25th Annual Science Research Symposium



Tuesday
May 27th
2025

Celebrating Our Achievements and Future Researchers



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2024 -2025

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25TH ANNUAL HORACE GREELEY SYMPOSIUM
SCHEDULE OF EVENTS

5:30 - 6:30 **Gym D**	**LIGHT REFRESHMENTS & PRESENTATIONS** Sophomore and Junior Class Poster Presentations
6:30 - 8:00 **Main Gym**	**WELCOME & OPENING REMARKS** Dr. Haroula Argiros, Ms. Priya Patel-Ma, Mr. Jerry Zupan
	**SENIOR INTRODUCTION** MCs: **Samuel Stryker, Rishi Kumar, Eve Rutman, Kathleen Paskowitz**
	**SENIOR PRESENTATIONS - ROUND #1** Nora Morton, Meadow Zhang, Harper Margolies, Amy Feng, Audrey Ho, Sara Jankovic
	**"A DAY IN THE LIFE OF"- PHOTO MONTAGE** MCs**: Samuel Stryker, Rishi Kumar, Eve Rutman, Kathleen Paskowitz**
	**SENIOR PRESENTATIONS - ROUND #2** Arjun Menon, Benjamin Chang, Shawn Liang, Daniel Ye, Andrew Pang, & Morgan Tsai
	**SCIENCE COMPETITION - PHOTO MONTAGE** MCs: **Samuel Stryker, Rishi Kumar, Eve Rutman, Kathleen Paskowitz**
	**SENIOR PRESENTATIONS - ROUND #3** Natalie Carousso, Justin Goldberg, Shrey Kumar, Zirui Song, Elizabeth Xiu, & Roshan Dhand*
	**SENIOR CELEBRATION & GIFTS** Emcees, Dr. Argiros, Ms. Patel-Ma, & Mr. Zupan
	**ACKNOWLEDGEMENT OF INCOMING FRESHMAN** MCs: **Samuel Stryker, Rishi Kumar, Eve Rutman, Kathleen Paskowitz**
	**FINAL PHOTO OF ALL CURRENT STUDENTS** Mr. Jerry Zupan
	**CLOSING REMARKS & CLEAN UP** Mr. Jerry Zupan, Ms Patel-Ma, & Dr. Argiros

GRATITUDE

"WHAT I KNOW IS THAT I AM GRATEFUL FOR THE CURIOSITY THAT DRIVES US ALL FORWARD."

— JANE GOODALL

To the Parents, Guardians, Caregivers, and Friends of the Horace Greeley Science Research Program

Thank you for your unwavering support of our program. Whether it was helping assemble posters, serving as practice judges, listening to countless run-throughs, donating time, providing food, or contributing in countless other ways—you've played an *essential* role in the growth and success of our students. Your generosity, encouragement and belief in what our young scientists can do has been instrumental in their growth and success. This program thrives because of you.

Superintendent Dr. Christine Ackerman: Your dedication to providing meaningful, high-quality opportunities for students has been instrumental in allowing this program to grow, innovate, and thrive—both in scope and in impact.

Dr. Adam Pease: For your impromptu lessons on hydroponics, carnivorous plants, and all things green—thank you for inspiring curiosity and cultivating a love for environmental science in the greenhouse and beyond.

Principal Dr. Sandra Sepe: Your leadership, encouragement, and commitment to academic exploration have helped create an environment where our students can thrive as young scientists. Thank you for championing curiosity, innovation, & excellence.

Assistant Principal Team: *Dr. Ronald Gamma, Mrs. Karime Flores, Dr. Joseph Sullivan, Ms. Christina Mauricio*: For your support with logistics, thoughtful feedback to students, and the behind-the-scenes work that helps the program run seamlessly—thank you.

Mr. Paul Bianchi: For his guidance during practice, his support as a chaperone, and his foundational role in teaching many of our juniors and seniors in Intro to Research—leaving a lasting and tangible impact on all students and teachers in the program.

Student Mentors: For generously volunteering your time, expertise, and facilities to support our young scientists—thank you. Your mentorship makes it possible for students to engage in authentic scientific research and experience the real-world impact of curiosity, rigor, and discovery.

Chappaqua Board of Education: *Mr. Ryan Kelsey, Ms. Cailee Hwang, Mr. Matthew Auerbach, Ms. Alissa Dorfman, & Ms. Hillary Grasso:* For your continued support and advocacy of the Science Research Program. Community support is essential to the success of programs like ours, and your commitment helps ensure that our students have the resources and encouragement they need to pursue meaningful scientific exploration.

Chappaqua School Foundation: For funding countless grants that have positively impacted our students—and for the generous support that provided us with a new poster printer, retractable posters, and more. Your commitment to innovation and enrichment continues to elevate the student experience in meaningful ways.

Science Department: Ms. Berardi, Mr. DeBellis, Mr. DeMarie, Ms, Hannon, Mr. Prignano, Mr. McManus, Mrs. McDonnell, Mrs. Loprinzo, Mrs. Moore, Mr. O'Neill, Ms. Russo, & Mr. Lichorat, led by Mrs. McCarthy and Mr. Kuczma. It takes a great team of teachers that always willing to help.

Science Department Secretary: Pamela Tole keeping all of our competitons forms and events organized

Math Department led by Glenn Wong & Tammy Korman for their tremendous support with statistical analysis

Art/STEAM Department for not only help with printing, but also for helping print and sew numbers on all our posters

STEM PTA for helping us find mentors & listening to practices

Technology Team: Mr. Andrew Taylor, & Dr. Adam Schoenbart, Mr. Jesse Uhl, Ms. Ann Marie Tetelman

Admin Assistants: Pamela Tole, Lora Radanovich, Gabrielle Giordano, Maura Olson

GLC Team: Ms. Pamela Schembri & Collette Briody

School Counseling Team: Rebecca Mullen, John Brennan, Daniel Cohen, Annalise Curtin, Carolyn D'Agostino, John Dunphy, Matt Frielder, Bernadette Kenny, Conor Lander, Sara Lewis, Stephanie Lia, & Patrick McAuliffe

Chappaqua Bus Company for getting us to our competitions

Custodial Staff for allowing us to stay late for for setting up our many local events, especially today.

WHAT IS SCIENCE RESEARCH?

Introduction to Research Sophomore Year	This highly selective program is offered to motivated sophomores who will pursue a topic of interest and focus on that topic during the first year. The course covers literary search techniques, oral and written presentation skills, problem-solving, and experimental design. Students will be prepared to pursue independent research after finding a mentor and then plan out their research project together. Students must acquire a mentor to continue to advanced science research junior and senior year. Students will present a research plan at the Horace Greeley Symposium and at the Somers Science Fair in early June.
Advanced Research I Junior Year	This course is intended for students who have completed the Introduction to Science Research course. It offers them the opportunity to work on an independent research project. Students are encouraged to work with mentors from the scientific community. Students will complete a research paper in the fall and then create research presentations in poster format for WESEF and JSHS. In the spring, a research presentation will be required in poster format at the Horace Greeley High School Science Research Symposium. Students will check the Student Life Canvas page in June for the summer assignment. Students must work at least five hours outside of scheduled class per week.
Advanced Research II Senior Year	Students in this course will focus on communicating their science research projects in three formats: oral presentation, written paper, and poster presentation. Students must submit their research papers and posters to local, regional, statewide, and national competitions, including Regeneron Science Talent Search, JSHS, and WESEF is mandatory. Students must also participate in the Horace Greeley High School Science Research Symposium in the Spring. The time commitment in the Fall of Senior year can be significant. Seniors will also mentor the sophomores and juniors to ensure those just starting their research journey are provided another level of assistance.



Ms. Patel-Ma, Mr. Jerry Zupan & Dr. Haroula Argiros

"One of the most rewarding parts of this program is the opportunity to truly get to know the students over the course of three years—not just as learners, but as individuals. Watching them grow and evolve as researchers, from the initial spark of choosing a topic to the increasing sophistication of their posters from 10th to 12th grade, is a unique and deeply fulfilling experience."

- Ms. Priya Patel-Ma

"Each student is completing their own research project and we all get to learn so much from them. The community of students work together so we can all achieve more together. I love when I see students helping each other prepare for competitions, or revising their 12-20 page research paper."

- Mr. Jerry Zupan

"It has been an absolute joy to witness the incredible growth of our students. Seeing seniors celebrate their culminating projects at this symposium is a testament to the dedication and hard work they have poured into three years of science research. We couldn't be prouder of them all!"

- Dr. Haroula Argiros


SENIOR


CLASS


2025

NATALIE CAROUSSO



IRRELEVANT CONTEXTUAL INFORMATION: ELUCIDATING COGNITIVE BIAS' EFFECT IN DECISIONS RELATING TO A CARETAKER'S ACCOUNTABILITY IN CASES OF GRAND LARCENY AND MALICIOUS PROPERTY DAMAGE

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Cornell
INTENDED MAJOR/CAREER PATH	Pre-med

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

My proudest moment was being able to compete in JSHS this year!

FAVORITE MEMORY

My favorite research memory was the pen decorating party. I also loved our class pancake breakfast and the bus ride to JSHS.

WORDS OF WISDOM

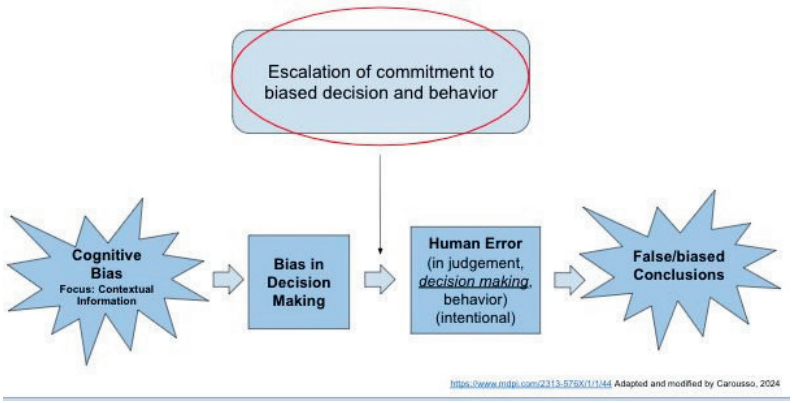
If your topic is something you are truly passionate about, research won't feel like busy work.

PROJECT ABSTRACT

In the last decade alone, racial bias contributed to thousands of wrongful convictions and unequal sentences due to racial profiling. Does racial bias, activated by irrelevant context, affect decision making? Searching for an answer to this question, I created a survey with a case study involving a caretaker's theft of $2,000 from their employer, and an additional case study involving a caretaker scratching their employer's car. I created two nearly identical versions of the survey, with the one difference being the race of the accused caretaker. Participants were recruited from other science research classes as well as a Facebook post, representing average people with no necessary background information on the subject. The diverse backgrounds of participants led to diverse answering choices. There were no significant discrepancies in results between the two survey versions. This result was pleasantly surprising as it alludes to no correlation between contextual information and racial bias. More research needs to be done on this subject, especially because similar studies have found significant correlations between bias and decision making. This study shows hope for humanity and a future of equal justice for all.

Irrelevant Contextual Information: Elucidating Cognitive Bias' Effect in Decisions Relating to a Caretaker's Accountability in Cases of Grand Larceny and Malicious Property Damage

How does racial bias ignited by reading irrelevant context effects extremity of sentencing in cases of grand larceny and malicious property damage?



Participants found through research class and Facebook ad
- Age range: 14-65
- Over 2x more females (46:21)
- 51% of participants labelled themselves White
- Majority report secondary education level

Two practically identical surveys (½)
- Only discrepancy was the **race of accused caretaker**
- Both caretakers were 31 yr/old male
- No prior criminal history
- Potentially relevant context (controversial)

First case study questions (involving theft of money)
- Should the caretaker be charged with grand larceny in the 3rd degree?
- Should the caretaker face jail time?
- Should the caretaker be fined? How much?

Second case study questions (involving scratching of luxury car)
- Should the caretaker pay for the repairs?
- Should the caretaker be fined?

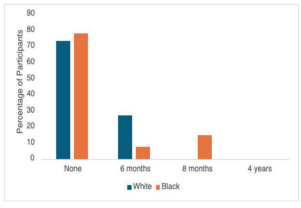
No significant difference in results between surveys

Race showed no measurable effect on bias levels

Contradictory to (Goyal 2015) and (Dror 2020)

Figure 6

The participants next decided whether the accused caretaker should face jail time.



Note: Blue bars represent the version where the caretaker was White, and the orange bars represent the scenario where the caretaker was Black. The chi-square statistic was 4.073, and the p-value was 0.076. The results were not significant with a p-value of less than 0.05.

Limitations:
- Potentially corrupted sample
- Displaying "correct" answer
- Personal opinion differences

Reasoning:

Randomness of participants in study
- Biases could cancel out
- Different from Dr. Dror and Dr. Goyal's studies where participants have same professions

Less bias displayed
- People able to control prejudice
- Don't let bias affect decision

Applications
- Counter to negative reflections of bias' effects on professionals
- Raises awareness to prejudice in the justice system
- Illuminates need for bias limiting tools

Future Research

Linear Sequential Unmasking (LSU)
- Limits bias by analyzing strictly evidence
- Practitioners input confidence levels
  - Restrictions placed

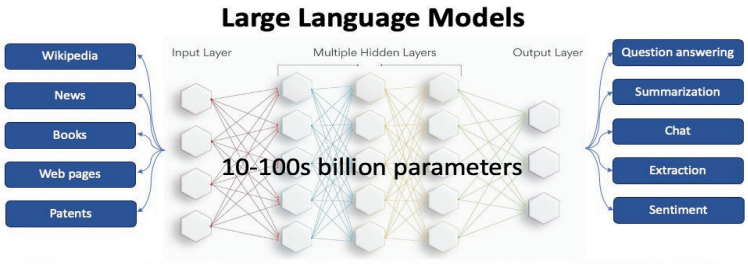
Analyze data breakdown between demographics

Problem	Goal	Hypothesis
• No one has explored bias' effects on average adults relating to judicial cases • Escalation to commitment of biased decision after reading context, leading to human error	• Explore how irrelevant context affects average adults determination in: ○ Cases of grand larceny ○ Cases of malicious property damage	• Racial bias would lead participants to suggest **less extreme punishments for the White caretaker** as opposed to the Black caretaker • **Hypothesis was NOT supported**

Lower AI Energy Consumption through Question Domain Triage Using LLM Embeddings

Benjamin Chang

Background and Objective:



The Rising Adoption and the Worry of Energy

High usage of LLMs

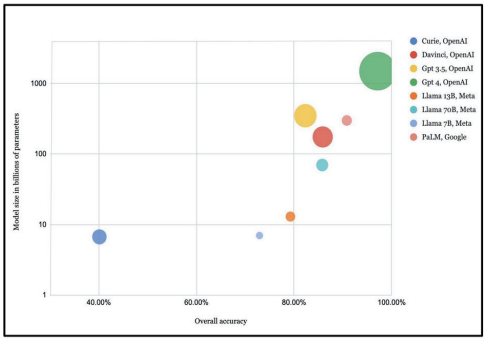
Environmental Impact

Model training and inferencing produces rapidly growing carbon dioxide footprint

Electricity usage → carbon emission

Objective:

To evaluate a **machine learning random forest classification model** trained on **LLM embedding vectors** of quizzes, and using the learned classifier for a **question domain triage** to route questions.



Data:

Classification metrics in different quiz categories

Domain	Precision	Recall	F1-score
Geography	0.41	0.86	0.55
Science	0.76	0.71	0.73
History	0.69	0.58	0.63
Math	0.55	0.87	0.68
Art, music	0.36	0.92	0.52
Sports	1	0.41	0.58
Literature	0.61	0.39	0.48
Other	0.66	0.16	0.26

Table A. classification metrics of eight knowledge domains from the disjoint NAQT datasets (training and test answers have few overlaps)

Question Triage Using LLM Embeddings

High accuracy with minimal data: Few hundred labeled samples + LLM embeddings → accurate domain classification (e.g., Geography, Arts). Smaller LLMs work well in subject-specific learning.

Multi-label challenges: Single-label constraints cause confusion (e.g., History/Literature ↔ Art). Multi-label classification (e.g., Art History) requires more data to avoid overfitting.

Mixed-subject limitations: General learning environments (e.g., quiz bowls) need larger LLMs for higher accuracy, despite higher energy use.

LLM embeddings validated: 2 categories >85% recall, 1 >85% precision.

Without embeddings, accuracy drops to random (12.5%). Smaller LLMs cost & energy efficiency for subject-specific use.

Methodology:

Continuation from previous project, using same questions

Transformed questions to embedding vectors of 1,536 dims w. OpenAI embedding-3 model

Random forest classifier trained on embeddin g vectors

Overview: An ensemble machine learning method that combines multiple decision trees to improve prediction accuracy and robustness.

Process:

Generates a collection of decision trees using random subsets of the training data and features.

Aggregates predictions by tallying votes from all trees (classification) or averaging results (regression).

Advantages:

Reduces overfitting by introducing variability among trees.

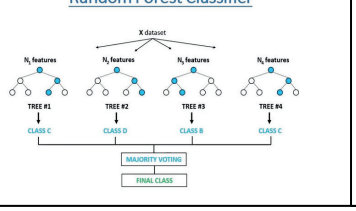
Provides feature importance scores to identify key variables in the dataset.

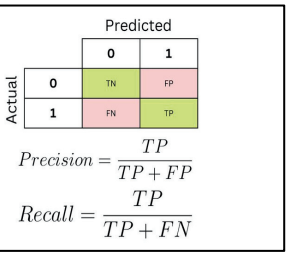
Application: Used for both classification and regression tasks.

Data compiled

Organized based on precision

Organized based on accuracy





$$Precision = \frac{TP}{TP + FP}$$

$$Recall = \frac{TP}{TP + FN}$$

Discussion:

Hypothesis & Results Summary

Hypothesis: LLM embeddings effectively represent knowledge context for academic quiz-like questions, enabling energy-efficient triage to smaller LLMs.

Key findings:

Smaller LLMs achieved >90% accuracy in Arts & Geography, validating their use in subject-specific educational contexts.

LLM embedding-based classification achieved recall >85% in Geography, Math, and Art, with precision >85% in Sports.

Without embeddings, accuracy dropped to random guessing (12.5%)

Application:

Targeted AI for education: Smaller LLMs can be strategically applied in selected contexts (e.g., Arts, Geography) to deliver efficient, eco-friendly AI solutions for academic question-answering.

High accuracy in focused domains: Smaller LLMs achieved >90% accuracy in Arts & Geography, showing potential for subject-specific educational use with lower environmental impact.

Approach generalizable to other applications to opportunistically leverage well-targeted small LLMs.

Future Focus:

Increase size and variety of training datasets by labeling questions with Frontier LLMs like GPT 4o, DeepSeek R1, i.e. LLM assisted labeling

Train multi-label classifiers for cross-domain questions, e.g. Art History

Leverage MoE (mixture of experts) models: Combine smaller LLMs with domain-specific fine-tuning to boost accuracy in targeted subjects while maintaining energy efficiency.

Explore next-gen LLMs: Investigate emerging architectures (e.g., sparse models, modular AI) to achieve higher precision & recall with lower computational costs.

BENJAMIN CHANG

LOWER AI ENERGY CONSUMPTION THROUGH QUESTION DOMAIN TRIAGE USING LLM EMBEDDINGS



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	NYU Tandon
INTENDED MAJOR/CAREER PATH	Engineering

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

- Finishing and printing out my first somers poster
- Finishing and presenting my posters at WESEF
- Being awarded: Excellence in Computer Science & Mathematics

FAVORITE MEMORY

I really enjoyed my time presenting in WESEF and ultimately gaining an award while gaining a lot of knowledge within the world of AI. I also enjoyed Arjun Menace climbing through the window.

WORDS OF WISDOM

Practicing your presentation once a day goes a long way. From a big guy I know: "Good things take time". And something I've always believed in: "Trust the process".

PROJECT ABSTRACT

The Large Language Model's rapid advancement since its inception in November 2022 has reinvigorated interest in Artificial Intelligence and led to predictions of a world of AI, which will automate mundane, repetitive chores in every industry. Accompanied with widespread adoption however, is the surging electricity consumption of AI data centers which grows faster than renewable energy supplies. This has led to discussions to build new nuclear power plants to meet surging electricity demand as well as shrinking LLM model sizes to save energy. Continuing from my science research project last year, which concluded smaller LLMs could be equally performant at answering academic quizzes in several knowledge domains, my current project focused on triage methods to dispatch domain specific questions to smaller yet fairly accurate LLMs to save energy. My proposed triage method applies a pre-trained knowledge domain classifier learned on LLM embedding vectors from labeled domain facts from geography, history, science, and art. A new question first has its embedding vector generated, then is classified to one of the trained knowledge domains, and finally gets routed to the smallest LLM applicable to answer questions from that domain. Even with a limited training data set of around 900 facts, I found the LLM embedding classifier reached recall scores above 85% in several domains for which small LLMs were shown to be competitive and energy saving. My research could lead to a more environmentally friendly adoption of AI for education and LLM assisted learning.

ROSHAN DHAND



PROJECT TITLE: SOCIAL, ECONOMIC, AND HEALTH DISPARITIES ASSOCIATED WITH DRUG, ALCOHOL, AND FIREARM MORTALITY IN THE UNITED STATES FROM 2014–2022

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Emory University
INTENDED MAJOR/CAREER PATH	Molecular/Cellular Biology & Public Health

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Taking the initiative to present my work beyond science fairs—at real conferences and symposiums—was incredibly rewarding, especially because of the interactions with doctors, policy analysts, and just curious people.

FAVORITE MEMORY

One of my favorite memories was making the science research trailer video with Andrew at my house and editing it together; it was a lot of fun!

WORDS OF WISDOM

I recommend finding a topic that genuinely interests you—and even if it's not your favorite, take every opportunity to learn and absorb new information. You might discover something you truly love along the way.

