marine Systems initiative and has partnered with Ocean Infinity, a global leader in uncrewed marine technology. Through this partnership, GLRC is housing and managing the Armada 8, an advanced unmanned vessel, for collaborative use in the Great Lakes Region. This asset will support the Lakebed 2030 initiative, which aims to fully map the Great Lakes to modern standards. The Armada 8 embodies cutting-edge technology that will advance research, education, and outreach in autonomous and intelligent marine systems, strengthening MTU's role in pioneering innovation in the Great Lakes region.

Materials and Methods:

In September 2024, the Armada 8 was deployed for a demonstration to assist in locating a missing National Center for Atmospheric Research (NCAR) Beechcraft 65-80 Queen Air, which disappeared in 1968. Since then, debris has periodically washed ashore, spurring new efforts to identify the wreck site. The aircraft is believed to be located within the “Great Lakes Triangle,” an area spanning from the tip of the Keweenaw Peninsula to Isle Royale and Ontonagon. For this mission, Norbit and Kongsberg generously provided multibeam sonar systems. The Armada 8 was equipped with the Norbit Multibeam Sonar to survey 29 square miles within the triangle, while the GLRC vessel, Soliton, utilized the Kongsberg sonar.

The Strategic Education through Naval Systems Experience (SENSE) enterprise is currently working on integrating a Sound Velocity Profiler (SVP) into the Armada 8 system to improve the accuracy of sonar data. Sonar readings can sometimes lack precision. The incorporation of an SVP will enhance data interpretation by providing accurate SVP curves that reflect the thermal gradient of the lake. This is crucial, as inaccuracies in the sonar data due to natural thermal gradients can lead to distortions, potentially obscuring key findings or causing false readings of water depths and targets.

Results and Discussion:

A total of 45 square miles were surveyed, with 29 square miles designated as the primary search area and the remaining 16 square miles along transit routes. The Armada had a pre-programmed survey route and ran autonomously as it scanned the lakebed. This increased the efficiency of the survey, as we could have a secondary vessel scanning the other side of the search area simultaneously. Several potential targets were identified, which will be revisited with underwater remotely operated vehicles (ROVs) and/or autonomous underwater vehicles (AUVs) in the upcoming spring. Various anomalies were detected, suggesting the possibility of multiple wreck sites in the region. This area has seen the disappearance of other aircraft and ships, and these findings may be linked to those events.

The SENSE Enterprise students have developed a prototype for deploying a Sound Velocity Profiler (SVP) and other deep-water measurement tools. This prototype incorporates an automated

downrigger, controlled by an Arduino system. Downriggers, typically used in deep-sea fishing, are designed to deploy and retrieve lines via a simple line and spool mechanism. Once the final prototype is complete, this downrigger will be integrated into Armada 8 for use in future surveys.

134. Ice Nucleation Testing on Bacterial Isolates Found in Local &

Student Presenter: Allen Cureton, Biochemisty & Molecular Biology (Bio-Focus)
Faculty Advisor: Trista Vick-Majors, Great Lakes Research Center

Authors: *Allen Cureton, K.M. Shafi, and Trista J. Vick-Majors*

Introduction:

Microorganisms have evolved mechanisms to control the temperature at which ice forms, which can benefit their survival. This project includes experiments on microbial isolates derived from cold environments aimed at evaluating the ability of bacteria to nucleate ice formation at warmer temperatures than water will freeze on its own. The goal is to determine how bacterial ice nucleation will react to exposure to a range of near 0°C temperatures. Overall, this research aims to optimize and better understand novel ice control mechanisms, with the goal of developing novel technologies designed to mitigate human challenges in working in extreme cold climates.

Materials and Methods:

For each experiment, three bacterial isolates were selected, and five colonies were selected as replicates. Each colony was inoculated in a culture media tube containing Luria Broth or R2A. The 15 new cultures were incubated at 20°C for 48 hours. The culture growth was then standardized to the lowest colony density based on OD600 determined on a spectrometer by diluting with sterile ultrapure water. After standardization, 100µL of each culture was deposited into a 96-well culture plate. The plate was then placed in a water bath cooled to -4 °C by circulating a propylene glycol solution through the bath. Every 10 minutes the temperature was lowered by 1 degree until all culture wells were frozen. The temperature at which each well froze was tabulated and at the end of the experiment, all points graphed for analysis. Once the initial experiment was complete, the experiment was repeated by first acclimating the original culture tubes at 0 °C to -4 °C and testing for changes in ice nucleation activity associated with the change in acclimation temperature every 24 hours for 120 hours.

Results and Discussion:

This set of experiments aimed to understand the influence of acclimation to low temperatures on ice nucleation activity. Previous work suggested that acclimation at 4 °C for 48 hours leads to maximum ice nucleation, but this is based on well-understood ice nucleators such as Pseudomonas syringae. In the work shown here, most isolates did not show any change in their ice nucleation temperature after up to 24 hours of acclimation. However, consistent with our expectation based on P. syringae, some isolates showed a temperature change after 48 hours, but the optimal acclimation temperature varied. Isolate A-492 began to nucleate ice at -6 °C after 48hrs of acclimation at 4 °C. Its best nucleation temperature was -5 °C after 96 hours of acclimation at 4°C. Isolate A-502 had a similar pattern with the culture acclimated at 1 °C for 96 hours. To optimize ice nucleation by either of these isolates, we recommend incubating them at 4°C for 96 hours (A-492) or 1°C for 96 hours for (A-504) prior to initiating ice nucleation. Together, our results show that improving our understanding of the physiological responses of these isolates will lead to improved application outcomes.

135. Temporal and taxonomic comparison of macroinvertebrate energy densities in the Salmon-Trout River

Student Presenter: Ben Toporski, Ecology and Evolutionary Biology
Faculty Advisor: Jill Olin, Biological Sciences

Authors: *Ben Toporski, Hunter Roose, Gordon Paterson, Jill A. Olin*

Introduction:

Macroinvertebrates are important prey for native stream fishes such as brook trout (Salvelinus fontinalis)1. Macroinvertebrates demonstrate feeding modes such as shredding, grazing and detritivory that provide different nutritional benefits to brook trout. In this study, the following hypotheses were tested: (1) family or order level taxonomic variability in energy density exists within invertebrate prey groups; and (2) temporal variability in the energy density of invertebrate prey exists between spring and fall. These data will be valuable for understanding taxonomic and seasonal variation in nutritional quality of prey providing insight into diet choice and growth potential of brook trout.

Materials and Methods:

Macroinvertebrates were collected from the Salmon Trout River from June and August of 2023 using benthic kick (500 μm) and drift (363 μm mesh) nets with specimens stored in 70% ethanol. Individuals were identified to Family or Order under a dissecting microscope, measured for total length (mm) and mass (mg) and sorted based on functional feeding groups2. Energy densities of macroinvertebrates representing the different feeding mode included for example Athericidae (predator), Pteronarcyidae (detrital shredder), Heptageniidae (scraper), Baetidae (gathering collectors), Simuliidae (filtering collectors), Curculionidae (herbivore shredder), and Lepidoptera (herbivore shredder) were determined using an established percent ash free dry weight (AFDW) method3. Individual macroinvertebrates were dried at 100oC until there was <4% or 0.54 mg difference between weights (usually 2-3 hours). Samples were then ashed in a muffle furnace at 550oC to obtain a percent AFDW value. Energy densities (Kj/g wet weight) for individual macroinvertebrates were then predicted using the percent AFDW regression model developed for aquatic macroinvertebrates by Weil et al. (2019). Energy densities will be compared using an analysis of variance to determine significant differences between taxa and months.

Results and Discussion:

Preliminary energy densities demonstrate differences between two of the functional feeding groups with the detrital shredder, Pteronarcyidae (2.63±1.05 Kj/g w.w.) exhibiting lower energy densities relative to the predatory Athericidae (8.32±4.52 Kj/g w.w.). Based on these initial results, we expect grazers such as Heptageniidae, that forage on aquatic based primary production, will have the highest energy density, owing to the continual seasonal availability of a high quality and abundant food resource. In contrast, we predict that herbivore shredders such as Lepidoptera that feed on living terrestrial organic material will have higher energy densities relative to Pteronarcyidae that feed on decaying terrestrial inputs to the river. Temporally, we predict that grazers will be highest in energy density in June relative to August due to high primary production that occurs in aquatic ecosystems during the early summer. However, as terrestrial inputs from leaf fall increase in the autumn, we expect that the detrital shredders will demonstrate increases in

energy densities with this increased resource availability. Understanding these taxonomic and seasonal differences in the nutritional contents of macroinvertebrates will provide important information for quantifying energy availability in a natural macroinvertebrate community for native brook trout.

The Undergraduate Research and Scholarship Symposium is hosted by the Pavlis Honors College

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