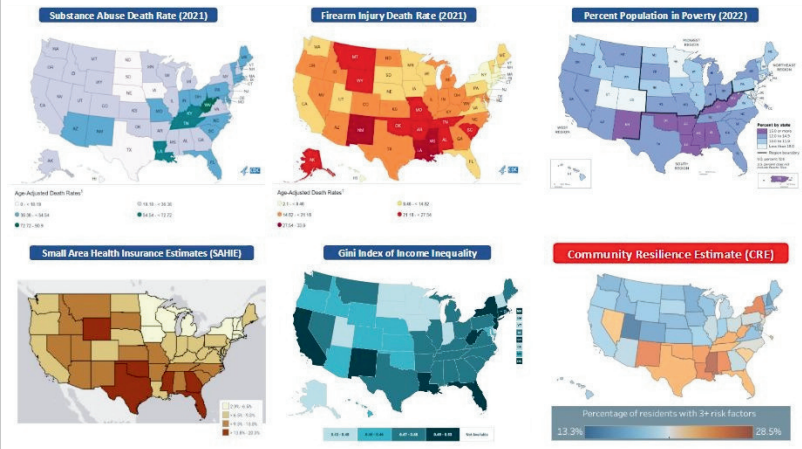
PROJECT ABSTRACT

Population-based deaths in the United States (US) from substance abuse and firearm injury significantly increased early in the coronavirus disease 2019 (COVID-19) pandemic and then persisted in 2021. Data regarding changes in firearm homicide and suicide deaths and alcohol- and drug-induced deaths through 2022, along with their associated county-level risk factors, are limited. We examined whether composite indexes of vulnerability like the Community Resilience Estimate (CRE showing the percent population with >3 risk factors) and Social Vulnerability Index (SVI) and other determinants of health are associated with these deaths. County-level crude rates of death from 2014-2022 were obtained from the Centers for Disease Control (CDC) WONDER database. CRE was obtained from the U.S. Census, the SVI from the CDC, and other risk factors from the Social Determinants of Health database. Deaths from alcohol, drugs, and firearms increased from 2014-2021, followed by lower or relatively stable rates from 2021-2022. Alcohol-related deaths decreased across all demographic groups, while drug-related deaths increased among American-Indians or Alaska Natives (15.1%). Firearm homicide deaths remained unchanged while firearm suicides decreased across all groups, except for an increase in American-Indians or Alaska Natives (23%). The CRE (2021), SVI (2022), and determinants of access to mental health treatment, substance/alcohol rehabilitation, and distance to health care facilities were significantly correlated with local firearm, drug, and alcohol death rates ($P<0.001$). These composite indexes can help predict risk of population-based mortality, which can guide future policies and resource allocation to mitigate excessive deaths from these causes.

Social, Economic, and Health Disparities Associated with Drug, Alcohol, and Firearm Mortality in the United States

Roshan Dhand,[1] Kenji Okumura,[2] Seigo Nishida,[2] Kevin Wolfe, A.[3] Dhand [2]
[1]Horace Greeley High School, Chappaqua NY / [2]New York Medical College / [3]Westchester Medical Center, Valhalla NY

Introduction & Research Question



Limitations: These maps only provide *visual relationships* between these social determinants of health and substance abuse and firearm injury death rates

HOW CAN WE USE THESE TOOLS TO *PREDICT* AT-RISK COMMUNITIES?

GAPS IN RESEARCH

1. Long-term Mortality

Studies have not fully explored substance abuse and firearm mortality trends in 2022

2. Predictive Tools

Limited use of tools like the SVI, CRE, and social determinants of health to assess disparities affecting these deaths

HYPOTHESES

1. Rates Decline/Stabilize

Substance abuse and firearm injury will remain constant or slightly decline in 2022

2. Risk Factors Align

CRE, SVI, and other social determinants of health will be associated with rates of death

Results

Mortality Trends

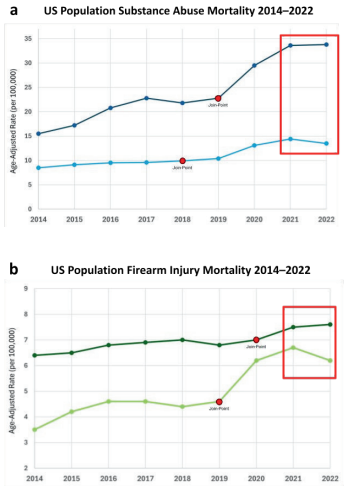


Figure 1. Selected Age-Adjusted Rates of Substance Abuse (a) and Firearm Injury Deaths (b) from 2014–2022

Access to Healthcare

Quartile Groups of Risk Factors		2021 Alcohol (N = 551)	2021 Drug (N = 892)	2021 Firearm (N = 504)
Access to Healthcare: Providers and Facilities				
Number of substance abuse treatment facilities with all three medications	Pearson Correlation	-0.158 P<0.001	-0.077 P=0.022	-0.208 P<0.001
Number of facilities that provide mental health services	Pearson Correlation	-0.252 P<0.001	-0.228 P<0.001	-0.255 P<0.001
Number of mental health care providers	Pearson Correlation	**-0.510** <0.001	**-0.373** P<0.001	**-0.359** P<0.001
Access to healthcare: Median distance in miles to healthcare facility using population weighted tract centroids in the county				
Distance to the nearest urgent care center	Pearson Correlation	**0.499** P<0.001	**0.323** P<0.001	**0.307** P<0.001
Distance to the nearest emergency department	Pearson Correlation	0.220 P<0.001	0.136 P<0.001	0.052 P=0.246
Distance to the nearest medical surgical ICU	Pearson Correlation	0.300 P<0.001	0.176 P<0.001	0.069 P=0.120
Distance to the nearest designated trauma center	Pearson Correlation	0.132 P=0.002	0.151 P<0.001	0.154 P<0.001
Distance to the nearest hospital with alcohol and drug abuse treatment	Pearson Correlation	0.389 P<0.001	0.245 P<0.001	0.187 P<0.001

Table 4. Correlation between county-wide mortality from firearms, drugs, and alcohol and quartiles of individual risk factors regarding access to healthcare.

Compiled Indexes

County-Level Mortality		2021 Firearm Deaths N	2021 Firearm Deaths Pearson Correlation	2021 Firearm Deaths Sig (2-tailed)	2021 Drug Deaths N	2021 Drug Deaths Pearson Correlation	2021 Drug Deaths Sig (2-tailed)	2021 Alcohol Deaths N	2021 Alcohol Deaths Pearson Correlation	2021 Alcohol Deaths Sig (2-tailed)
Compiled Indexes	2021 CRE	504	**0.538**	<0.001	892	**0.442**	<0.001	551	**0.489**	<0.001
	2022 CRE	501	**0.493**	<0.001	884	**0.439**	<0.001	544	**0.496**	<0.001
	2022 SVI	501	0.423	<0.001	884	0.190	<0.001	544	0.207	<0.001
Correlation Between Causes of Death	2021 Firearm		1		473	0.403	<0.001	416	0.310	<0.001
	2021 Drug	473	0.403	<0.001		1		519	0.196	<0.001
	2021 Alcohol	416	0.310	<0.001	519	0.196	<0.001		1	

Table 3. Correlation between county-wide mortality from firearms, drugs, and alcohol and compiled indexes

Methodology

Tracking Mortality

Mentor Role
- Supervise data collection
- Perform initial data analysis

Student Role
- Retrieve data from databases
- Final data analysis and organization

Data Extraction

CDC WONDER
- Datasets on mortality of US **general population**
- **Underlying causes of death** from 1999-2020 and 2018-2021

Study Design
- **US Population** (all ages)
- Study period of **2014-2022**

Death Categorization

Firearm Injury: Suicide, Homicide

Substance Abuse: Drug, Alcohol

Selection Criteria
- **Gender**
  - Male or Female
- **Racial groups**
  - White, Hispanic or Latino, Asian or Pacific Islander, American Indian or Alaska Native, and Black or African American
- **Census Divisions**
  - New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, Pacific
- ***By County***
  - Obtain values available for 3,144 U.S. counties

Programs
- Joinpoint Regression Software Version 5.3.0
- Excel 2024
- Statistical significance was defined as **p<0.01**

Statistical Analysis
- **Age-Adjusted Death Rates**: Age adjustment allows for fair population comparisons
- **Join-point regression**: Average Annual Percent Change (AAPC) of death rates

Evaluating Indexes & Social Determinants of Health

Social Vulnerability Index (SVI)

Integrated Components:

Below 150% poverty
Unemployed
Housing cost burden
No high school diploma
No health insurance

Racial & Ethnic Minority Status
Multi-unit housing
Mobile homes
Crowding
No vehicle
Group quarters

Age 65+
Age 17 or less
Disability
Single-parent households
Limited English proficiency

Estimated number of people with:
- 0 components of SV (Low)
- 1-2 components of SV (Medium)
- 3 or more components of SV (High)

Social Determinants of Health

Number of:
- Mental health care providers

Distance to the nearest:
- Urgent care centers

Quintiles based on strength: Counties divided into five groups from 1 (weakest) to 5 (strongest)

Community Resilience Estimate (CRE)

Integrated Components:

Income to Poverty Ratio <130%
Crowding (≥0.75 persons/room)
Communication barriers (low education or English skills)
Single or no caregiver
Age 65+

Full-time household employment
Disability limiting activities
No health insurance
No vehicle access
No broadband internet

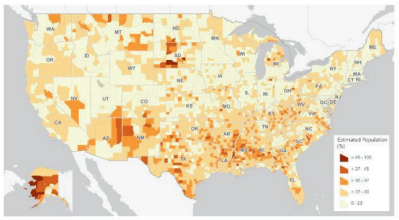
Overall SVI score (0–1) is calculated from:
- Socioeconomic Status
- Household Characteristics
- Racial & Ethnic Minority Status
- Housing Type & Transportation

Statistical Analysis

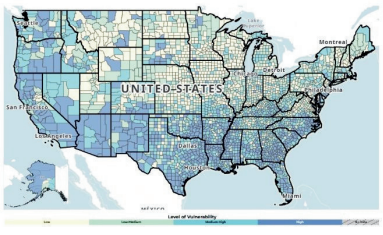
Pearson's Correlation Coefficient
- Associate county-level deaths with index or quintiles
- Produces a value (r) from -1 to 1
- Yield *positive* or *negative* correlation

Conclusions

Community Resilience Estimate: Percent Population w/ 3+ Risk Factors (2022)



Social Vulnerability Index (2022)



CRE (2021) shows a **strong positive correlation** with all deaths.

SVI (2022) has a **weaker but still significant** correlation with all deaths.

CRE isolates populations by risk level (0, 1–2, 3+) and may **better predict** counties at risk for death.

SVI offers a broad view of county vulnerability but may be **less precise** for specific mortality causes.

Which county-level risk factors are most predictive?

Number of mental healthcare providers has a **significant negative correlation** with alcohol, drug, and firearm death

22% of people who died of drug overdose had a mental health disorder in 2022 [24]

Distance to urgent care center has a **significant positive correlation** with alcohol, drug, and firearm death

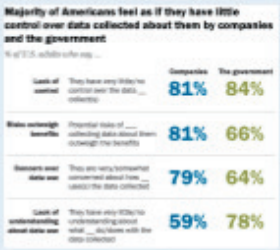
Longer travel times to urgent care centers exacerbate disparities in timely care, especially for acute conditions like drug overdoses and firearm injury [25]

Artificial Intelligence and User Data: A Study on Privacy Protection in Large Vision-Language Models

Amy Feng, Horace Greeley High School,

Problem

- ~⅔ of Americans experience data theft online
- Cybercrime costs **$10.5 Trillion** annually
- Online Large Language Models (LLMs): widely employed with a large demographic of users
- Potential for Personal Identifiable Information (PII) to leak through prompts
  - Dataset found that **59.67% of user prompts** contain privacy-sensitive keywords/objects





Goal & Hypothesis

Goal: To develop a model that is able to *increase user privacy* without impacting utility during large LLMs usage through multiple different methods of removing a PII object

- Previous models: **unscalable & inapplicable**

Hypothesis: Images ran through the model will have increased user privacy without compromising user utility, but boxing out an object will have a larger increase in privacy than blurring

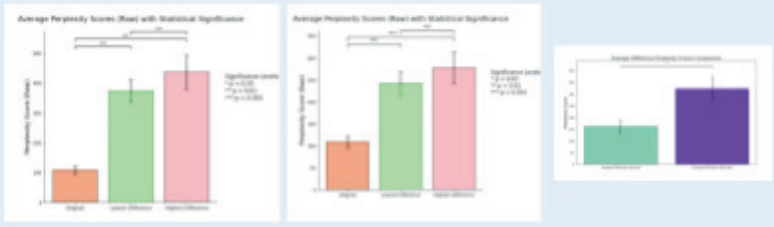
Results



Analysis #1: Confidence by ChatGPT

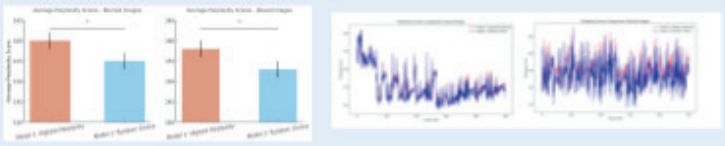
Major finding: modified images protect privacy by decreasing the confidence of ChatGPT to answer PII questions (*both methods* worked to decrease the confidence of the LLM)

Analysis #2: Perplexity Scores



Major finding: evidence that modified images protect privacy by increasing perplexity scores statistically significantly; blurring is more effective than boxing

Analysis #3: Naive vs. Developed



Major finding: developed model works better than naive

Methods: Developed Model



Methods: Data Analysis

Data Collection: 2015 Detection dataset of COCO, **5,000 images processed**

Three forms of Data Analysis

1. **Comparison of privacy through an online LLM**: original and modified images run through ChatGPT and paired with 8 PII questions to measure the difference in confidence response from the AI model
2. **Comparison of perplexity scores:** model calculated & compared perplexity scores (i.e. privacy scores) for original and modified images using paired t-test ($p < .05$)
3. **Naive versus. Developed model:** to demonstrate that the developed model's ability to recognize the best version of the modified image will help protect users more than randomly drawing, paired t-test used to compare ($p < .05$)





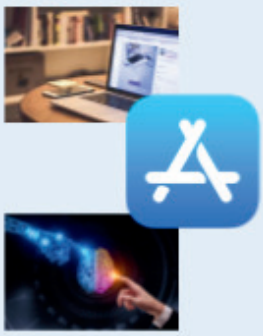
Discussion

Applications:

1. Creating a web application/website
2. Mobile application that users can download
3. Integrating model into existing security software for businesses or community spaces

Future Work:

1. Expand to two more methods of removing an object: rewriting and replacement
2. Work for verbal prompts, move past 'vision-language' model



Conclusion

Overall, this project was able to **fulfill expectations** and successfully reach its goal: protect user privacy during AI usage without hindering the user heavily

- Student developed effective model, ran all analysis, and completed project
- Both methodologies (boxing and blurring) were able to increase user privacy, as demonstrated
- Blurring tended to have a higher increase in user privacy than boxing, but both methods helped users
- Results backed by statistical analysis using paired t-tests

AMY FENG

PROJECT TITLE: ARTIFICIAL INTELLIGENCE AND USER DATA: A STUDY ON PRIVACY PROTECTION IN LARGE VISION-LANGUAGE MODELS



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of California, Berkeley
INTENDED MAJOR/CAREER PATH	Undergrad Business Major, Spieker, in Haas

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

During awards ceremony, seeing my friends and peers succeed and great awarded for their achievements always makes me so proud and happy, especially knowing how hard people worked.

FAVORITE MEMORY

Making pens during the class party, stealing snacks from the classroom, and playing pictionary. The pancake breakfast was a great memory too!

WORDS OF WISDOM

Even if your research project does not go exactly how you wish it did, sometimes the best results are the unexpected ones. Everyone is going to face obstacles during research - keep going!

PROJECT ABSTRACT

Nearly two thirds of Americans have experienced some form of data theft online. Artificial intelligence (AI), a fast growing industry, houses similar concerns, with 59.67% of user prompts to Large Language Models (LLMs) containing privacy-sensitive keywords. This project focuses on image prompts from users, as AI has been shown to gather substantial information from images. This paper introduces a novel model that modifies images from users with three modules: privacy, analysis, and user-interface. The researchers have incorporated two pre-existing models, YOLO and LLaVA, into the model and analyzed images from datasets publicly available online. This project consists of the following three major data analysis components: comparison of responses from ChatGPT when posed Personally Identifiable Information PII questions about images (e.g. "Where was this picture taken?"), comparison of perplexity scores between original and modified images (analyzed with a paired t-test), and a comparison between a naive model and the developed model. It was found that ChatGPT was unable to answer PII questions as clearly with modified images as it was for originals, demonstrating an increase in privacy for users, a preliminary analysis that illustrated the model's success. Furthermore, the modified images showed a significant increase ($p < 0.05$) in perplexity scores, quantifying an increase in user privacy and indicating an increase in difficulty for AI to gather private data from the user image. The final comparison between a naive model and the developed model demonstrated that the developed model was able to outperform the naive model regarding privacy protection.

JUSTIN GOLDBERG



PROJECT TITLE: ADA COORDINATORS' PERCEPTIONS OF POLICY IMPLEMENTATION IN NEW YORK CITY: A PUBLIC HEALTH PERSPECTIVE

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Tulane University
INTENDED MAJOR/CAREER PATH	Public Health

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

I have had the opportunity to compete at multiple competitions and showcase my research. I had the privilege of presenting my research to NYU faculty at the school of Global Public Health and be published in the journal of Public Health Disasters

FAVORITE MEMORY

My favorite memory from science research was going to New York City and working on my research project alongside my mentor and NYU faculty. In addition, I enjoyed seeing Arjun climb through the window.

WORDS OF WISDOM

Take advantage of your opportunities - This is your opportunity to dive deep into a specific topic that may lead you down unexpected paths. New opportunities may come of this, and make sure to take advantage of your resources and the people around you

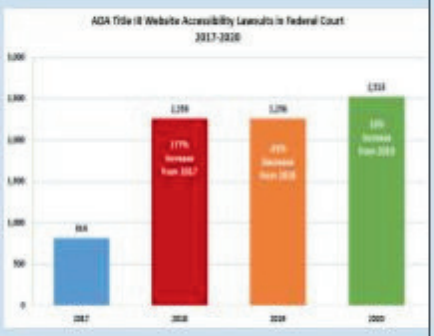
PROJECT ABSTRACT

Following a severe pandemic, the need for effective public health policy is as evident as ever. Effective policy must play a role in safeguarding our well-being and quality of life while encompassing regulations and initiatives that aim to improve the overall health of a specific population. Our understanding of the connections between public health policies and the conditions, perceptions, and perspectives that shape policy remains incomplete as studies have overlooked the direct experiences of policy implementers. In this study, the perspectives, perceptions, and working conditions of policy implementers were analyzed through a survey approach. This included self-efficacy, job satisfaction, and burnout levels among policy implementers compared to the efficacy of policy implementation. Data collected from the survey indicated that there are negative perceptions regarding the effectiveness of public health policies when achieving effective policy implementation goals, with notable room for improvement in policy inclusivity and adaptability areas. Statistical analysis indicated that all data analyzed was significant, as the ANOVA and Kruskal-Wallis p-values were less than 0.05. When forming the most effective policy, these external factors must all be taken into account as the majority of respondents indicated that they have little to no connection with the community when they create public health policy. It can be concluded that these external factors lead to lower levels of job satisfaction, self-efficacy, and high burnout ratings for policymakers, indicating poorer health outcomes within the specified population.

ADA Coordinators' Perceptions of Policy Implementation in New York City: A Public Health Perspective

Background

- Effective public health policy supports well being and promotes **equality**
- ADA coordinators serve as **policy implementers**
- Dynamic setting to explore equity, inclusion, and public health **outcomes**





Results & Analysis

- Majority rated ADA access and inclusivity as only **moderately** effective
- Self-efficacy **higher** among participants involved in peer support groups (p = 0.0265)

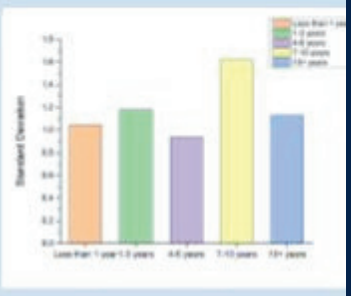


Table 1a. Descriptive Results for outcome variables

Perceived Self-Efficacy	
Overall, how would you rate your effectiveness with respect to ensuring ADA access?	N/%
Extremely effective	5(9.43)
Very effective	16(30.19)
Moderately effective	25(47.17)
Slightly effective	7(13.21)
Overall, do you feel you are ensuring inclusivity for people with disabilities in your jurisdiction?	
Strongly ensuring inclusivity	19(35.85)
Moderately ensuring inclusivity	23(43.4)
Slightly ensuring inclusivity	10(18.87)
Not ensuring inclusivity	1(1.89)
How familiar are you with your institution's diversity, equity, and inclusion (DEI) goals?	
Extremely familiar	15(28.3)
Somewhat familiar	7(13.21
Moderately familiar	18(33.96)
Slightly familiar	4(7.55)
Not at all familiar	9(16.98)

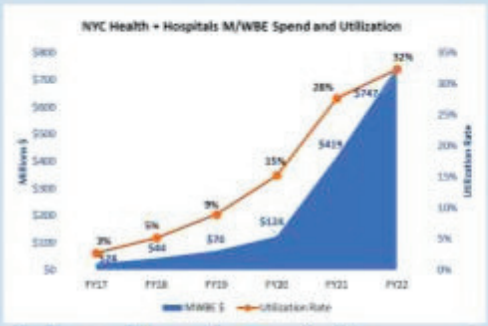
- DEI familiarity varied
- Awareness did not always align with **perceived effectiveness**
- Burnout levels low; job satisfaction moderately high

Methodology

- Targeted **ADA Coordinators** in the NYC metropolitan region
  - (n = 133)
- Survey assessed burnout, self-efficacy, DEI awareness, job satisfaction, and community connections
- Statistical tests included Chi-Squared, ANOVA, and Kruskal-Wallis
- Inspired by FEMA Region 9 survey study on disability preparedness
  - [Gershon, 2021]
- Mentor assisted with survey distribution, statistical review, and participant consent

Discussion & Conclusion

- Findings support the hypothesis: perception and satisfaction **influence policy effectiveness**
- Future efforts should focus on policy training, DEI education, peer support access



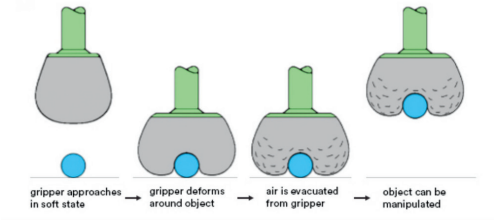
- **Need-based implementation** most optimal
- Results provide insights in terms of improving public health outcomes and policy implementation strategies

Designing a Particle Jamming Bag-Valve-Mask for Improved Seal Performance in Single-Person CPR

Audrey Ho

Introduction

- BVM ventilation is an airway management technique for CPR and emergency response. Air cushioned seal.
- Particle jamming involves transitioning a compliant, low-density packing of granular matter, into a rigid, high-density packing via externally applied stress [9].



Engineering Goal

- Problem: Unexplored uses of particle jamming and soft robotics in bag-valve-mask ventilation and design.

Engineering Goal: This project aims to create a successfu prototype for a soft robotic, particle jamming BVM to improve mask seal during single-rescuer CPR.

- Success will be defined as 500-560 mL of tidal volume (Vt) on a manikin, which provides sufficient ventilation, but will not cause damage to the lungs.

Methodology

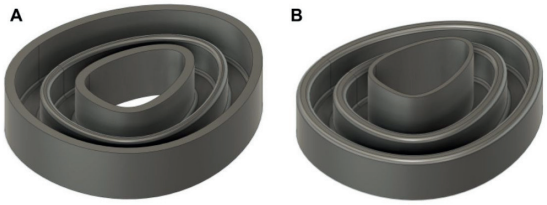
Student and Mentor Role
- Student independently constructed and tested the prototype, and developed the testing methodology
- Mentor advised student

3D printing
- Dual chamber reservoir design for increased surface area

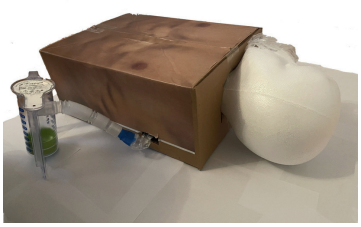
AUTODESK® FUSION 360™

Granular jamming
- Coffee grounds
- Negative pressure [10]
  - Syringe system

- Dual chamber reservoir system for cast moulding, along with ground coffee for granular jamming.



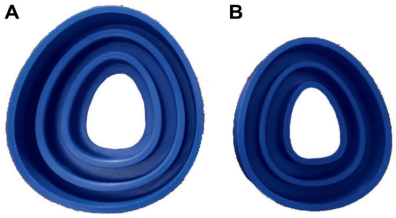
- Clear plastic bag, opening from the mannikin's "mouth" to a hole on the side of the chest
- Secured to an incentive spirometer mouthpiece.





Results

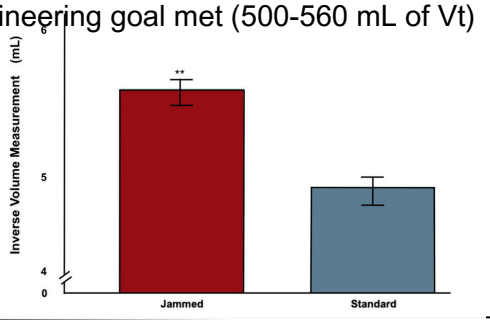
- Successfully devlived 516 mL of tidal volume Vt, meeting the benchmark of **500-560 mL**.
- Executed jamming air cushioned seal





Major Findings:

- Significant difference between jammed and unjammed
- p = 0.0046
- Engineering goal met (500-560 mL of Vt)



Explore alternative granular materials

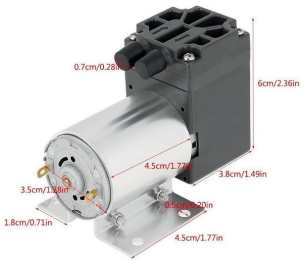
- Sand, glass beads Compliant, softer materials [14]
  - Ex. hydrogel beads Less rigid, but still mold to face topography





Attached vacuum system

- Changing syringe system [13]. Negative pressure
  - Attachment to mask





AUDREY HO

DESIGNING A PARTICLE JAMMING BAG-VALVE-MASK FOR IMPROVED SEAL PERFORMANCE IN SINGLE-PERSON CPR



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Cornell University
INTENDED MAJOR/CAREER PATH	Mechanical Engineering

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

David M. Holmes WESEF Engineering Innovation Award

BASF Expanding Knowledge in Science Award

FAVORITE MEMORY

Talking with the people next to me at WESEF.

WORDS OF WISDOM

Research can be tedious, but persistence is key. Keep pushing forward, even when the results don't come immediately.

PROJECT ABSTRACT

There are many challenges associated with an inadequate seal for bag-valve-mask (BVM) ventilations. In single-rescuer CPR compared to two-rescuer CPR, maintaining an adequate mask seal while delivering ventilations is difficult, as having two hands on the mask is more ideal, along with increased fatigue leading to improper technique. In addition, an improper seal can result in air leakage, leading to improper tidal volume measurements/readings, and cause the escape of nebulized medications. This study develops a prototype for a soft robotic BVM featuring particle jamming to enhance mask conformity and seal. By utilizing granular jamming with coffee grounds in the mask's cushioned area, this design allows the BVM to adapt to the patient's facial topology, reducing air leakage and enhancing ventilation efficiency. The prototype was tested for tidal volume (Vt) delivery, with a target of 500–560 mL, suitable for lung-protective ventilation. The jamming and standard BVM had a significant difference ($p=0.01$). These results indicate promising improvements in mask seal ability, suggesting applications in emergency care where single-rescuer CPR is required, and further research could explore alternative grain materials and jamming mechanisms to refine this prototype.

SARA JANKOVIC



TOPPLING THE DOMINO EFFECT: A NOVEL APPROACH TO PREDICTING SYSTEMIC BANKING DISTRESS USING INTERACTING NETWORKS ANALYSIS

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of Pennsylvania
INTENDED MAJOR/CAREER PATH	Finance and Mechanical Engineering

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Watching my friends and peers rise to receive their awards!

FAVORITE MEMORY

Playing Pictionary in class with my friends!

WORDS OF WISDOM

Don't let unexpected results surprise you! Take them with stride and turn them into your strengths.

PROJECT ABSTRACT

Banking crises have dire consequences for societal welfare—15 million people became unemployed during the 2008 GFC and the banking sector's equity dropped by 20% due to the 2023 Banking Crisis—that highlights the profound importance predictive modeling holds as a tool to mitigate and prevent banking crises. However, existing regulatory frameworks and most existing predictive models remain inadequate. While avoiding crisis is challenging, understanding the underlying dynamics may prove sufficient or give direction. Therefore, this study aims to develop a predictive bottom-up model using an interactive networks system framework composed of two layers to understand financial crises for means of prevention and mitigation. Last year, a model is developed, then fitted and tested using equity returns from the 2008 GFC, COVID-19 pandemic, 2012 Sovereign Debt Crisis, and 2023 Banking Crisis. The model accurately predicted crisis dynamics by closely following the time-series profiles of the cases and predicted crises with 80% accuracy as opposed to past models with low AUC values around 0.5. This year, safe haven nodes were added to the model infrastructure to simulate the influence of banks such as J.P. Morgan which at times bail out failing banks, as seen in historical crises. Such networks are found to be less crisis-prone and tend to stabilize quicker. Overall, this model holds significance as a unique tool for aiding monetary policymakers in navigating crises, holding the potential to revolutionize how monetary policy is applied in avoiding costly economic hardship with accurate prediction and significant flexibility.

Toppling the Domino Effect: A Novel Approach to Predicting Systemic Banking Distress Using Interacting Networks Analysis

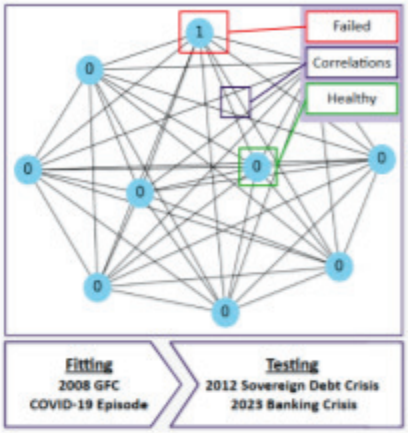
Sara Jankovic, Horace Greeley High School, Chappaqua, New York

Research Objective

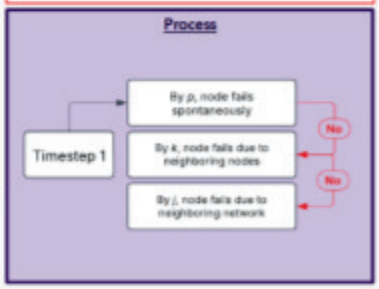
- Crucial to develop predictive methods to mitigate banking crises to prevent widespread detriment (like 2008)
- Current predictive banking models are largely insufficiently accurate
- Interactive networks is applicable to real networks, yet never used for banking
- Interactive networks analysis is applicable to the banking system using a two-layer system of global and regional banks.

Goal: Develop a model analyzing the banking system using an interactive networks framework consisting of two layers, regional and global, and achieve equivalent temporal dynamics and an accuracy of 80% or higher in predictive ability.

Methodology



Parameter	Definition
p	Independent spontaneous failure
q	Independent spontaneous recovery
k	Correlation between nodes
j	Correlation between networks



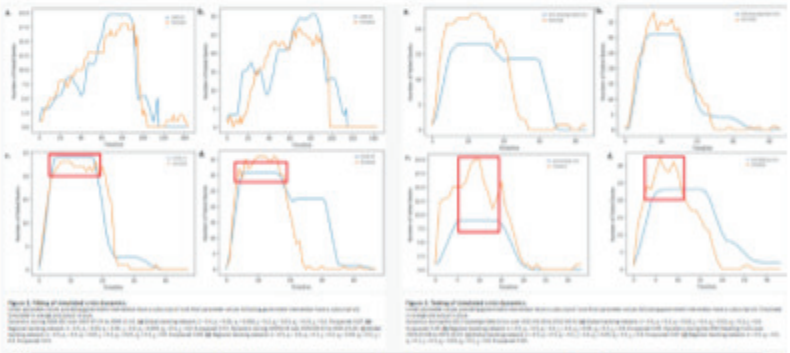
Data Collection:

- Daily stock prices of banks from Bloomberg
- 20%+ drop is considered a "failure"

Data Analysis:

- Examine R-squared values and time-series profiles

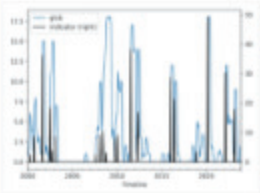
Results



Time-series profiles match + In-Sample R-squared ≥ 0.7 (0.87, 0.74, 0.89, 0.61)

Time-series profiles match + Out-of-Sample R-squared ≥ 0.5 (0.49, 0.95, 0.87, 0.69)

Produced model is sufficiently accurate at predicting the dynamics of banking crises in 4 cases.



- Out-of-sample accuracy: 80%
  - Overall accuracy: 88%
- Model displays **high degree of accuracy in prediction of crises**

Outperforms past models (Fricke, 2017) which indicate near complete randomness (50% accuracy).

Conclusion

- Applications:
  - Early warning system interrupting cycle
    - Potentially reduce ¾ of potential impact
    - For 2008, reduces from $11 trillion lost to **just $3 trillion lost**
  - Scenario risk analysis

Problem

No models sufficiently predict banking crises despite the broad, destructive impacts.

Engineering Goal

Develop a two-layered networks model that replicates actual dynamics with 80% accuracy.

Methodology

- Developed an **interactive networks model** with two layers (regional and global banks) and **normalization anchors** applied to **4 cases**
- Daily equity returns from 2000-2023 of **67 banks** (22 global, 45 regional)

Major Findings

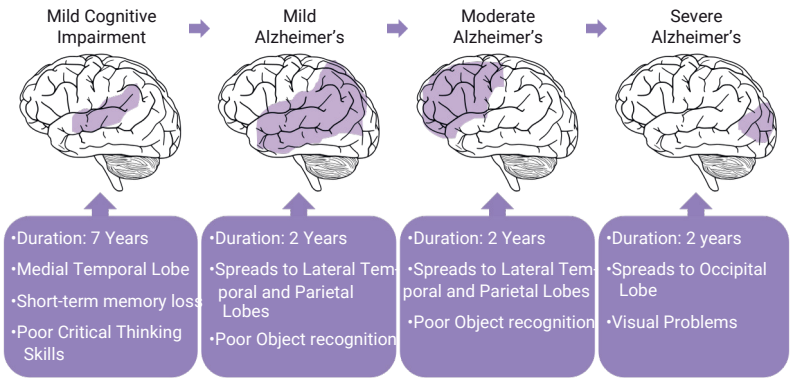
- Engineering goal affirmed → **model accurately describes dynamics & early warning system**
- **Outperforms past models → 80% accuracy**

Novelty

- Interactive networks framework → **bottom-up, microstructure** approach
  - Outperforms past **top-down** models
  - Describes not only **outcomes**, but also **crisis evolutions**
- Material improvement **in efficacy of avoiding crises over past models**

Introduction

Stages and Effects of Alzheimer's Disease



OBJECTIVES

Problem

Alzheimer's Disease is typically diagnosed in late stage after onset of severe symptoms

Current methods of AD diagnosis are either invasive or require complex feature engineering

Purpose

Develop a low cost and high accuracy tool for early detection of AD using machine learning algorithms

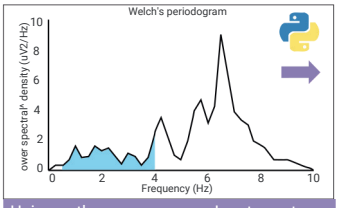
Develop a non-invasive and statistically accurate method for extracting and modeling AD relevant EEG data

Hypothesis

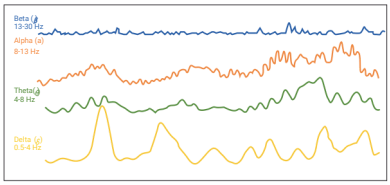
AD feature extraction and training of a supervised machine learning model on EEG data will create an AD detection tool with a >87.8% sensitivity (Houmani et al., 2018)

Using python programming for EEG data preprocessing

Transforming EEG data: Time to Frequency Domain



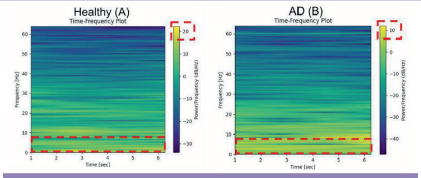
Using python program on Jupyter notebook: computation of power spectral density for each electrode (using Fast Fourier Transformation



Spectral Density time series data computed using time windowed computation of frequency band values. Window ranges from x = 20 (high frequency) to x = 100 (low frequency)

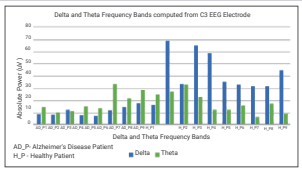
Feature Extraction for SVM Model

Using Time-Frequency Plot for Electrode Selection



Significant Difference: Time frequency plot of C3 electrode using Health Patient (A) and AD Patient (B), both with eyes closed

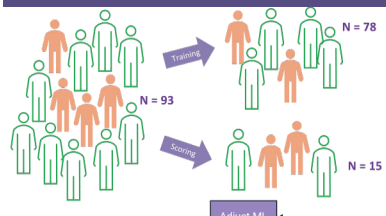
Healthy Patient has a higher power frequency for Delta and Theta frequency bands than AD Patient



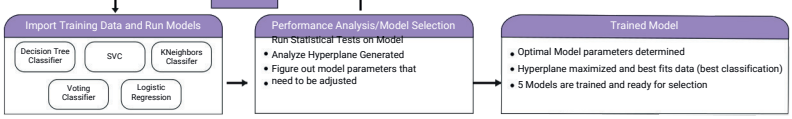
Significant Difference: Comparison of delta and theta powers (measured in μV2) for healthy and AD patients.

Clear difference in the absolute Delta power between AD and healthy patients

A scalable programming framework for multi-model training and selection of Support Vector Machines (SVM) Models



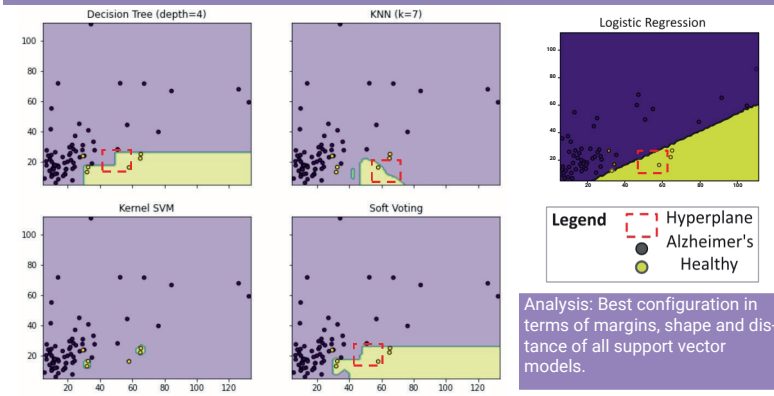
The dataset was randomly split into training (80%) and scoring (20%) for eyes closed cohort of patients



Results and Analysis

Experiment 1 of 20: Delta (δ) and Theta (θ) Frequency Bands from Motor Cortex of Right Hemisphere EEG Signal

Model Training Results



Analysis: Best configuration in terms of margins, shape and distance of all support vector models.

Plot of results of model training on a 2-dimensional feature space:
-AD and Healthy Patients are represented as black and yellow dots
-The hyperplane separates the two clusters
-Note that among the five classifier models, logistic regression represents the best fit on training data

Model Scoring and Sensitivity-Accuracy Calculations

Patient Id	Model Result	Verification
Patient 1	AD Positive	True Positive
Patient 2	AD Positive	True Positive
Patient 3	AD Positive	True Positive
Patient 4	AD Positive	True Positive
Patient 5	AD Negative	True Positive
Patient 6	AD Positive	True Positive
Patient 7	AD Positive	True Positive
Patient 8	AD Positive	True Positive
Patient 9	AD Positive	True Positive
Patient 10	AD Positive	True Positive
Patient 11	AD Negative	True Negative
Patient 12	AD Positive	False Positive
Patient 13	AD Negative	True Negative
Patient 14	AD Negative	True Negative
Patient 15	AD Positive	False Positive

Confusion Matrix			
		PREDICTED VALUES (N=15)	
		Positive = 11	Negative = 4
ACTUAL VALUES (N=15)	Positive = 10	True Positive (TP)= 10	False Negative (FN)= 0
	Negative = 5	False Positive (FP)= 2	True Negative (TN)= 3

$$Recall\ (RC) = \frac{TP}{(TP+FN)} \qquad Precision\ (PC) = \frac{TP}{(TP+FP)}$$

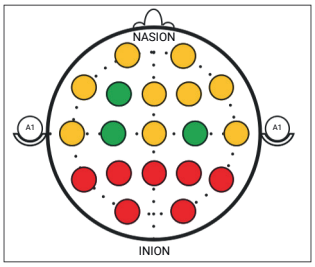
$$F1\ Score = 2 * \frac{PC * RC}{(TP+FP)} \qquad Accuracy = \frac{TP+TN}{(TP+TN+FP+FN)}$$

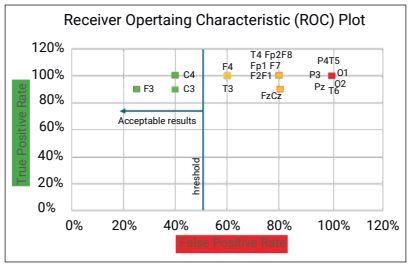
Metric	Recall	Precision	F1 Score	Acuracy
Value	100%	83.3%	91%	87.0%

Novel Finding: Using Logistic Regression Model,
-15 cases were processed to classify them as AD vs. Healthy
-12 were predicted correctly
-2 were false positive
-0 as false negative

Experiment 2 of 20: Delta (δ) and Theta (θ) Frequency Bands from Motor Cortex of Left Hemisphere EEG Signal

Comparative Result: Result of 5VM Model run on all electrodes using Delta (δ) and Theta (θ) frequency bands

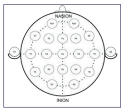




•Highest model accuracy at the Motor Cortex of Right and Left Hemisphere
•Delta (δ) and Theta (θ) frequency bands achieve the highest sensitivity and specificity
•Support Vector Machine Models trained on EEG data provides a scalable AD Detection

Conclusion

EEG Pre-Processing → Limitations → Results



Metric	Sensitivity	Accuracy
Value	100%	94%

Metric (Per Patient)	Dataset
Varies	180 Patients

The C3 and C4 electrodes best discriminants between AD and Healthy patients

Statistical measures demonstrate Logistic Regression model is reliable and can accurately detect patients

Short EEG Recording Intervals & Small Training Dataset

My Hypothesis was supported by statistical evaluations (<87.7% sensitivity), demonstrating a SVM Model is a reliable screening tool for Alzheimer's Disease

SHREY KUMAR

PROJECT TITLE: NEURAL BIOMARKER-BASED DIAGNOSIS OF ALZHEIMER'S DISEASE: AI MODELS SENSITIVITY AND ACCURACY RESULTS ON MULTIPLE ELECTROENCEPHALOGRAPHY DATA SETS



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Case Western Reserve University
INTENDED MAJOR/CAREER PATH	BME/Minor in Data Science

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

- 3rd Place JSHS Regional Finalist (Nat'l JSHS Finalist)
- 3rd Place in Computational Bio- WESEF (2024 and 2025)
- 3rd Place in Medicine and Technology and STANYS alternate (2024 and 2025)

FAVORITE MEMORY

- Playing tennis at JSHS nationals. It was so much fun to both present in front of the most pretigous researchers in the military, as well as have fun with people that have similar goals.

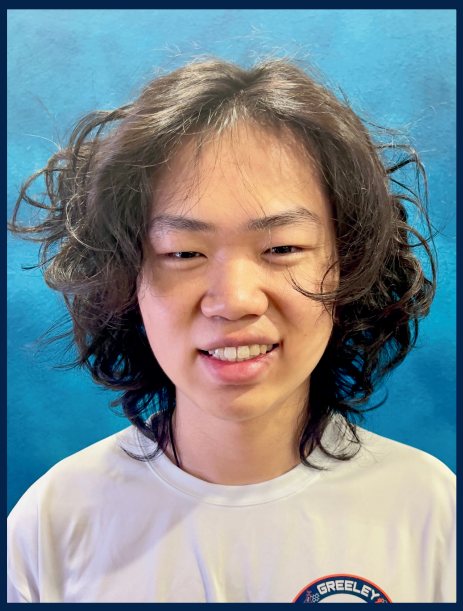
WORDS OF WISDOM

- My research journey had many problems and difficulties. However, if you keep working hard and are genuinely interested in your work, success will come.

PROJECT ABSTRACT

Millions of people in the United States suffer from Alzheimer's Disease (AD), an incurable form of dementia that continues to increase in prevalence. Current methods of AD diagnosis are limited to a late stage by which time the treatment options are limited, quality of life is poor, and cost of treatment is exponentially high. Early medical diagnosis of AD is difficult since non-invasive techniques require extensive tests and still generate false positives and negatives, leading to misdiagnosis. This study proposes supervised machine learning models trained on readily available Electroencephalography (EEG) patient data to diagnose potential AD patients. Relevant features were extracted and analyzed from two open-source EEG databases, collected from 180 patients and used in four experiments to train and test the machine learning model of best fit. Our artificial intelligence (AI) model is an alternative to current late-stage detection methods which require complex and risky procedures that can lead to inaccuracies. In addition, current algorithms require feature manipulation and sort through thousands of raw EEG data points to obtain unreliable results. The results demonstrate that, given EEG data of 180 close-eyed patients, the trained logistic regression model- the machine learning model of best fit - achieved 100% sensitivity and 94% overall accuracy for the C4 electrode, using data recordings of only eight second segments for each patient. This novel AD screening tool, with a cloud-based AI model, can be easily deployed at primary health care clinics to screen patients for AD during their yearly clinical visits to increase early diagnosis.

XIAOCHUAN (SHAWN) LIANG



GENERATIVE ADVERSARIAL NETWORKS IN MODELING PATIENT INTERNAL MOTIONS

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Cornell University
INTENDED MAJOR/CAREER PATH	Computer Science

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

USACO Silver
Qualified for AIME
Horace Greeley Summa Cum Laude Society
AP Scholar with Distinction

FAVORITE MEMORY

My favorite memory was probably the time when we made memes after WESEF in junior year. It was very therapeutic and honestly pretty funny

WORDS OF WISDOM

Don't stress about awards nearly as much as the actual knowledge you learn from your research. Even if competitions don't acknowledge your work, you'll have learned about something.

PROJECT ABSTRACT

Radiation therapy is widely used to treat cancerous cells; however, it is costly and has significant side effects if not properly used. During treatment, some organs, such as the liver, may shift slightly due to the patient's respiration, making accurate real-time tracking and contouring essential to minimize damage to healthy tissues. Current tracking systems usually include precise real-time positioning and contouring of the treatment area, which require costly imaging technologies to run throughout the entire therapy session, increasing the overall treatment cost and limiting the availability of advanced equipment like MRIs to hospitals. This research studies the application of Pix2Pix, a Conditional Generative Adversarial Network (GAN), as an alternative to traditional contouring methods in liver cancer radiotherapy. The result shows that a well-trained Pix2Pix can help accurately track liver movement during respiration. With AI computing power becoming increasingly affordable, I anticipate that GANs like Pix2Pix can be industrialized to make cancer treatment more accessible and cost-effective.

Generative Adversarial Networks in Modeling Patient Internal Motions

Shawn Liang

Introduction

Currently, about 50% of cancer patients have radiation therapy in their treatment plan, however, because of the need of MRI in radiation therapy, the cost of this treatment is very high.

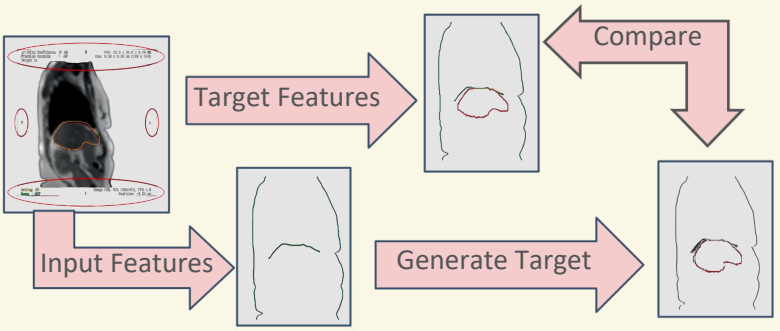
Goal

The goal of this research is to provide an alternative to MRIs in radiation therapy by using a conditional generative adversarial network to predict organ location based off the body outline and the diaphragm outline only.

Hypothesis

The predicted accuracy of the conditional GAN will be 90% or higher on the DICE scale, with only inputs on the body outline and the diaphragm outline. DICE will be explained in Methodology.

Methodology



DICE Coefficients

Due to our emphasis on measuring the area accuracy of our data, we decided to use DICE

DC: the **dice coefficient,** defined as

$$DC = \frac{2\,|T \cap P|}{|T| + |P|}$$

$$DC1 = \frac{|T \cap P|}{|P|} \qquad DC2 = \frac{|T \cap P|}{|T|}$$

T = Target organ area

P = Predicted organ area

Results & Discussion

Dataset	Avg DC	StdDev DC	Avg DC1	StdDev DC1	Avg DC2	StdDev DC2	Avg CD	StdDev CD	Avg Size	Max Move
s003	94%	0.8%	91%	2.5%	98%	1.8%	2.3	0.8	84.3	22.2
s004	96%	0.7%	97%	0.9%	95%	0.9%	1.1	0.4	85.8	10.0
s015	97%	0.7%	95%	1.1%	99%	0.7%	1.2	0.5	82.8	25.2
s026	95%	1.0%	96%	2.0%	95%	1.3%	1.6	0.7	76.9	20.4
s036	92%	2.0%	91%	2.5%	93%	3.9%	1.6	1.0	43.0	33.6
s048	89%	1.3%	84%	1.4%	94%	1.8%	4.5	1.1	68.2	39.2
-										
ss003	95%	1.1%	93%	2.3%	96%	2.0%	2.6	0.9	82.8	
ss015	95%	0.8%	95%	1.6%	95%	1.0%	1.3	1.0	81.5	
ss026	94%	1.4%	95%	2.2%	93%	2.9%	1.7	0.9	76.0	
ss036	89%	6.6%	88%	4.8%	91%	9.9%	1.9	2.3	43.1	

We found that in all 10 of our datasets, 8 of them support the hypothesis, while only 2 datasets have a DICE score of lower than 90%.

- Sets with ss mean shifted sets, essentially they are the same as their counterparts, just moved. These sets typically have lower accuracies than their counterparts.
- CD was also a good general accuracy indicator as anything higher than 3 is bad.

Applications

- Machine learning model is specifically made to be able to perform the job of an MRI in radiation therapy.
- The model should also be able to perform the job of other imaging methods such as x-rays or CT scans for very specific cases involving tracking organs.
- Could potentially be used to detect abnormalities in moving patterns of patient internal organs.

Future Research

- In the future I need to make a machine that would be able to use this model in an actual clinical setting.
- Additionally, I will need to improve the accuracy and the speed of the machine learning model.

Characterization of Nano and Micro Particles in Crumb Rubber Artificial Turf Infill

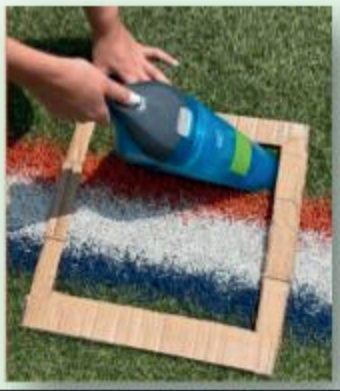
Research Problem:

- **Crumb Rubber** on Artificial Turf is known to contain a multitude of **carcinogens**
- No research regarding the size and concentration of artificial turf crumb rubber particulate
- Large gaps in current methodology regarding nanoplastic analysis



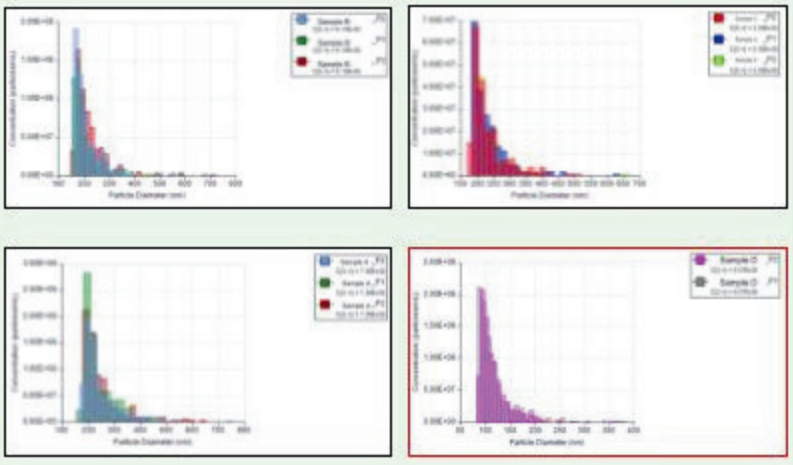
Novel Methodology:

- Collect samples of artificial turf crumb rubber
- Prepare liquid solution of Crumb Rubber
- Analyze samples using a **novel methodology** with the **TRPS exoid instrument**





Results:



Major Findings: Concentration over 100,000,000 nanoparticles per ml; all four samples, many particles as small as 88 nm; supports both hypotheses

Interpretation & Conclusions:

Hypotheses one and two supported; Crumb Rubber particulate is small enough to enter the human body through **inhalation** and **dermal contact**

No current restrictions on artificial turf crumb rubber; this research is important in policy making

HARPER MARGOLIES

CHARACTERIZATION OF NANO AND MICRO PARTICLES IN CRUMB RUBBER ARTIFICIAL TURF INFILL



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Boston College
INTENDED MAJOR/CAREER PATH	Global Public Health

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

- JSHS State Finalist
- NOAA Taking the Pulse of the Planet Award
- Fourth Place at WESEF for Environmental Science
- First Place at Somers for Environmental Science

FAVORITE MEMORY

- Pen Making
- The bus ride to WESEF
- Meme making
- Our promo video for science research from junior year

WORDS OF WISDOM

- You will learn so many important life skills from this class; from public speaking, to research papers, to posters, and more!
- Have fun and enjoy the experience, it's not just about winning.

PROJECT ABSTRACT

Artificial turf fields have become an increasingly popular playing surface globally. These fields are of concern for their crumb rubber infill, which has been found to contain many carcinogens and toxic chemicals. Our understanding of the size of the artificial turf crumb rubber particulate remains incomplete, creating an inconsistency in understanding if athletes are being exposed to these chemicals. In this study, we aimed to characterize the size and concentration of artificial turf crumb rubber particulates to better understand if these particles are small enough to enter the human body. Samples from nine artificial turf fields in the Westchester, New York area were collected. To analyze these samples, we developed a novel methodology in which the Tunable Resistive Pulse Sensing (TRPS) Exoid instrument was used to analyze nanoparticles of crumb rubber for their size and concentration. We found extremely high concentrations (greater than 2E+8 particles/ml) of nanoparticles in all four analyzed fields. Of these fields, we found particles as small as 88 nm, and a majority of our analyses noted that particles averaged between 100-200 nm. These results support that artificial turf crumb rubber particles are small enough to enter the human body through inhalation and dermal contact, and particles can also penetrate the blood-brain barrier and enter the bloodstream. We conclude that artificial turf crumb rubber particulate contains a high concentration of nano particles that have potential to enter the human body. This research is fundamental in determining the safety of artificial turf crumb rubber infill.

ARJUN MENON



GENE EXPRESSION PATTERNS OF RETINOBLASTOMA EV CARGO AND UPTAKE PROTEINS

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Columbia University
INTENDED MAJOR/CAREER PATH	Molecular Biology - Medical Policy

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Being able to present at ISEF 2024. I was fortunate enough to go with a group whom I enjoyed the company of, and it was an amazing learning experience.

FAVORITE MEMORY

Taking the bus back from WESEF, talking and having a good time with everyone.

WORDS OF WISDOM

Find a topic that gives you fulfillment. You don't have to enjoy every second of research, but you should do a porject that makes you feel proud.

PROJECT ABSTRACT

Retinoblastoma (Rb) is a rapidly developing cancer of the retina that metastasizes through extracellular vesicles (EVs)—lipid-encased particles released by cells to modify the tumor microenvironment (TME) for tumor growth. My previous research demonstrated that inhibiting surface protein activity on retinal cells decreases EV uptake and identified Clathrin-Dependent Uptake (CDE) as the primary mechanism driving metastasis in Rb. However, the spatial distribution of receptor proteins in the TME remains unclear. This study aimed to determine whether prominent uptake proteins are more abundant on retinal cells or EVs. Using Y79 retinoblastoma cells and their EVs, we analyzed the expression of HSPG2, VPS4, and DNM1 via qPCR. RNA isolation, cDNA synthesis, and qPCR were conducted following Gharbaran et al. (2021). mRNA levels were normalized to GAPDH, with ΔCT values calculated across three technical replicates using the CFX Connect Real-Time PCR System. Results showed that all three genes were present in both cells and EVs, with higher expression levels in cells. HSPG2 exhibited the highest expression in cells, followed by VPS4 and DNM1. In EVs, VPS4 had the highest expression, followed by DNM1, while HSPG2 was undetectable, likely due to low RNA concentrations. This study is the first to confirm the presence of these uptake proteins in this manner, which can lead to development of more targeted therapies.

Gene Expression Patterns of Retinoblastoma EV Cargo and Uptake Proteins

Arjun Menon

INTRODUCTION/RESEARCH QUESTION

Problem:

- Retinoblastoma (Rb) is a form of **ocular**
- **cancer** most common in infancy **Retinoblastoma metastasis** is associated with the production and proliferation of **extracellular vesicles (EV)**

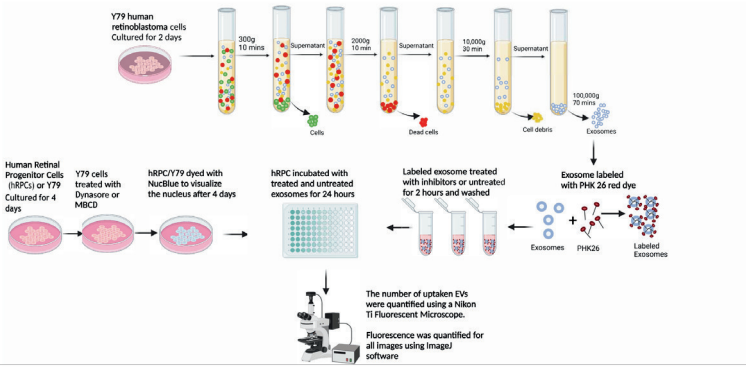
Gap in Research: Limited knowledge of retinoblastoma EV uptake proteins, endocytic pathway and drugs that can inhibit the uptake of retinoblastoma extracellular vesicles

Solution: Identify **novel drugs** that can **inhibit EV uptake** into healthy and cancer cells and thus **reduce retinoblastoma pathogenesis**

- **Aim 1:** Determine presence of uptake proteins (**VPS4, HSPG2, DNM1**) on the cells and their EVs through gene expression
- **Aim 2:** Determine the presence of oncogenes (**E2F3, KIF14, MDM4, MYCN**) in the Rb cells and their EVs

METHODOLOGY

Exosome Isolation



Quantitative PCR

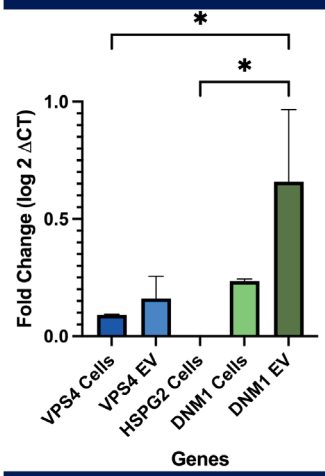
Primer design: NCBI –to get reference sequence of the genes. Primer design software to design sequence specific forward and reverse primers

mRNA extraction/cDNA conversion: mRNA was extracted from Y79 cells and EV. mRNA was converted to cDNA –to make the product stable

Quantitative PCR: Cells and EV were used for the expression analysis. Intercalating dye is used to display weak fluorescence in its unbound form

RESULTS

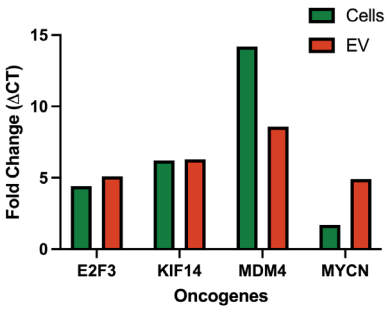
Gene expression of receptor proteins



Increased expression in the EV when compared to the cells for DNM1

No significant difference in VPS4 expression between cells and EV No expression for HSPG2 in both cells and EV

Gene expression of oncogenes



Increased expression for almost all oncogenes both in the cells and the EV

CONCLUSIONS

SIGNIFICANT FINDINGS

Uptake receptor genes were expressed both on the Rb cells and their EV
No expression for HSPG2 EV which was probably due to an experimental error
Oncogenes were expressed both in the cells and in the EV indicating transfer of material from cells to EV

SIGNIFICANT CONCLUSIONS

Uptake receptor genes were expressed on both Rb cells and their EVs Higher expression of DNM1 in EVs suggests uptake proteins on EVs play a greater role in EV uptake Both cells and EVs contain high protein concentrations, making them viable targets for uptake-blocking drugs

Evaluation of the Performance of Breakwater Designs at a Coastal Marsh Shoreline Using a Smartphone-Based Wave Intensity Sensor (WILSON)

Problem:

Coastal estuaries are disappearing. In order to find the right breakwater structures to protect these communities, we need to evaluate a structure's wave attenuation capabilities. To do this we need wave measurement devices. However, professionally used wave measurement devices are prohibitively expensive.

Objective:

Create a cost effective wave measurement tool (WILSON) and use it to measure waves and evaluate shoreline protection solutions (breakwaters)

Hypotheses:

H1: WILSON will accurately measure synthetic wave heights.
H2: WILSON will measure boat wakes.
H3: WILSON will observe breakwater efficiency and significance between structures ($p<0.01$).

Methodology:





WILSON was designed, created, and verified in the summer of 2023. During this time, the WILSON was used to collect boat wake data as well. In the summer of 2024, the WILSON was used to make statistical conclusions about various breakwaters by measuring how well they decrease the size of such boat wakes.

Phase 1: Device Calibration	Phase 2: Field Testing	Phase 3: Breakwater Research
Created and verified WILSON device Compared WILSON to professionally used wave measurement tool	Deployed WILSON in the field to measure boat wakes in the field Various vessels	Observed breakwaters wave attenuation capabilities Statistical comparison

Data Analysis and Results:

Calibration:
WILSON was found to measure synthetic waves within 10% accuracy.

Professional Device Comparison:
WILSON was found comparable to professionally used wave measurement tool with 10% variance between devices.

Field Testing:
The WILSON was able to measure boat wakes via displacement data after field deployments and video analysis.

Breakwater Research:
Verified boat wake data was then used to successfully compare various breakwaters in their wave attenuation capabilities ($p<0.01$). The largest breakwater with the most surface area was found to be the most efficient at attenuating waves.

Interpretations and Conclusions:

Affordable Kinematics Measurement Tool → Increased accessibility for physics based research + analysis

Smartphone Application in Marine Science/Engineering → Larger understanding of waterways, erosion, + recreational boating

With the creation of the WILSON device, there are endless possibilities for cost effective smartphone-based research in the fields of marine science and coastal engineering. It is crucial that we better understand our ever changing coastlines. With novel tools like the WILSON, researchers can better understand the harmful impacts of recreational boat wakes and make informed decisions about coastal engineering solutions like breakwaters.

NORA MORTON

EVALUATION OF THE PERFORMANCE OF BREAKWATER DESIGNS AT A COASTAL MARSH SHORELINE USING A SMARTPHONE-BASED WAVE INTENSITY SENSOR (WILSON)



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of North Carolina at Chapel Hill
INTENDED MAJOR/CAREER PATH	Marine Science

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

- Regeneron STS: Semifinalist
- NY-Upstate JSHS: 1st Place
- National JSHS Finalist
- WESEF: 2nd Place
- NYSSEF: 3rd Place
- NYSSEF: NOAA's Taking the Pulse of the Planet Award

FAVORITE MEMORY

My favorite memory from science research was JSHS, from the scary bus ride, to the competition day suspense, to the award ceremony, and playing cards on the way home, JSHS was an amazing and memorable experience.

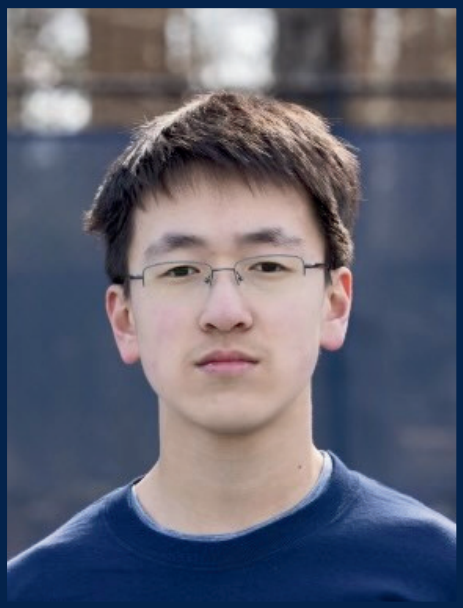
WORDS OF WISDOM

Find something you are interested in and chase every opportunity to get your work out there. You will never regret submitting to another competition, but you will regret missing out on the opportunity to try your best.

PROJECT ABSTRACT

Coastal wetlands, vital for wildlife habitat and natural flood defense, are critically threatened by sea level rise and eroding damage from wakes and waves created by recreational boating. Scientists, engineers, and coastal communities have partnered to test various "living shoreline" structures intended to reduce wave impacts on marsh. Comparing the efficacy of various breakwaters in reducing wave heights, I created a novel cost-effective wave action device, the **W**ave **I**ntensity **L**ogging **S**ensor **O**f **N**ora or "WILSON" and deployed it to compare three breakwaters protecting adjacent areas of the Intracoastal Waterway in New Jersey: Breakwater 1 (interlocking concrete blocks), Breakwater 2 (triangular concrete structures), and Breakwater 3 (geosynthetic tubes). The WILSON included an anchor, a float, and an iPhone operating SensorLog acceleration data collection. In 2024, I collected data from four units simultaneously, monitored boat and wave activity by a camera, and compared open water to individual breakwaters. Mean isolated-wave heights were reduced 57% by Breakwater 1, 21% by Breakwater 2, and only 11% by Breakwater 3, ($p<.001$) Breakwaters ⅔ insignificant from open water. In 1 hour intervals of ambient waves, Breakwater 1 reduced wave height 84%, Breakwater 2 reduced wave height 70%, Breakwater 3 attenuated 51% (not significant) and waves were reduced 21% across Open Water (no breakwater) (p 0.001). This constructed a reproducible method to collect wave data in a cost-effective manner accessible to students, teachers, or researchers. These studies can help inform coastal resilience infrastructure decisions and contribute to protection of both natural habitats and adjacent coastal communities.

ANDREW PANG



THE LANGUAGE OF INFLATION: TRANSFORMER WITH MIXED FREQUENCY ALIGNMENT IN TIME SERIES FORECASTING

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Georgia Tech
INTENDED MAJOR/CAREER PATH	Computer Science

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Completing and submitting my STS application on time.

FAVORITE MEMORY

Making pancakes in class.

WORDS OF WISDOM

Don't take yourself too seriously, enjoy the experience and the process.

PROJECT ABSTRACT

Time series forecasting is a significant domain of research with meaningful applications in healthcare, natural sciences, and economics. One of its major uses is inflation forecasting, the importance of which was accentuated by the devastating impact of the 2021 global inflation surge. However, a current challenge in state-of-the-art (SOTA) time series forecasting models is effective cross-channel leverage of mixed-frequency inputs without drastic information loss, particularly on the temporal axis. Therefore, the Parametric Alignment for Mixed Frequency Transformer (PAMFT) model is proposed, consisting of a frequency alignment mechanism feeding into a Transformer architecture. Four frequency alignment mechanisms were explored: (1) flat interpolation, (2) linear interpolation, (3) fully-connected layers, (4) parametric fully-connected layers. The model was subsequently trained and tested on a dataset of Consumer Price Index (CPI) and various economic indicators in the US between 1979-2024. It was found that the PAMFT model outperformed multiple SOTA models in testing, including the Philadelphia Fed's Survey of Professional Forecasters (SPF). Both in the pre-pandemic and post-pandemic periods, the PAMFT model outperformed the SOTA in terms of RMSE by 62.1% and 72.4% respectively. This model can be applied to improving SOTA inflation forecasting, assisting policymakers and everyday consumers alike in being better informed of macroeconomic trends, and potentially mitigating financial impact particularly during crisis periods.

The Language of Inflation: Transformer With Mixed-Frequency Alignment in Time Series Forecasting

By: Andrew Pang

Aim of Research

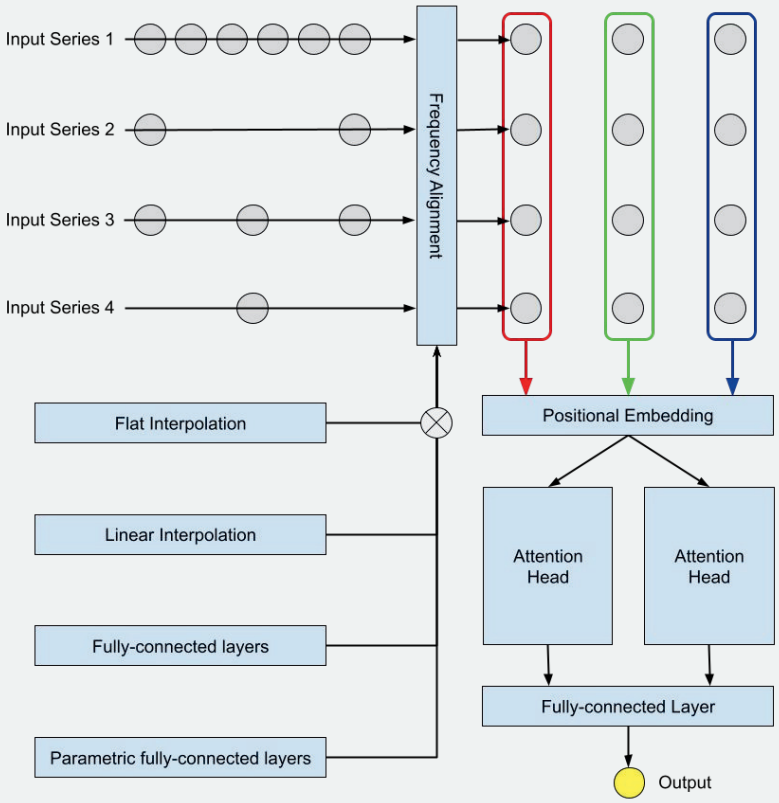
Contribution #1

Propose the Parametric Alignment for Mixed Frequency Transformer (**PAMFT**), a novel TNN architecture for time series forecasting tasks involving **mixed-frequency** data. PAMFT is composed of a novel **frequency alignment mechanism** feeding into a traditional Transformer architecture

Contribution #2

Perform **predictions** using PAMFT on the **US inflation index**, and evaluate its performance through comparison with common benchmarks such as AR(1), Phillips Curve, VAR(1), Aggregation, SPF, and PaLM.

Methodology



Results

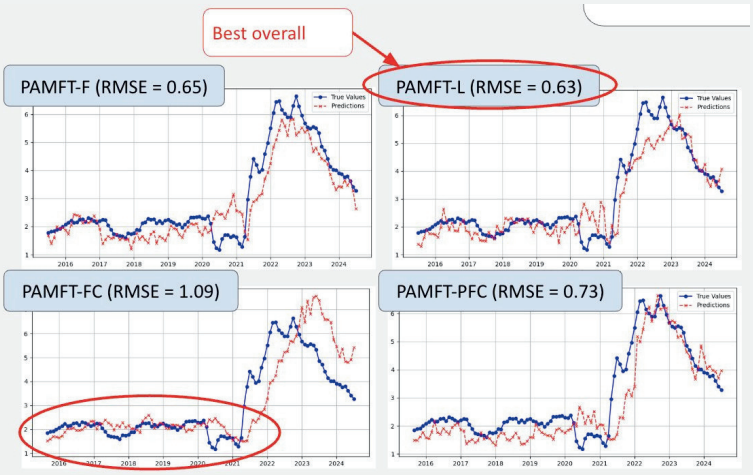


Table 4: Testing results (RMSE) of the 4 PAMFT models are compared against benchmarks on the pre-pandemic, post-pandemic, and full sample periods. Percent changes of RMSE error terms of the PAMFT compared to current SOTA methods are also provided.

Model	RMSE (pre-pandemic)	RMSE (post-pandemic)	RMSE (Full Sample)
AR(1)	1.17	-	-
Phillips Curve	1.06	-	-
VAR(1)	1.13	-	-
Aggregation	0.96	-	-
SPF	0.75	5.70	-
PaLM	-	3.02	-
PAMFT-F	0.371	0.844	0.653
PAMFT-L	0.319	**0.834**	**0.633**
PAMFT-FC	**0.284**	1.512	1.093
PAMFT-PFC	0.462	0.919	0.734
% change	-62.1%	-72.4%	-

Benchmark validation

PAMFT exceeded all industry benchmarks

Pre-Pandemic: 62.1% improvement

Post-Pandemic: 72.4% improvement

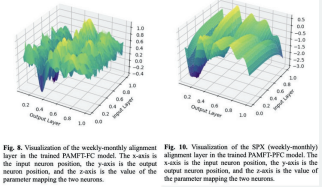


Fig. 8. Visualization of the weekly-monthly alignment layer in the trained PAMFT-FC model. The x-axis is the input neuron position, the y-axis is the output neuron position, and the z-axis is the value of the parameter mapping the two neurons.

Fig. 10. Visualization of the SPX (weekly-monthly) alignment layer in the trained PAMFT-PFC model. The x-axis is the input neuron position, the y-axis is the output neuron position, and the z-axis is the value of the parameter mapping the two neurons.

Conclusion

Contributions

1. **Propose** the PAMFT consisting of a frequency alignment mechanism feeding into a transformer
2. **Evaluate** PAMFT on US inflation index and compare with industry **benchmarks**

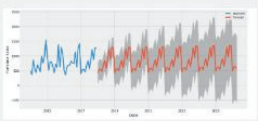
Application

Improve state-of-the-art inflation forecasting → better inform American public and authorities

Can be used in other fields → healthcare, energy market, climate

Future Work

1. Adapt the model for long-term forecasting



2. Improve interpretability in the transformer architecture
3. Expand PAMFT to other applications

The Influence of Time-of-day on Serotonin Neurons and Serotonergic Chemosensitivities after Induced Seizures

Introduction

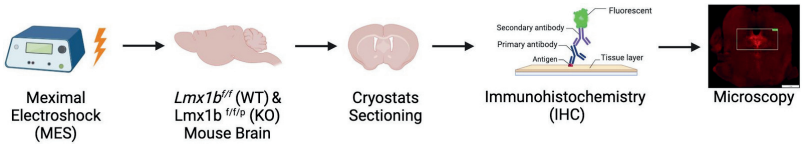
- Epilepsy is a neurological disease associated with spontaneous seizures.
- 1 in 26 people will develop epilepsy in the lifetime.
- Sudden unexpected death in epilepsy, or SUDEP, is a phenomenon where seizures result in death.
- SUDEP occurs more frequently during the night for both diurnal human and nocturnal mouse models.
- The mechanism driving the nighttime risk of death in SUDEP is *unknown.*
- The neurotransmitter serotonin (5-HT) is the target of study, due to its known daily fluctuations in the brain, relationship with seizure mortality and severity, and role in CO_2 chemosensitivity.

HYPOTHESES

1. Circadian rhythm disruption (Lmx1b Knock-out and para-chlorophenylalanine, PCPA) will result in fewer 5-HT neurons at night and increase recovery time to seizure-associated death.
2. 5-HT-dependent chemosensitivity (CO_2 arousal, autoresuscitation, and post-ictal recovery) will be time-of-day-dependent, with nighttime seizures resulting in impaired arousal mechanisms and prolonged recovery times.

Methods & Materials

Experiment #1 - Neuroanatomy



Experiment #2: Serotonin Physiologies + The Development of a Novel Open-loop System

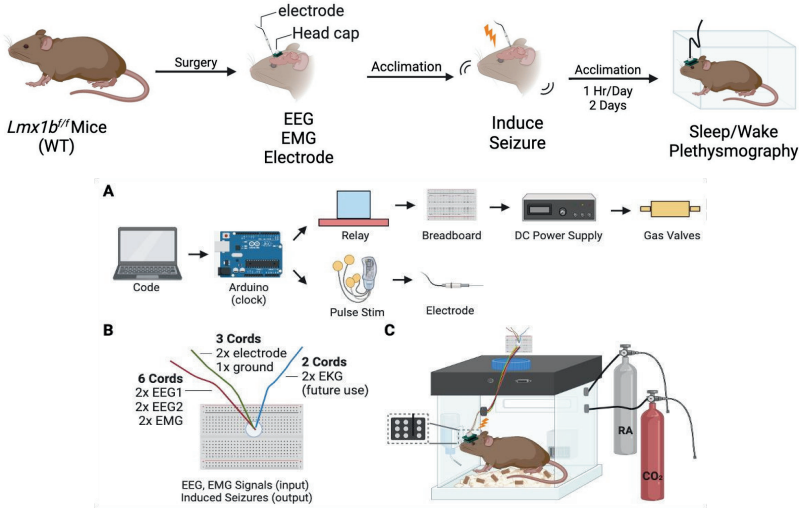


Figure 1. Novel open-loop system, Plethysmography (Pleth) chamberand Mice's head caps were refined based on research part 1. A, A flow chart that shows the design of the system with the addition of electrode to induce seizures after attaching with the novel head cap. **B,** Illustrative design of the new head caps with a novel function of receiving signals from the open-loop system to induce seizures to the mice. **C,** Representative graphic of the plethysmography chamber with an improved design for better sealing. Graphs are made and prepared using BioRender.

Results & Discussions

Experiment #1 - Neuroanatomy

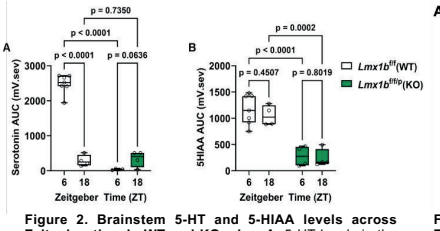


Figure 2. Brainstem 5-HT and 5-HIAA levels across Zeitgeber time in WT and KO mice. A, 5-HT levels in the brainstem are significantly lower during the nighttime (ZT18) compared to the daytime (ZT6) in WT mice. In KO mice lacking 5-HT neurons, levels remain consistently low at both time points. **B,** The metabolite 5-HIAA follows a similar pattern, with significantly lower levels at ZT18 than ZT6 in WT mice, but no difference in KO mice.

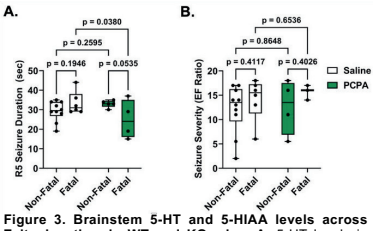


Figure 3. Brainstem 5-HT and 5-HIAA levels across Zeitgeber time in WT and KO mice. A, 5-HT levels in the brainstem are significantly lower during the nighttime (ZT18) compared to the daytime (ZT6) in WT mice. In KO mice lacking 5-HT neurons, levels remain consistently low at both time points. **B,** The metabolite 5-HIAA follows a similar pattern, with significantly lower levels at ZT18 than ZT6 in WT mice, but no difference in KO mice.

Experiment #2: Serotonin Physiologies

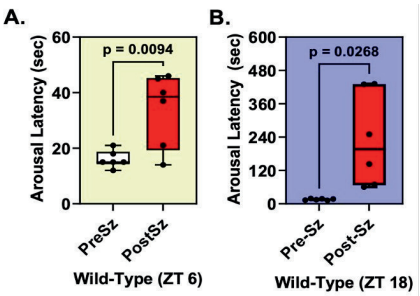


Figure 4. Nighttime seizures impair CO2 arousal in wild-type mice. A, Arousal latency in response to CO_2 is compared before (PreSz) and after (PostSz) seizures during the daytime (ZT6). A significant increase in arousal latency is observed post-seizure ($p = 0.0094$). **B,** Arousal latency in response to CO_2 is compared before (PreSz) and after (PostSz) seizures during the nighttime (ZT18). The increase in arousal latency post-seizure is more pronounced at night ($p = 0.0268$). Data are represented as box-and-whisker plots, with median and interquartile ranges.

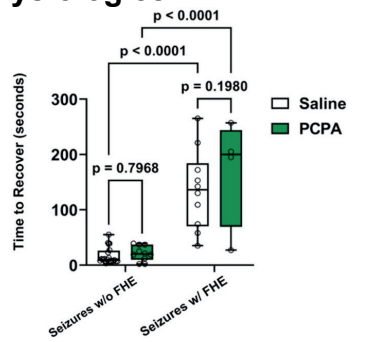


Figure 5. Post-Ictal Recovery Times for Seizures with and without Full Hindlimb Extension (FHE) in Saline- and PCPA-Treated Mice. The box plot shows the recovery time (in seconds) for seizures without FHE (left) and seizures with FHE (right) in saline-treated mice (white boxes) and PCPA-treated mice (green boxes). Statistical significance between groups is indicated by p-values.

Future Directions & Applications

Future Directions

1. Find time-of-day-dependent regulation of 5-HT-associated genes.
2. Explore alternative serotonin physiologies before and after induced seizures.
3. Study serotonin levels and gene expression patterns using iDISCO (whole brain tissues).

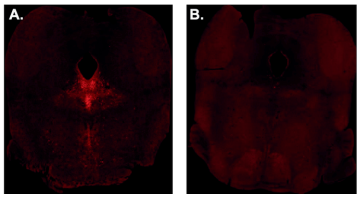


Figure 6. Representative IHC from mice lacking serotonin neurons and wild-type littermates. A, wild-type (*Lmx1b*$^{f/f}$) and B, knock-out (*Lmx1b*$^{f/f/p}$).

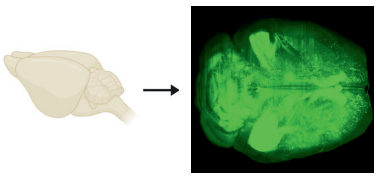


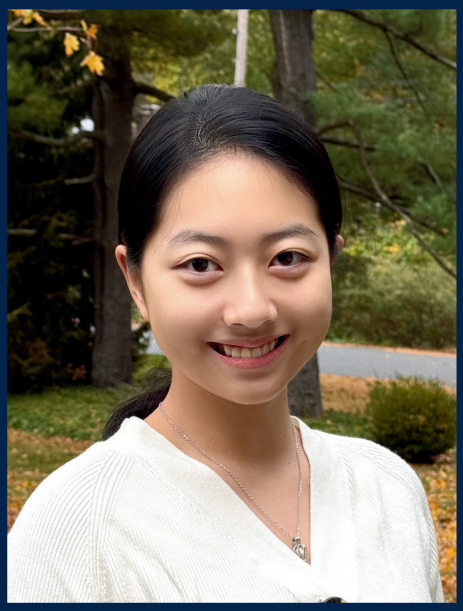
Figure 12. Representative graph of iDISCO (three-dimensional imaging of solvent-cleared organs) created using BioRender and online source.

Future Applications

1. Open-loop System: Reduce confounding variables for better understanding of circadian rhythms & time-of-day dependent physiologies.
2. Chronotherapeutic Strategy: Improve or develop treatments to reduce the nighttime risk of death by optimizing the timing of medicines.
3. Raise public awareness of epilepsy to reduce bias and encourage support for patients and families.

ZIRUI (REMEY) SONG

PROJECT TITLE: THE INFLUENCE OF TIME-OF-DAY ON SEROTONIN NEURONS AND SEROTONERGIC CHEMOSENSITIVITIES AFTER INDUCED SEIZURES



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	University of California, San Diego
INTENDED MAJOR/CAREER PATH	Neuroscience, Pre-med

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

2024 NYSSEF Finalist (Honorable Mention Awards)
2024 USABO National Finalist
2023&24 USMDO Gold Medalist
2024&2025 ISU World Junior Synchronized Skating Championships Bronze Medalist

FAVORITE MEMORY

Getting sweet treats (mints, candies, chocolate bars, & etc.) from Mr. Zupan every class.

WORDS OF WISDOM

Be prepared. Be confident. Be relaxed. And more importantly, HAVE FUN!!!

PROJECT ABSTRACT

Sudden unexpected death in epilepsy (SUDEP) primarily occurs during the night, and accumulating evidence in mouse models of seizure-associated death also demonstrates nighttime risk independent of sleep state. The neurotransmitter serotonin (5-hydroxytryptamine, 5-HT) has been implicated in SUDEP due to its time-of-day fluctuation, role in CO2 chemosensitivity, awakening in response to increased CO2. Seizures may impair normal serotonergic activity, preventing appropriate respiratory and arousal responses to increasing CO2. We hypothesized that: (1) circadian rhythm disruptions (Lmx1b Knock-out, KO and para- chlorophenylalanine, PCPA) will result in fewer 5-HT neurons in the nighttime, and increases recovery time to seizure-associated death. (2) 5-HT-dependent chemosensitivity (CO2 arousal, autoresuscitation and post-ictal recovery) will be time-of-day-dependent, with nighttime seizures resulting in impaired arousal mechanisms and prolonged recovery times. We used high-performance liquid chromatography (HPLC) to measure 5-HT and its metabolite 5- Hydroxyindoleacetic acid at different times of day and chemically depleted serotonin using PCPA to test how time-of-day influence seizure mortality. To increase experimental accuracy, mice were housed in a refined novel Plethysmography chamber and novel open-loop system to perform CO2-O2 gas challenges automatically to test serotonin chemosensitivities. We found brainstem 5-HT levels were lower at night in both Lmx1b WT and KO mice. Serotonin depletion via PCPA or Lmx1b KO disrupted time-of-day serotonin fluctuations, worsened recovery from seizures with full hindlimb extension (FHE), and increased nighttime vulnerability to seizure-associated mortality After amygdala-kindled seizures, CO2 arousal, autoresuscitation, and post-ictal recovery time was profoundly worsened in the nighttime with a longer time to wake up after a respiratory arrest.

MORGAN TSAI



OPTIMIZING AIR QUALITY CLASSIFICATION: A COMPARATIVE ANALYSIS OF LARGE LANGUAGE MODELS AND DEEP LEARNING MODELS TO PROVIDE AN ACCESSIBLE HEALTH PLATFORM

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Boston University
INTENDED MAJOR/CAREER PATH	Behavior and Health

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

- NOAA Oceanic and Atmospheric Administration's Taking the Pulse of the Planet Award
- Mind Matters VP
- Assistant editor of teen newspaper

FAVORITE MEMORY

Competing in competitions and getting to see other student's projects.

WORDS OF WISDOM

Don't be afraid to ask for help when needed-the course is built for you to have support when doing research for the first time!

PROJECT ABSTRACT

Air pollution causes over 6 million premature deaths annually worldwide. High quality air pollution detectors are costly and hefty, making it less feasible for large scale deployment. Traditional air quality monitoring relies heavily on fixed monitoring stations and costly equipment, which limits accessibility. To address this issue, we propose a photo based air quality system, leveraging smartphone technology to estimate air quality through image analysis. Large language models (LLMs) and deep learning models can analyze visual indicators such as haze and visibility in order to approximate air quality levels. Assessing air quality based on photos enables accurate air quality information, crucial to those with health vulnerabilities. In this project we hypothesized that existing deep learning models will provide a more accurate analysis compared to LLMs based on deep learning models being able to be customized for air quality. Using air pollution images to demonstrate how deep learning models can efficiently identify air quality from photographs, deep learning models show a superior performance compared to all large language models tested, offering a cost-effective solution to measuring air quality world wide. We tested multiple LLMs and deep learning models to evaluate their performances in classifying air quality levels. The results showed that deep learning models outperform LLM architectures in accuracy, showing possible potential in deep learning being a reliable method for global air quality assessment in underserved areas.

Optimizing Air Quality Classification: A Comparative Analysis of Large Language Models and Deep Learning Models to Provide An Accessible Health Platform

Q1: Research Question

Objectives:

1) Compare performance of ResNet, EfficientNet, VGG, and DenseNet in categorizing air quality from images
2) Examine the abilities of large language models (LLMs) in accurately assessing air quality

Problem Statement:

1) Air quality continues to cause millions of premature deaths
2) Little research in comparing different convolutional networks (CNNs) in categorizing air quality

Hypothesis:

CNNs will outperform large language models (LLMs) in categorizing air quality from images due to their ability to be customized and trained on a dataset of labeled air quality images

Q2: Methodology

Input:
You are an expert in evaluating the air quality of an area based on an image. Here is an image – focus on the background and give an estimate of air quality as good, moderate, unhealthy for sensitive groups, unhealthy or hazardous"

Output:
Processed image to generate output classification for air quality

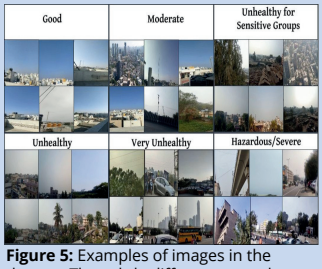


Figure 5: Examples of images in the dataset. The subtle differences can be shown in the similarities between the unhealthy photos versus the moderate photos.

- Each model was trained on a dataset comprising an 80-20 split
- Conducted experiments using 6 different combinations of batch sizes and epochs
  - 8-3
    16-3
    16-10
    32-3

Q3: Data Analysis/Results

Claude
Looking at this image as an air quality expert, **I would classify the air quality as "Good" based on several visual indicators:**

Sky Visibility: The sky **appears distinctly blue and clear**, without any visible haze or discoloration
Distance Clarity: The buildings and trees in the background are clearly visible with sharp edges, **showing no signs of particulate matter interference**
Natural Color Rendition: The colors of buildings and vegetation appear natural and undistorted, which **suggests minimal air pollution**
No Visible Particulate Matter: There's **no visible smog, haze, or suspended particles in the air**
Foliage Health: The trees appear healthy with green foliage, which **can be an indicator of good air quality**

On the **Air Quality Index (AQI) scale, this would likely fall in the 0-50 range, indicating "Good" air quality,** where air pollution poses little to no risk.
However, I should note that while visual assessment can provide helpful indicators, accurate air quality measurements **require proper monitoring equipment to detect pollutants that may not be visible to the eye, such as certain gases and smaller particulate matter.**

Input:
"You are an expert in evaluating the air quality of an area based on an image. Here is an image — focus on the background and give an estimate of air quality as Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy or Hazardous."

LlaMa:
The image shows a photograph of the sky with some factories and workplaces in the background. The sky has a **dark color and haze, and one can see multiple smoke trails within the sky.** Also can see a pollution grid in the bottom right-hand corner indicating a **mild level** of pollution. Another light pollution grid just above it indicating **more light pollution is present.**

ChatGPT:
Based on the visible conditions in the image, the **air appears relatively clear, with good visibility and a blue sky, suggesting an absence of heavy pollutants or smog.** Estimating air quality solely from an image is challenging, but given these visual indicators, it **likely falls within the "Good" to "Moderate" category,** depending on finer details like particulate levels and pollutants, which **aren't discernible** from a photo alone.

For a precise assessment, **using an air quality monitor** to measure $PM_{2.5}$, PM_{10}, and other pollutants would provide accurate results.

Phi Vision
As an AI language model, I **cannot accurately assess air quality based solely on an image.** To get a reliable assessment of air quality, I recommend using the following methods: **Check Official Air Quality Reports: Many cities and regions have air quality monitoring systems that provide real-time updates.** Look for agencies like the Environmental Protection Agency (EPA) or local environmental departments. Use Air Quality Monitoring Devices: These devices can measure pollutants in real-time and provide accurate readings. You can find a variety of options, from simple monitors to advanced systems. **Consult Air Quality Apps:** Many apps provide real-time air quality information based on data from monitoring stations and forecasts. **Please rely on these methods for accurate air quality information.**

Figure 6: Each output for each LLM. Although the input for each LLM was the same, the output for each model was different.

EfficientNet

Batch Size	Epochs	Best Validation Accuracy	Timing (s)
8	3	67.53%	181
8	10	72.31%	604
16	3	67.53%	146
16	10	75.21%	488
32	3	65.32%	132
32	10	74.23%	438

- Optimal combination
  - Batch size 16
  - 10 epochs
- Runtime for combination was the longest
  - 488 seconds

ResNet

Batch Size	Epochs	Best Validation Accuracy	Timing (s)
8	3	69.12%	148
8	10	73.42%	471
16	3	70.84%	126
16	10	74.64%	417
32	3	66.87%	120
32	10	74.60%	402

- Optimal combination
  - Batch size 16
  - 10 epochs
- Runtime was 417 seconds

DenseNet

Batch Size	Epochs	Best Validation Accuracy	Timing (s)
8	3	69.78%	226
8	10	73.25%	756
16	3	72.72%	180
16	10	74.85%	589
32	3	69.08%	166
32	10	77.01%	567

- Optimal combination
  - Batch size 32
  - 10 epochs
- Runtime was 567 seconds

VGG

Batch Size	Epochs	Best Validation Accuracy	Timing (s)
8	3	72.80%	281
8	10	77.83%	933
16	3	71.12%	206
16	10	77.91%	687
32	3	67.12%	205
32	10	74.52%	684

- Optimal combination
  - Batch size 16
  - 10 epochs
- Runtime was 687 seconds

Q4: Interpretation and Conclusion

Models	Optimal Batch Size	Optimal Epochs	Best Validation Accuracy	Timing (s)
EfficientNet	16	10	75.21%	488
ResNet	16	10	74.64%	417
DenseNet	32	10	71.12%	206
VGG	8	10	77.01%	567

Figure 11: Comparison of all models' most optimal combinations.

Hypothesis was supported

Convolutional Neural Networks outperform Large Language Models due to its large strengths in image analysis

Real World Applications

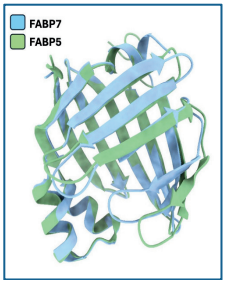
- LLMs and deep learning models can be utilized to inform public policy decisions Incorporating
- user feedback can help promote more awareness on air quality effects on an individual's health

Future Research

- Integrating convolutional neural networks with recurrent neural networks could be applied to image classification

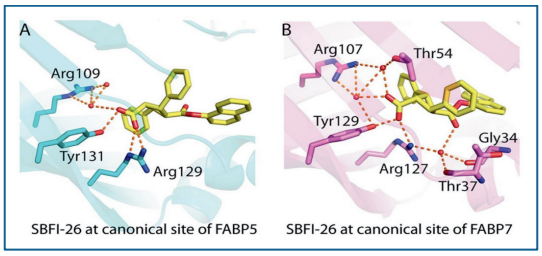
Ligand-based Virtual Screening to Discover Blood Brain Barrier Penetrating FABP5 Inhibitor to Treat Opioid Addiction

FABP5 is a type of fatty acid binding protein (transport proteins for fatty acids and lipophilic substances) expressed in key areas of the brain, including the NAc, and could serve as a promising target for inhibition to treat opioid addictions



However, existing inhibitors also bind to FABP7 (another FABP expressed in the NAc) which retains the integrity of the blood brain barrier (BBB)

Thus, it is not a target for inhibition, as this may lead to increased permeability of opioids and increased withdrawal symptoms



Began with preparing SBFI-102 as reference molecule and docking SBFI-102 with DOCK6 to FABP5/7

AMBER MD

Refine the initial binding poses of SBFI-102 within FABP5 and FABP7 by exploring the ligand-protein interactions in a dynamic environment

Followed by virtual screening

39,759 compounds

Enamine

- Good docking score with FABP5, binding interactions (Top **100 compounds**)
- Good BBB permeability (**5 compounds**)
- Poor binding to FABP7 (**3 compounds**)

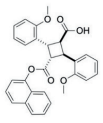
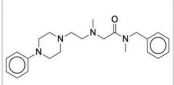
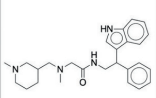
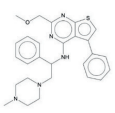
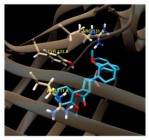
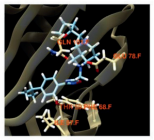
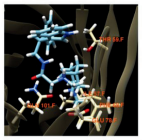
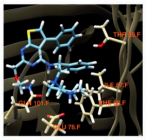
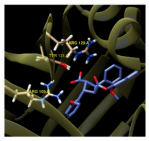
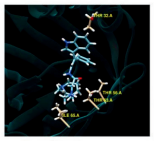
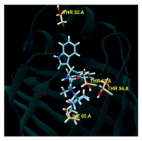
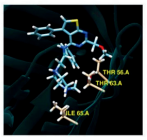
Pharmacokinetics and toxicity predictions on the 100 compounds using pkCSM

Compounds had good BBB permeability (> 0.3 logBB) after pkCSM, while SBFI-102 did not (-0.794 logBB)

Compounds had poorer binding to FABP7 than SBFI-102 and better binding to FABP5

Major Findings

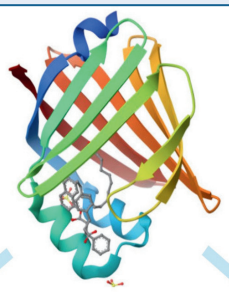
Promising potential FABP5 inhibitors with selectivity and improved BBB permeability (Hsu et al., 2017)

Chemical Structure	 SBFI-102 (reference)			
Score with FABP5/7 (kcal/mol)	-40.38/ -58.39	-65.04/ -42.33	-63.13/ -40.53	-62.54/ -48.74
BBB Permeability (logBB)	-0.79	0.40	0.47	0.31
Binding Poses to FABP5				
Binding Poses to FABP7				

This study lays a strong foundation for future research, suggesting applications in the development of novel treatments for opioid addiction

- Holds promise for advancing the field of neuropharmacology and addiction treatment

Epidermal fatty acid binding protein
- 135 residues
- FA binding and oxidation
- Lipid metabolism
- Cell proliferation



Therapeutic Potentials of FABP5 Inhibitors

Antinociception **Drug addiction** *Anti-cancer effects*

Future studies should focus on in vitro and in vivo validation, with biological testing of the three compounds to confirm the compounds' bioactivity → including interaction with other proteins, metabolic stability, and other potential off-target effects

ELIZABETH XIU

LIGAND-BASED VIRTUAL SCREENING TO DISCOVER BLOOD BRAIN BARRIER PENETRATING FABP5 INHIBITOR TO TREAT OPIOID ADDICTION



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Johns Hopkins University
INTENDED MAJOR/CAREER PATH	Biomedical Engineering

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

- 1st Place at WESEF in Comp. Bio/Bioinformatics
- 4th Place at WESEF in Computer Science
- 3rd Place at Somers Science Fair in Cellular and Molecular Biology

FAVORITE MEMORY

- Eating lifesavers every class
- Making pens before winter break
- Bus rides to WESEF setup
- Bus rides back from WESEF
- Getting bagel emporium before WESEF

WORDS OF WISDOM

- Stay organized!
- Don't stress or burn yourself out early on in the year
- Be sure to balance having fun with school
- Don't overwork yourself - relax!!

PROJECT ABSTRACT

Opioids, prescribed to manage chronic pain, are highly addictive and were responsible for 81,083 overdose deaths in 2023. An area in the brain called the Nucleus accumbens (NAc) processes rewards from addictive substances like opioids, but drug abuse can disrupt its plasticity, increasing drug-seeking behavior; effective delivery of pharmaceuticals across the blood-brain barrier (BBB) also remains a challenge. Brain-expressed fatty acid-binding protein 5 (FABP5) could be a promising target for inhibition. Conversely, FABP7, which maintains BBB integrity, is not a target for inhibition to avoid increased opioid permeability and withdrawal symptoms. SBFI-26 and SBFI-102 are non-selective inhibitors of FABP5 and FABP7, with SBFI-102 having a Ki of 0.55 ± 0.05 μM for FABP5 and 0.67 ± 0.04 μM for FABP7. This project aimed to identify compounds that selectively bind to FABP5 with better BBB permeability. Known FABP5 inhibitor SBFI-102 served as a reference molecule, docked to FABP5/7, followed by 25 ns molecular dynamics simulations using AMBER and analysis with cpptraj. RMSD values indicated high structural stability and no substantial conformational changes. Virtual screening of 39,759 compounds from the Enamine Discovery Diversity Library identified 100 compounds with better FABP5 docking scores than SBFI-102. ADME/T predictions using pkCSM narrowed this to five compounds with good BBB permeability (logBB > 0.3). These compounds were then docked to FABP7, identifying three with poorer binding to FABP7 and better binding to FABP5. These three compounds are promising potential FABP5 inhibitors with selectivity and improved BBB permeability.

DANIEL YE



MEASURING ICE NUCLEATION IN VARIOUS FROZEN FOOD

BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Harvard University
INTENDED MAJOR/CAREER PATH	Applied Math, Economics

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Nike All-American
3x National Latin Exam Medalist
3rd Place Tri-County Science & Technology Fair
Horace Greeley Summa Cum Laude Society
AP Scholar with Distinction

FAVORITE MEMORY

My favorite memory was scavenger hunting during junior year because it brought the whole class together, and we were given a fun prize at the end.

WORDS OF WISDOM

Good things take time.

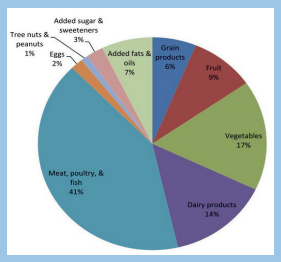
PROJECT ABSTRACT

In 2011, the Food and Agriculture Organization of the United Nations estimated that approximately one-third of all edible food produced for human consumption is lost or wasted worldwide annually. One method of minimizing food loss is freeze preservation in which the formation of ice crystals during this process can be controlled by controlling ice nucleation. Recent developments have seen the usage of a micro-thermography system to obtain ice nucleation data from zucchini, potato, broccoli, and beef. Uniquely, leafy greens such as spinach abundantly contain the enzyme RuBisCo, which has been demonstrated to be an effective ice-nucleating protein. This paper provides experimental nucleation data on spinach using the same micro-thermography system. In short, spinach samples were placed on a temperature-controlled cold stage and frozen at a constant rate until reaching a predetermined temperature. The freezing process was recorded by a thermal imaging system, and an image analysis program provided quantitative data to obtain ice nucleation rates that was transferred into Microsoft Excel. It was found that the nucleation rate in spinach increases when temperature decreases as expected, verifying nucleation behavior found in zucchini, potato, broccoli, and beef. Additionally, spinach was most similar in nucleation rate to beef compared to all other vegetables tested, which is correlated to the abundance of RuBisCo in spinach leaves compared to other non-leafy samples of zucchini, potato and broccoli. Future studies should focus on measuring nucleation rates in other parts of spinach and other leafy vegetables to further examine the significance of RuBisCo in freeze preservation.

Measuring Ice Nucleation in Various Frozen Foods

Daniel Ye
Horace Greeley High School, Chappaqua, New York

Food Loss: 1.3 billion metric tonnes of food produced is lost or wasted worldwide.



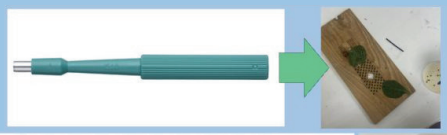
Freeze Preservation of Food: Ice crystal Size/distribution determine physical, textural, nutritional qualities, etc.

Ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCo): Responsible for carbon fixation in plants during photosynthesis.

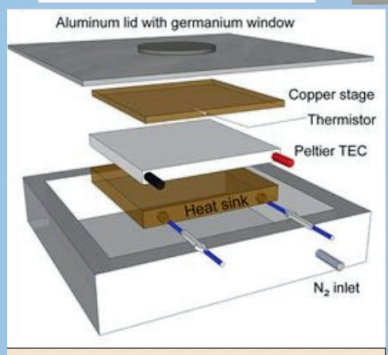
Problem: Difficult to obtain accurate measurements of ice nucleation temperatures.

Goal: Measure ice nucleation rate in spinach using micro-thermography system.

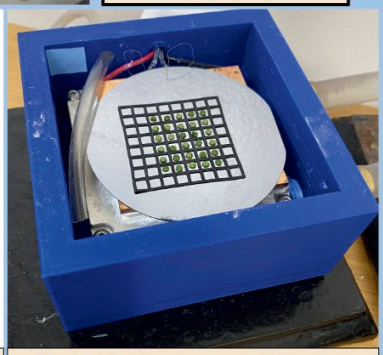
Hypothesis: Spinach will exhibit an ice nucleation rate most similar to beef because RuBisCo is a strong INP that is found abundantly in leafy vegetables [9, 15].



1. Cut out 30 circular pieces
2. Transfer into petri dish for moisture preservation
3. Transfer onto silicon slide plastic grid (5x6)



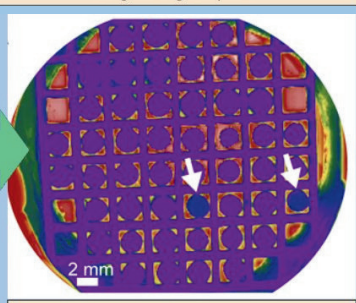
N2 inlet and aluminum lid with a germanium window serve to prevent condensation build up.



Plastic grid reduce temperature fluctuations caused by the misplacement of samples and minimize the influence of heat release on neighboring samples.



Portable thermal camera is positioned above the cold stage and connected to an Android tablet for image acquisition.

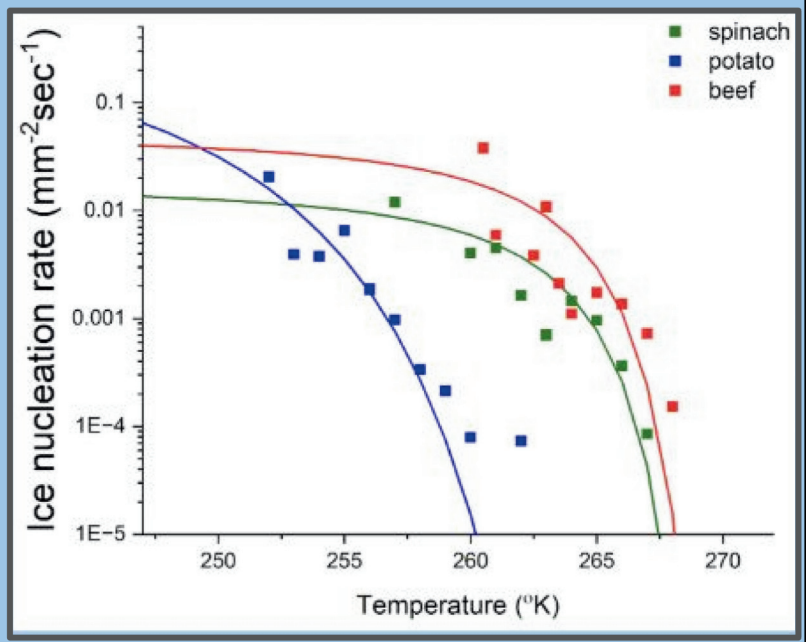


Android tablet records freezing process. Blue color represents release of latent heat during a nucleation event.

$$J = \frac{N_f^i}{\frac{\Delta T}{c}\left(N_{unfr-N_f^i}^i\right) + \sum_{j=1}^{N_f^i} \Delta t_{f,j}} \quad (1)$$

$$R = \frac{J}{A} \quad (2)$$

$$ln(R) = ln(A) + \frac{C}{(T-T_m)^2 T} \quad (3)$$



Discussion:

- Exponential relationship verify nucleation behavior observed in zucchini, potato, broccoli, and beef [7].
- Presence of RuBisCo in spinach may contribute to similar nucleation rate for beef [9, 15].

Applications:

- Enhanced freeze preservation food models
- More accurate global climate models

Future Research:

- Measure Ice Nucleation Rates in other leafy vegetables, other parts of spinach
- Measure Ice Nucleation Rate in Ferritin

References:

Leveraging Lipid Nanoparticle Technology for the Targeted Delivery of mRNA to Germinal Center B Cells

By Meadow Zhang

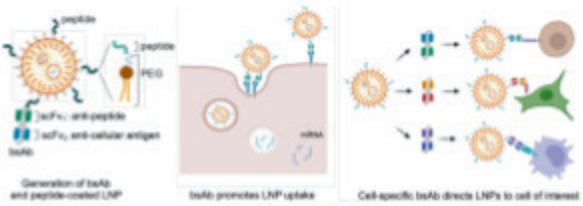
1) Introduction

Key Term--Germinal center (GC) B cells: subset of antibody-producing cells found in GCs

Problem:

- Lack of research on GC B cell mutations
- Only current method of altering GC B cell gene expression is by creating a knockout mouse model (costly)

Background:



- **Lipid nanoparticles** (LNPs) can allow for delivery of mRNAs to alter gene expression
- **Bispecific antibodies** (BsAbs) can allow for linking of two objects

Hypothesis: LNPs and BsAbs can be used to deliver mRNAs to GC B cells to alter their gene expression

2) Methodology

Primary Goal: Test if LNP-BsAb system can allow for successful expression of mRNA in targeted cells

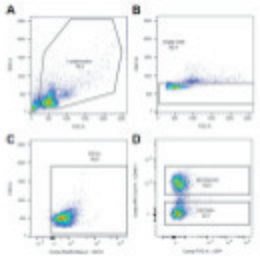
Specifications:

- mRNA delivered in LNPs: green fluorescent protein (GFP)
- Target antigen of BsAb: DEC-205



Abbreviated Methods:

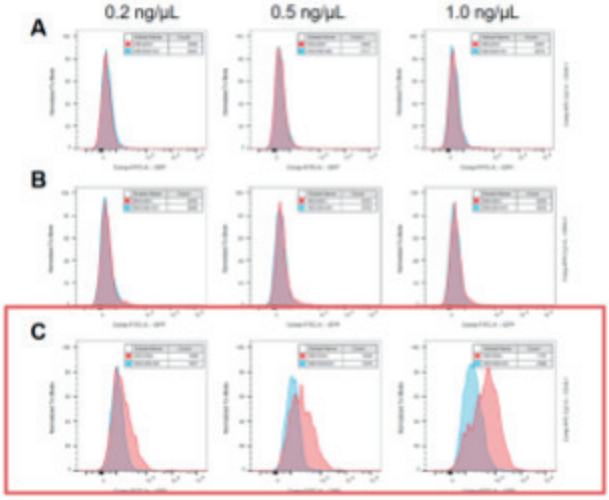
1. **Isolate B cells** from splenic cells from DEC-205 WT and KO mice.
2. **Administer cytokines** aCD40 and IL-4 to increase DEC-205 expression.
3. **Administer LNPs and BsAb**s in different ratios and concentrations.
4. **Harvest cells for flow cytometry** to measure GFP expression.



Prism

3) Results & Discussion

GFP Expression of DEC-205 WT vs KO B cells



Findings: LNPs can be delivered with specificity to DEC-205 WT cells stimulated with cytokines in an LNP concentration-dependent manner (**supports hypothesis**).

4) Conclusions & Significance

Major Finding: mRNA delivery system is successful as GFP expression was specific to DEC-205 WT cells

Applications:

- **Study of cancerous mutations** in GC B cells through mRNA delivery
- Allow for **targeted delivery of drugs** to treat GC B cell cancers



Future Research: Apply this mRNA delivery system to investigate cancerous mutations in GC B cells via *in vivo* studies with mice

Final Word: *This novel methodology for targeting GC B cells has significant implications for future immunological research.*

MEADOW ZHANG

PROJECT TITLE: LEVERAGING LIPID NANOPARTICLE TECHNOLOGY FOR THE TARGETED DELIVERY OF MRNA TO GERMINAL CENTER B CELLS



BEYOND THE RESEARCH: THE NEXT STEPS

COLLEGE/UNIVERSITY/TRADE	Cornell University
INTENDED MAJOR/CAREER PATH	Global & Public Health Science

HIGHLIGHTS FROM THE JOURNEY

PROUD MOMENTS

Watching all of my friends accept their awards on the WESEF and Somers stages every year!

FAVORITE MEMORY

Visiting Mr. Zupan with Nora and Sara after STS results came out :)

WORDS OF WISDOM

Ask questions!! There is something to learn from everyone.

PROJECT ABSTRACT

Although germinal center (GC) B cells are implicated in numerous cancers such as Burkitt lymphoma, the exact molecular mechanisms by which GC B cells function remain unclear. Elucidating the genetic interplay behind GC B cell function is crucial in developing treatments for GC B cell-associated malignancies, however, genetic manipulation of GC B cells has long persisted as an obstacle in the field. To address this challenge, this study sought to identify a novel method of delivering mRNAs directly to GC B cells to alter their gene expression. A lipid nanoparticle (LNP)-bispecific antibody complex was designed to bind to the DEC-205 receptor, a receptor produced at high levels by GC B cells, then deliver mRNAs encoding green fluorescent protein (GFP). To optimize the usage of the LNP-antibody complex, cells were treated with different concentrations of LNP and antibody. Following treatment, GFP expression levels of splenic B cells from DEC-205+ and DEC-205 knockout mice were compared using flow cytometry. The results showed that, under optimal treatment conditions, DEC-205+ cells exhibited significantly higher GFP expression ($p < 0.05$) compared to DEC-205 knockout cells. These results indicate that by leveraging LNP technology, GC B cells can be targeted with specificity. Future research should focus on translating this GC B cell-targeting technology to mouse models to confirm in vivo success. The system for selectively altering GC B cell gene expression developed in this study has significant implications for further investigation of GC B cell gene functions and treatment development for GC B cell-associated malignancies.

JUDE AL-MUFTI



PROJECT TITLE: INFLAMMATORY BIOMARKERS IN ACUTE ISCHEMIC STROKE: ASSESSING THE PROGNOSTIC VALUE OF NEUTROPHIL-LYMPHOCYTE RATIO FOR FUNCTIONAL RECOVERY OUTCOMES

AWARDS	NY JSHS State Finalist, 2nd in Sigma Xi Student Research Showcase, Presented at the 17th World Federation of Interventional and Therapeutic Neuroradiology Conference
EXTRACURRICULARS	Competitive sabre fencing, Biology Olympiad, Maria Fareri Children's Hospital volunteer, Drawing, Creative writing, Dentistry office intern/assistant, Women in STEM ambassador, & Science Olympiad.

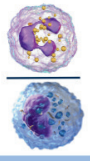
PROJECT ABSTRACT

Stroke is the second-leading global cause of mortality and is responsible for approximately 11% of all deaths worldwide. Despite substantial progress in the treatment and management of acute ischemic stroke (AIS), a notable variability persists in the functional recovery and rehabilitation of stroke patients, 50% remain associated with poor outcomes despite successful interventions with thrombolytics and endovascular thrombectomy (EVT). Identifying specific biomarkers is crucial for the timely and efficient management of stroke patients to monitor and mitigate mortality and complications such as intracranial hemorrhage (ICH). Inflammatory markers, particularly the neutrophil-to-lymphocyte ratio (NLR), have emerged as promising indicators, given the role of neutrophils in initiating inflammatory cascades and the neuroprotective properties attributed to lymphocytes. A retrospective study by Goyal et. al. (2013), found that the admission NLR in patients who underwent mechanical thrombectomy (MT) was a predictor of symptomatic ICH and mortality at 30 days. The gap in knowledge is that despite advancements in treatment methods like thrombolytics and EVT, many patients still experience poor outcomes. The goal of this study is to identify specific biomarkers that can predict functional recovery and complications in stroke patients. This study represents a subgroup analysis of data from the DEFUSE3 Trial, which investigated the efficacy of EVT combined with medical management versus medical management alone in AIS patients treated between 6 and 16 hours of symptom onset.

QUAD CHART

Research Question/Introduction

- Acute ischemic stroke (AIS): Blocked blood vessel by clot or aneurysm, accounts for 87% of Stroke
  - Treatment → Endovascular Therapy (EVT), Medical Therapy
- Neutrophil-Lymphocyte Ratio (NLR) → Inflammatory biomarker in Stroke & mitigates mortality and complications



- Effective indicator of functional recovery, prediction, neurological outcomes
- Despite substantial progress in the treatment and management of AIS → **50% remain associated with poor outcomes** despite successful interventions with thrombolytics
- NLR will serve as a predictive biomarker for stroke outcomes and guide risk stratification in clinical management

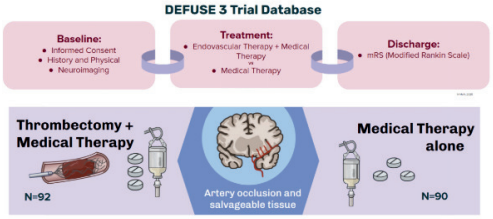
Data Analysis & Results

- **Higher NLR predicts worse recovery**
  - Patients with NLR > 8.6 had significantly poorer functional outcomes (p = 0.048)
- **Increased mortality with high NLR**
  - Higher NLR was linked to greater in-hospital mortality (p = 0.029)
- NLR has shown to be a great, cheap and accurate predictor of unfavorable prognosis
  - **NLR < 8.6** → patients were 2.5x more likely to have favorable outcomes
  - **NLR > 8.6** → mortality rates were 2.5x more likely to occur

n=92	NLR ≤ 8.6	NLR > 8.6	OR (95% CI)	p-value
Good function (mRS 0-2)	24	17	2.534 (1.007, 6.373)	0.048
In-hospital mortality	3	10	0.216 (0.055, 0.081)	0.029
Good TICI score (2b, 3)	11	6	1.833 (0.614, 5.475)	0.278

Methodology

- Subgroup analysis of data from the **DEFUSE 3 Trial**
- Efficacy of EVT & medical management V.S medical management alone



Interpretation & Conclusions

- A significant association was found between patients with NLR less than 8.60 and good functional neurologic outcome at 30 days, as well as significantly lower rates of death, both in-hospital. There was no significant difference in TICI score or preictal antiplatelet use among EVT patients with respect to NLR, supporting the use of NLR as a lone predictor of outcomes in AIS patients.
- Patients who received EVT and had an NLR < 8.60 had better functional outcomes at 30 days
- Identified a **new, applicable biomarker for AIS patients**
- As technology progresses to further the acute treatment of stroke, so must clinical management of stroke patients to stratify them accordingly based on stroke severity and type of stroke, and guiding their treatment in the days and weeks afterward → **Biomarkers have been discussed as a valuable tool for this purpose.**

JONAS BALCETIS

A NOVEL INVESTIGATION INTO WARFARIN'S ROLE IN ANTICOAGULANT TESTING



AWARDS	JSHS Regional Finalist, WESEF Biomedical Science 4th
EXTRACURRICULARS	Club Diving, PVAC, Phelps Hospital Volunteering

PROJECT ABSTRACT

Although Warfarin was discovered over zfifty years ago, there is still widespread controversy on how to interpret Lupus Anticoagulant (LA) test results. Historically, studies have shown Warfarin can lead to false positive results in DRVVT and STA-Clot assays. Existing studies examining Warfarin's false positivity have not employed sufficient variables to rule out the possibility of true positives. This study utilizes a criteria that excludes any patients with a history of thrombi, autoimmune disease, cancer, miscarriage, ages not in the 20-60 range, and past LA tests. With our criteria, any positive samples identified in this study would unequivocally indicate false positives caused by Warfarin. By using a highly specific patient selection and validated assays, this study aims to isolate Warfarin's effects on La testing with precision and reliability-a level of specificity and control that has not been employed in prior studies. Out of the 28 samples tested, 24 samples came back negative for both DRVVT and STA-Clot. The 4 positive samples had a positive DRVVT but negative STA-Clot. No correlation was found between DRVVT Ratios/STA-Clot deltas or any demographic information collected. While 4 samples came back positive for DRVVT, all 4 also came back negative for STA-Clot. This contrast could indicate that Warfarin could have a slight tendency to yield false positive results in DRVVT assays, but most likely indicates an error during the selection phase of the project. As a result, we can conclude that Warfarin may not have a significant influence on LA assays.

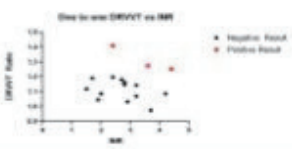
QUAD CHART

Objectives

- Determine whether Warfarin affects Lupus Anticoagulant (LA) test results, specifically if it causes false positives.
- Analyze how INR levels correlate with LA test outcomes in Warfarin patients.
- Assess the reliability of LA testing in anticoagulated patients.

Results

- Correlated DRVVT and STA-Clot assays against INR, Age, Albumin, Race/Ethnicity, and conflicting medications
- No correlations found between any factors



Methodology

- Created and utilized a novel, highly specific sample selection criteria, that excluded any possibility for a true positive LA value
- Created scatter plots to determine if Warfarin level and control variables have any effect on LA false positivity
- Interpreted any positive as a false positive

Conclusion

- Found no correlation between Warfarin and DRVVT/STA-Clot false positivity, suggesting LA testing may be valid while on Warfarin
- Study design provides a rigorous, replicable framework for future anticoagulant research
- Findings contradict 50+ years of accepted medical assumptions

MUKUL BATTU



THE EFFECTS OF CONFOUNDING VARIABLES ON ALZHEIMER'S DISEASE IN MRI CLASSIFICATION USING DEEP LEARNING

AWARDS	3rd Place Bioinformatics: Somers Science Fair 2024
EXTRACURRICULARS	Chappaqua Ambulance, Greeley Baseball, Trumpet Player, & Global Eye Project

PROJECT ABSTRACT

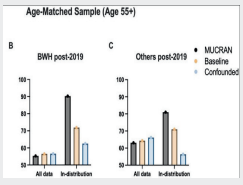
Alzheimer's Disease (AD) is an incurable neurodegenerative disease, and recent research has shifted focus from therapeutics to accurate detection using AI models. However, existing models often struggle with low accuracy due to confounding variables. This study introduces a novel shape detection algorithm as a preliminary measure to improve detection before applying it to the Alzheimer's Disease Neuroimaging Initiative (ADNI) dataset. The first phase involved shape generation, data-loading, and neural network creation. Code was implemented in Google Colab to generate images containing 1-3 randomly assigned shapes (circles, triangles, squares) in various colors (red, blue, and green). Labels were created for each image listing the corresponding shapes, which were combined into a CSV file. Four data-loaders were programmed for inputting the shape files and labels into a custom neural network for further processing. The 4 corresponding datasets were split into training and testing sets, with shapes having either random or fixed color assignments. The neural network was designed to classify the identity of shapes based on both their form and color. Results showed low average accuracy rates of 0.70 for each dataset, not surpassing the 0.95 accuracy found in previous deep learning models, confirming effectiveness. In future research, phase 2 will involve applying this model to brain scans from the ADNI dataset to test its ability to classify Alzheimer's disease based on imaging data. This approach could also later be adapted to predict other neurodegenerative diseases.

QUAD CHART

Research Question

How can the removal of confounding variables improve the accuracy of a deep learning model optimized to detect and classify Alzheimer's Disease MRI scans?

- AD affects 50 million people in US
- Previous DL models have had low accuracies due to confounding variables



Findings

- Phase 1:
  - Loss values consistently <0.75
  - General and specific shape accuracies
  - for fixed and random datasets around 0.7 Confusion matrices had high triangle imbalance
- Phase 2:
  - Controls were predicted most often
  - Accuracies around 0.5 (not supporting)

Methodology

- Used Python Pilow library for novel binary shape classification
  - color
  - Shape

Discussion/Conclusion

- Models tended to focus on ONE variable
- Effective training processes throughout
- Accuracies do not support hypothesis for both phases

CINDY CHEN

DETERMINING THE INFLUENCE OF MUTATIONS IN THE TUMOR SUPPRESSOR GENE LKB1 ON CANCER-ASSOCIATED IMMUNE CELLS



AWARDS	WESEF 1st Place (Cellular and Molecular Biology), Somers Science Fair 2nd Place (Cellular and Molecular Biology)
EXTRACURRICULARS	AAPIA (Co-Vice President), Dear Asian Youth Westchester (Co-Vice President), Peer Leadership, Phelps Hospital Volunteer, GWYOA

PROJECT ABSTRACT

Liver kinase B1 (*LKB1*) is a tumor suppressor with somatic mutations occurring in approximately 20% of lung adenocarcinoma (LUAD) cases. Previous research demonstrates that *LKB1* mutations facilitate resistance to PD-1-targeting antibodies. However, the mechanism by which *LKB1*-mutant tumors accomplish tumor immune evasion is poorly understood. To accomplish this, we employed a published single-cell-RNA sequencing (scRNA-seq) dataset derived from *Lkb1*-WT and -mutant mouse LUAD tumors and Seurat, a well-established tool for analyzing scRNAseq, to examine the influence of *Lkb1* mutations on the changes of gene expression in tumor-associated immune cells. Differential gene analysis was used to identify differentially expressed genes in five immune cells types. The significant upregulation of *Sdc4*, *Timp1*, and *Fn1* ($p<0.001$) in granulocytes was revealed, which collectively may aid in stimulating the activity of neutrophils by their function in promoting cell migration, impacting the extracellular matrix, and cytokine production. These are consistent with pre-existing findings of hyperactive neutrophils and increased secretion of neutrophil-specific cytokines in *LKB1*-mutant tumors. Additionally, *Mir22hg*, a long non-coding RNA, was significantly downregulated in neutrophils ($p<0.001$). *Mir22hg* has previously been shown to display tumor-suppressive behavior in cancer cells, but has not been investigated in the context of cancer-associated immune cells. Our findings suggest potential avenues for elucidating the mechanism by which *LKB1*-mutant-cancer-associated immune cells may demonstrate their immunosuppressive phenotype.

QUAD CHART

Research Question

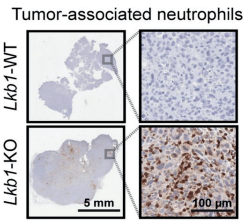


Figure 1. *Lkb1*-KO tumors have significantly higher levels of associated neutrophils than *Lkb1*-WT tumors.

→ Mutations in *LKB1* affect ~20% of lung adenocarcinomas
→ *LKB1* mutations drive resistance to common immunotherapies
→ *LKB1*-mutant tumors recruit abundant and hyperactive tumor-associated neutrophils (TANs)

How do LKB1 mutations influence the behavior of tumor-associated immune cells and promote tumor invasion?

Methodology

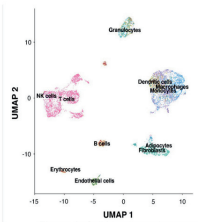


Figure 2. Cell identity assignment

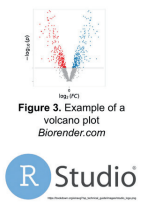


Figure 3. Example of a volcano plot *Biorender.com*

1. Data
- Pre-processing of publicly available single-cell RNA sequencing data from mouse LUAD tumors

2. Cell identity assignment
- Visualizing cell type biomarkers across data with reduced dimensionality

3. Differential gene analysis
- Calculating differentially expressed genes
- Conducting literature search

Results

Sdc4, ***Fn1***, and ***Timp1*** mRNA levels are higher in *Lkb1*-mutant TANs, and are associated with increased neutrophil activity

Morrbid and ***Mir22hg*** levels are lower in *Lkb1*-mutant TANs
→ *Morrbid* is known to influence the lifespan of neutrophils
→ The function of *Mir22hg* in TANs is unknown, though it acts as a tumor suppressor in human LUAD

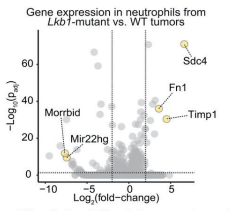


Figure 4. Visualization of differentially expressed genes in neutrophils associated with *Lkb1*-mutant tumors relative to neutrophils from *Lkb1*-WT tumors. The horizontal dotted line corresponds to an adjusted p-value (p_{adj}) of 0.05. The vertical dotted lines mark Log_2(fold-change) values of -2 and 2.

Conclusions

1. Confirmed increased TAN activity in *LKB1*-mutant tumors
2. *Mir22hg* identified as a potential novel regulator of neutrophil behavior in *LKB1*-mutant tumors

Future Research

- Verify lower levels of *Mir22hg* in mouse models
- Assess effects of depleting *Mir22hg* on gene expression and neutrophil activity in cell cultures

To determine which cellular pathways *Mir22hg* is influencing

WENDY CHEN



THE EFFECT OF CALORIE RESTRICTION ON HUMAN METABOLISM: INSIGHTS INTO ADAPTATION

AWARDS	1st place Somers Science Fair, 3rd place WESEF
EXTRACURRICULARS	Debate, Women in STEM, Science Olympiad, Varsity Swim

PROJECT ABSTRACT

Obesity and type two diabetes have had increasing prevalence in the past few years. Calorie restriction is a dietary regimen where people reduce their average daily caloric intake without causing malnutrition or lacking essential nutrients. Previous studies have found that calorie restriction over a long period of time is able to increase lifespan in both mice and humans, respectively. However, there is no clear mechanism behind it. One possibility is that metabolic adaptation accounts for this longer lifespan. In this study, we investigate the effect of calorie restriction on organ mass and metabolic rate as a measure of metabolic adaptation. My hypothesis was that after a long period of calorie restriction, organ mass and metabolic rate will decrease, and metabolic adaptation occurs. This study used data previously collected by my mentor, de-identified, and no new data was collected by me. In this study, participants were split into the calorie restriction group and the ad-libitum group, who kept their normal diet. Demographics, baseline energy expenditure, and body composition were collected. The two groups were compared to determine if there was metabolic adaptation. The results of this study were that both organ mass and metabolic rate decreased after the calorie restriction and the calorie restriction group had a significant difference compared to the ad-libitum group. An application of this research is that calorie restriction is a very accessible tool, and it has been shown to decrease risks for many chronic diseases such as type 2 diabetes, atherosclerosis, and heart disease.

QUAD CHART

Introduction

Current Problem

- Calorie restriction causes prolonged aging in mice, but there is an unknown cause behind it
- Mice with longer life spans have slower metabolism

Hypothesis

- Calorie restriction in non-obese humans will lead to slower metabolism and decreased organ mass as a mechanism for a longer life span.

Results

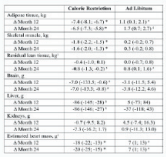


Table 1: Significant decreases in organ mass for the calorie restriction group at both time points.

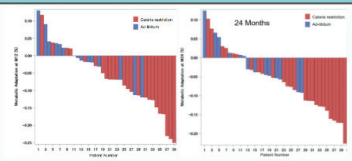


Figure 1: Waterfall diagram of metabolic adaptation for each participant at both time points. Most of the calorie restriction participants experienced a significant decrease in metabolic rate.

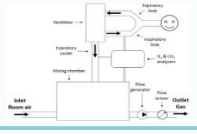
Methodology

Acquire Dataset → **MRI Imaging** → **Indirect Calorimetry**

- CALERIE study: subset of 50 patients
- conducted over 2 years
- 25% calorie restriction



Segmentation measures organ mass.



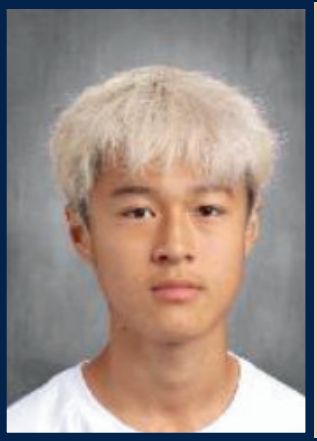
Gas exchange used to calculate metabolic rate.

Conclusion

- Hypothesis was supported because metabolic rate and organ mass decreased
- Applications:
  - Diet for patients with hyperactive organs
  - Decreased risk for type 2 diabetes, cardiovascular disease, obesity, etc
- Future Research: look at decreased oxidative stress and inflammation as other possible mechanisms

DAYUAN CHENG

PROJECT TITLE: A NOVEL MEASUREMENT OF UAV SENSITIVITY TO TURBULENCE AND ITS RELATIONSHIP TO PHYSICAL PROPERTIES



AWARDS	2nd place Physics (Somers)
EXTRACURRICULARS	Varsity+JV+club Soccer, youth soccer+church volunteer

PROJECT ABSTRACT

According to an analysis of the National Transportation Safety Board (NTSB) Aviation Accident and Incident, turbulence is one of the main reasons unmanned aerial vehicles, or UAVs, crash when operating. Due to their increasing popularity, it is becoming increasingly important to recognize any gaps in knowledge and address them as quickly as possible, such as a quantification of sensitivity to turbulence, of which our understanding remains incomplete. In this study, we use the norm of Sobolev Space to create a quantification of sensitivity to turbulence to calculate the difference between actual and expected route flown by the UAV. The model UAV was flown in windless and turbulent conditions within the Gazebo simulation along a predetermined route and data from the autopilot software was collected at intervals of 1 hertz. We found that while the increase in rotor power led to a decrease in turbulence sensitivity, the increase in mass of the UAV led to an increase in turbulence sensitivity. We conclude that this quantification of sensitivity to turbulence is verified and will be able to be applied to UAVs. This quantification could be applied to any UAV and will be accessible to all researchers across the world due to its virtual nature. Future research will include different characteristics such as material and could encompass different types of turbulence besides wind. This research attests to the quantification's validity and could be a powerful tool in all sorts of applications.

QUAD CHART

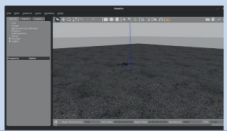
Problem and Engineering Goals

Drones being increasingly used in many fields, however there is a lack of a quantification for turbulence performance for drones. The relationship between changing physical properties such as weight and flight dynamics is also not well understood.

1. Introduce Turbulence Sensitivity as a mathematical method of measuring turbulence performance
2. Identify the relationships between turbulence sensitivity and changing physical properties

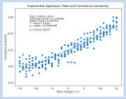
Project Design

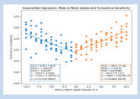
- Independent variables of mass, rotor power, combined, which change in 1% intervals from -x to x% (varies)
- Using wind plugin for wind simulation, run each variable change 7x with fixed start and end point of flight
- Collect data output by autopilot and input values into turbulence sensitivity definition to calculate

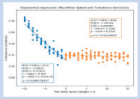


Results

- As mass increased, turbulence sensitivity increased, increase in mass is harder to recover from deviation
- As rotor power increased, turbulence sensitivity decreased, easier to recover
- As both increased, turbulence sensitivity increased
- As both decreased, turbulence sensitivity increased too



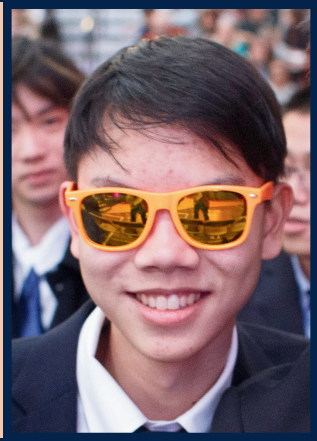




Conclusion

- Measurement was supported from the data
- Identified mass and rotor power as key factors in UAV flight dynamics and turbulence performance
- Reducing risk when flying drones in the real world
- Able to test new UAV models and optimize mass to rotor power ratios for optimal performance in turbulence

TINGRAY CHUNG



NEAR REAL-TIME SPEECH CORRECTION USING LARGE LANGUAGE MODELS

AWARDS	WESEF Excellence in Computer Science, JSHS NY Finalist, Wharton Data Science Finalist
EXTRACURRICULARS	Science Olympiad Exec, AAPIA Vice President, Playing Piano for 12+ years, Conference publication in Taiwan and Montreal

PROJECT ABSTRACT

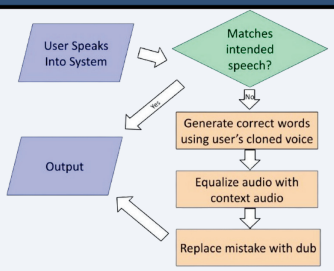
In many situations, maintaining clear and accurate dialogue in near-real time is crucial and the recent rise in machine learning computers provides a potential solution. However, most zero-shot voice cloning models need large amounts of data and time for training, and fine-tuning a model to a user's voice can require a prolonged time to train. This study aims to address these limitations by creating a system that can generate natural speech corrections in near real-time that takes advantage of voice samples in short time frames to create corrected audio segments. The audio is first transcribed. Then, the transcription was compared with a script to determine where the speaking errors occurred along with the timestamps. Lastly, audio is generated that mimics the user's voice but has the corrected audio and is passed through equalization filters to match the user's speech characteristics. A mean opinion score survey was conducted to evaluate the extent of the model's performance. Our results indicate that the corrected audio is seamlessly integrated and nearly identical to the user's voice. To further improve its potential, we show that computational linguistics techniques can optimize the reference audio to clone a user's voice, with improvements in the quality of the cloned voice. This phase utilizes language models and linguistic characteristics to create natural sentences that include the most diverse set of phonemes. Our findings highlight the practical application of correcting a user's speech in near real-time and ways to optimize the performance of voice cloning models using enhanced reference scripts.

QUAD CHART

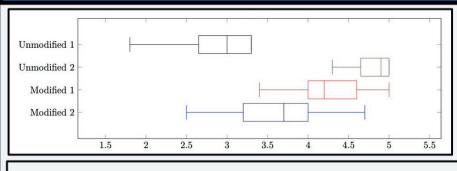
Engineering Goal

Create a system that can **generate natural speech corrections** using voice cloning and equalization techniques in **near-real time**

Evaluated with a Mean Opinion Score Survey

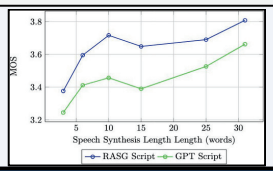


Findings



- Our algorithm **significantly improves MOS**
- Across all generation lengths, **higher quality voice cloning**

Corrected audio clips have **comparable ratings** to the unmodified clips



Framework

Optimizing Voice Cloning Performance
Choosing specific words for script
- ➢Maximize **phoneme diversity**
- ➢Increase frequently used words
- ➢Words around **3-4 syllables**

$$\text{Score}(w) = \max(0, \alpha \cdot D(w) + \beta \cdot f(w) - \text{Penalty}(w))$$

Baseline: OpenAI's ChatGPT 4-o
- ➢Known for human-like text
- ➢Script is **not optimized** for voice cloning

Generate Correction

Create dub using Coqui's XTTS-V2
Scale generated correction volume to original audio's volume

Adjusting Timbre

Take FFTs of each time frame of the original and replacement audio
Equalize the replacement audio to match original audio

Conclusions

- **Improved TTS** model to replicate user's voice
- Generate accurate synthetic corrections **under 2 seconds** using **algorithmic and AI** methods

Applications
- Live broadcasting
  - Television
- Accessibility tools
- **Correcting speech mistakes!**

Future Work
- **Current limitation:** Inserting long words in short time periods
- Multilingual support
- **Hardware improvement**

KATHERINE EVANGELINOS

MINIMIZING DIFFERENTIAL POWER ANALYSIS RISKS ON SMART CARDS: AN ENGINEERING APPROACH TO ARTIFICIAL NOISE AND KEY VARIATION



AWARDS	3rd Place Engineering @ WESEF, JSHS Regional Finalist, 2nd Place Computer Science @ Somers Science Fair
EXTRACURRICULARS	Science Olympiad Competitor, SummerTech Counselor

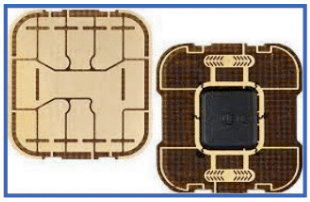
PROJECT ABSTRACT

The cryptographic schemes on which smart cards are reliant for secure transactions have been proven to be vulnerable to side-channel attacks such as Differential Power Analysis (DPA). To prevent this weakness in common AES schemes, previous methods include leak reduction and noise reduction, which are effective methods, but often end up power-heavy and time consuming. Therefore, the objective of this study was to prevent DPA attack efficacy productively by creating artificial noise in cryptographic operations and reducing repeated key usage, both established methods at preventing DPA. I performed DPA once on the unaltered card, to provide a baseline to compare with the altered algorithm, and tested the protection of artificial noise against key variation as well as both noise and key variation against the control. In performing DPA, the chip's electromagnetic emissions were recorded with a probe, and the waves were visualized and processed using an oscilloscope. The resulting correlation between the obtained value and the actual cryptographic key was reduced by 13%. This has larger implications for internet security, especially in systems that use smart cards or integrated microcontrollers that rely on cryptographic algorithms for data security, namely contactless payment cards, identification cards, and radios, to name a few. Since cryptographic attacks and algorithms will continue to evolve with computational advances, such as the onset of widespread quantum computer use, it is important to adapt defense measures to newer security risks. This may include examining how quantum-integrated algorithms influence DPA resistance, whether they are protecting or targeting data.

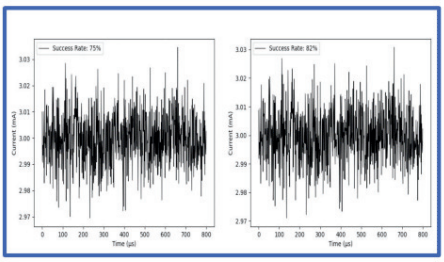
QUAD CHART

Problem & Engineering Goal

- Increased reliance on technologies for memory creates a need for security
- Smart cards handle extremely vulnerable user data
- Despite security measures, Differential Power Analysis (DPA) still puts cards at risk for fraud
- **Engineering Goal:** Resist DPA by creating artificial noise in power consumption and increasing frequency of cryptographic key changes



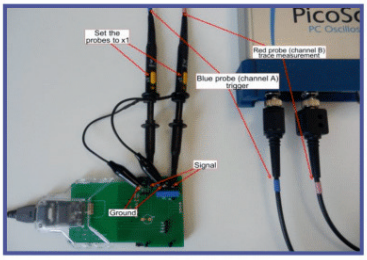
Results



- Trial set 1: 10% reduction
  - Artificial noise
- Trial set 2: 3% reduction
  - Key switching
- Trial set 3: 10% reduction
  - Both methods

←Traces captured during DPA, before and after prevention measures were implemented.

Methodology

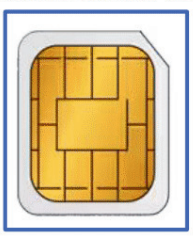


- Implement prevention measures on encryption algorithms present on the ST31N400
- **Artificial Noise:** Dummy operations to reduce correlation between power and key used
- **Key Diversification:** Reduce patterns in power consumption

Conclusion

- Supports viability of a combination of artificial noise and key switching





Future Research

- Quantum computing, encryption
- Expansion to other devices
- Hardware exploration

WARREN FU



BIOPHYSICAL DRIVERS OF ERLOTINIB RESISTANCE: COX REGRESSION ANALYSIS OF GROWTH DYNAMICS IN T790M-MUTANT LUNG ADENOCARCINOMA

AWARDS	1st place in Bioinformatics at Somers, JSHS Nationals 2nd Runner-Up, 2nd place in CBIF at WESEF, NYSSEF Finalist, 2x USABO Semifinalist, 3x AIME Qualifier
EXTRACURRICULARS	Livestreaming Math, Growing Algae, Morning Announcements

PROJECT ABSTRACT

Lung adenocarcinoma patients treated with 1st and 2nd generation epidermal growth factor receptor (EGFR) Tyrosine Kinase Inhibitors (TKIs) almost inevitably develop resistance to treatment, with the EGFR T790M mutation accounting for 60% of resistance cases. To better understand the biophysical mechanisms of this resistance, we combined Ordinary Differential Equation (ODE) modeling with Cox regression analysis. We hypothesized that conversion rate from drug-sensitive to drug-resistant states would be the key parameter driving resistance. An ODE model describing the longitudinal macroscopic evolution of drug-sensitive and drug-resistant cancer cell populations was developed and coupled with Cox regression to find the relationship between model parameters and progression-free survival in a patient cohort. The model was fit to digitized tumor growth curves using the Limited-memory Broyden-Fletcher-Goldfarb-Shanno Bound-constrained (L-BFGS-B) optimization algorithm. To expand the cohort, three synthetic patient cohorts (N=600 each) were generated through systematic parameter perturbation in simulations. Cox regression analysis revealed that resistant cell growth rate was the strongest predictor of relapse (Hazard Ratio [HR]=2.66, p<0.001), followed by conversion rate (HR=2.28, p<0.001) and sensitive cell growth rate (HR=2.09, p<0.001), only partially supporting our hypothesis. Treatment efficacy positively correlated with faster relapse (HR=1.64, p<0.001) and conversion rate (r=0.91), suggesting aggressive treatment may accelerate resistance. Our results indicate therapeutic strategies should focus on controlling resistant cell proliferation and minimizing conversion rather than maximizing treatment intensity.

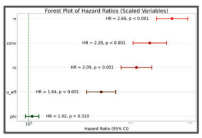
QUAD CHART

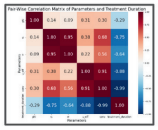
Problem Statement

- Lung cancer is the leading cause of cancer death worldwide—kills millions per year
- Treatment resistance is inevitable in lung adenocarcinoma tumors—**huge problem**
  - EGFR-T790M present in 60% of resist. cases
- Ordinary differential equations (ODEs) are used to characterize tumors, but we don't understand biophysical params. (ODE variables)—**want to do this**

Findings

- Found that resistant cell growth rate (r_r) was important
- Treatment efficacy (u_{eff}) correlates with faster resistance (???)





- **High correlation** between treatment efficacy and conversion rate from sensitivity to resistance (conv)
- Correlation between u_{eff} and resistance

Methodology

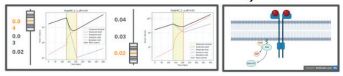
- Defined **novel dual equation ODE** system and fit to tumor longitudinal data from **Grassberger et al. (2019)**
- Generated 3 synthetic datasets (N=600 each) through parameter perturbation

$$\frac{dS}{dt} = r_s S - u(u_{eff})S - u(conv)S$$
$$\frac{dR}{dt} = r_r R + u(conv)S$$

- Ran cox regression on synthetic datasets to generate **hazard ratios (HRs)**—this tells us which about their relative impact in resistance events

Discussion

- Treatment does not necessarily improve outcomes
  - **More treatment ≠ better outcomes**
- Develop treatment strategies that balance tumor reduction with resistance management
- Control tumor behavior through **treatment dosage**
- In the Future: Model other mutants, like **RAS**



ISABELLA GARCIA

THE EFFECT OF ENVIRONMENTAL TEMPERATURE ON EQUINE COLIC SEVERITY: UNDERSTANDING CLINICAL SIGN VARIATION



AWARDS	3rd Place in Animal Science at Somers, 2nd Place in Animal Science at WESEF, International GENIUS Olympiad Finalist
EXTRACURRICULARS	Competitive Horseback Riding through USEF and IEA, Creative Writing, Veterinary Shadowing, Therapeutic Horsemanship Volunteer, Barn Working Student

PROJECT ABSTRACT

Equine colic is defined as abdominal pain in horses and is commonly caused by issues in the gastrointestinal system; however, this definition is broad, leading to a large range of severity across cases. A handful of studies have looked at the relationship between the environment and colic, but no specific research has been done on the environmental temperature's effect on severity, so understanding of the relationship between the environment and colic remains incomplete. Veterinarians across locations in the United States were contacted to provide the location, date, severity, and results of colic cases that occurred in between September 2022 and November 2024. Severity was put on a scale of one through five with one as mild and five as severe and each of the five levels were given descriptions. Then, the NOAA weather database was used with the locations provided to find the average temperature for each day a case occurred. It was found that as the environmental temperature range increased, the severity of colic cases increased as well. However, a significant increase in temperature only occurred between severity levels one and five as well as severity levels two and five with p-values of 0.025 and 0.001, respectively. From these results, it was concluded that there is a partially significant correlation between average daily temperature and the severity of colic clinical signs which means it is likely that daily temperature can cause colic cases to become more severe.

QUAD CHART

Research Question

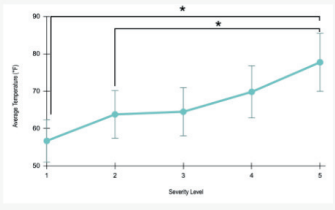
Does environmental temperature have an effect on the clinical sign severity of colic horses?

Problem:

- More than 64,000 horses in the United States die from colic or colic related issues each year
- Previous studies have found an increased number of cases reported but did not separate severities
- Severity can have a large range



Data Analysis and Results

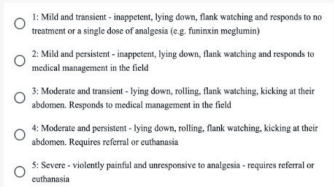


- Trends showed colic cases were on average more severe during higher temperatures
- Severity levels 1 and 5 as well as severity levels 2 and 5 have significantly different temperatures

Methodology

Independent variable: Temperature in the location of diagnosis
Dependent variable: Severity of colic clinical signs measured 1-5

- Data included date, location, severity, and outcome of each colic case
- NOAA used to collect temperature in location of diagnosis



Analysis

- One way ANOVA F-tests and unpaired T-tests were used
- Significant p-value defined as <0.05

Interpretation and Conclusions

The hypothesis was **partially** supported



Application

- Equine veterinarians and horse owners can implement plans to lessen the chances of their horses becoming affected by intense heat

Future Research

- Research the effect of other environmental elements on colic
  - Precipitation
  - Humidity
  - Rapid change in temperature

ZOE GOLUB



OPTIMIZING ORAL IMMUNOTHERAPY FOR PEANUT ALLERGIES: THE ROLE OF ANTIHISTAMINES IN MINIMIZING ADVERSE EVENTS AND TREATMENT DURATION

AWARDS	3rd place in Medicine and Health at Somers
EXTRACURRICULARS	Chappaqua Volunteer Ambulance Corp Aider, White Plains Hospital Volunteer, 914 Cares Junior Advisory Board Member, Quaker Notes

PROJECT ABSTRACT

Over 33 million Americans live with life-threatening food allergies, with strict allergen avoidance and symptomatic treatment being the standard care . However, this approach often leads to significant stress due to the risk of accidental exposures. Oral immunotherapy (OIT) has emerged as a promising treatment, particularly for pediatric patients, though adverse events remain a concern. Given the rising prevalence of food allergies , improving OIT's safety and efficiency is crucial. This study investigated the potential of antihistamines to reduce adverse events and enhance the OIT process. Using pre-existing, confidential patient data, we divided participants into two groups: a control group (no antihistamines) and an experimental group (antihistamines administered during OIT). Data collected included age, gender, time to the minimum maintenance dose (3 peanuts), and significant adverse events. The results demonstrated that antihistamines significantly reduced the time to reach the maintenance dose and decreased the frequency and severity of adverse events. These findings suggest that antihistamines improve both the safety and efficiency of OIT. Incorporating antihistamines into OIT protocols could create a safer, more effective path to food desensitization, benefiting children with life-threatening allergies. Future research should explore variables such as age to optimize OIT outcomes for diverse patient populations. This personalized approach could further refine protocols, improving safety and acceptance of OIT in clinical practice.

QUAD CHART

Objective

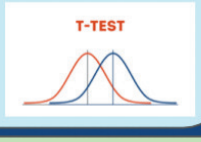
- To investigate whether antihistamines improve the safety and efficiency of peanut OIT
- To assess if antihistamines reduce adverse events and shorten the time to a minimum maintenance dose
- To improve OIT protocols for better patient outcomes





Data Analysis and Results

- Antihistamines reduced time to maintenance dose by 62 days ($p < 0.0001$)
- Lower incidence of adverse events, including anaphylaxis, nausea, and urticaria
- Antihistamines may serve as immune-modifying adjuvants for OIT



Methodology

- Participants → 50 children (5-10 years old) with peanut allergies
- Groups → 25 children received antihistamines; 25 received placebo
- Data collected → time to minimum maintenance dose, adverse events, demographics
- Analysis → Statistical comparison using simulated data (Chu et al. 2022)



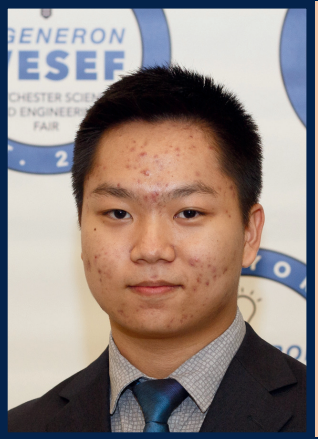
Interpretations and Conclusions

- Potential to improve OIT safety and acceptance in clinical settings
- Further research needed with real-world patient data
- Study expansion to include other allergens (tree nuts, milk, eggs)



KEVIN GUO

IN VITRO VALIDATION AND CHARACTERIZATION OF MUSCLE-SPECIFIC ANTIBODY-SIRNA CONJUGATES FOR TARGETED DELIVERY OF SIRNA



AWARDS	**ISEF Finalist**, 1st Place in Medicine and Health (WESEF), 1st Place in Medicine and Health (Somers), Honorable Mention (American Society of Human Genetics Essay Contest)
EXTRACURRICULARS	Student Researcher (Regeneron Pharmaceuticals), Vice President (Biotechnology Club), President (Chinese Club), Greeley Tennis (JVA), Executive (HOSA), Co-Founder (Greeley Soles4Souls)

PROJECT ABSTRACT

The use of therapeutic siRNA to silence genes in a sequence-specific manner has been limited by its need for delivery to target cells. However, while antibody-mediated siRNA delivery shows promise as a delivery mechanism, discovery of extrahepatic ligand-receptor systems remains an ongoing challenge. In this study, we evaluated the effectiveness of AbA, a muscle-specific antibody, for siRNA delivery by conjugating to a muscle-targeting siRNA (siRNA1) and analyzing the knockdown and binding of AbA-siRNA1 conjugates *in vitro*. Furthermore, we investigated the use of differentiated C2C12 cells as a myotube model by evaluating the expression of an antigen typically only found on myotubes (AgA). Using RT-qPCR to determine mRNA levels, knockdown activity of AbA-siRNA1 was compared to that of siRNA1 alone and isotype-siRNA1 to evaluate the impact of conjugation on RNAi. Flow cytometry was then used to assess cell binding and quantify AgA expression of differentiated C2C12 cells. AbA-siRNA1 was found to efficaciously knock down the target gene in a dose-dependent manner with similar potency to the controls, suggesting that conjugation did not affect knockdown. Additionally, conjugates showed specific binding with high affinity to AgA. However, binding was slightly less potent compared to AbA alone; this was speculated to be caused by the relatively high drug-antibody ratio. Finally, differentiated C2C12s were found to express AgA to a higher extent than undifferentiated cells, indicating endogenous expression. In future studies, AbA could be a compelling candidate for muscle-targeted siRNA delivery, while differentiated C2C12s could be used to better represent *in vivo* skeletal muscle conditions.

QUAD CHART

Rationale & Research Objectives

Rationale

- Small interfering RNA (siRNA) silences disease-associated genes
- Specific delivery is needed
- Extrahepatic (ex. muscle) delivery of siRNA is especially difficult
- Lack of cell line representing *in vivo* muscle conditions

- Conjugate novel muscle-targeting antibody to siRNA
  1. Evaluate knockdown/binding of conjugates
  2. Evaluate effects of conjugation
- Differentiate myoblasts to myotubes
  3. Quantify expression of antigen typically only found on myotubes (AgA)

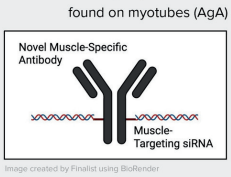


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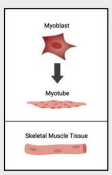
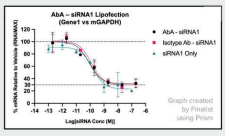
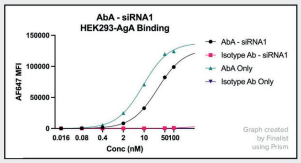


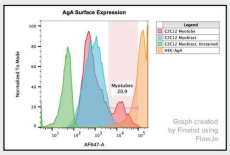
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Results

- Potent knockdown and binding
- Conjugation did not affect knockdown, but did slightly affect binding
- Differentiated C2C12s endogenously expressed AgA







Methodology

Part 1 (Knockdown Validation)

- C2C12 myoblast cells
- Procedure:
  1. Transfect cells via lipofection and incubate
  2. Extract target gene mRNA with magnetic beads
  3. RT-qPCR to quantify mRNA
  4. Analysis in Prism/Excel using $2^{-\Delta\Delta Ct}$ method

Part 2 (Binding Characterization)

- HEK293-AgA cells
- Flow cytometry to determine binding
- Analysis in FlowJo and Prism

Part 3 (C2C12 Myotube Model)

- Flow cytometry to determine AgA expression

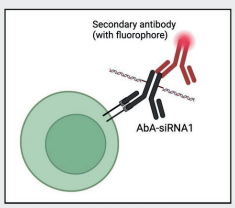


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Conclusion

Novelty

- Most ligand-siRNA studies have only focused on liver targets
- Previous muscle ligand targets are broadly expressed
  - AgA/AbA is specific to skeletal muscle tissue
- Unknown how well C2C12 myotubes can replicate *in vivo* conditions

Applications

- AbA-siRNA1 used therapeutically to treat muscle disease
- AbA used to deliver other muscle-targeting siRNAs
  - Treat a variety of skeletal muscle diseases
- C2C12 myotubes used to better represent muscle tissue

Future Research

- *In vivo* data
- Use other muscle-targeting siRNAs
- Internalization/RISC loading assay









BENJAMIN HARRIS



PROJECT TITLE: CLIMBING IN DIVERSE PIPES WITH A WHEELED, SOFT TENSEGRITY ROBOT

AWARDS	Visionary Engineering Award, The David M. Holmes WESEF Engineering Innovation 4th Place Award, Science Olympiad States 1st, 3rd, & 4th.
EXTRACURRICULARS	Robotics Club, Science Olympiad, Space Initiative

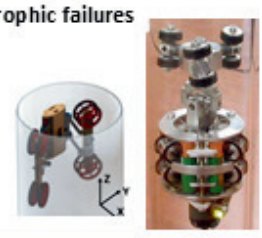
PROJECT ABSTRACT

Pipes are needed to transport essential materials like water, steam, air, petroleum products, and more. The deterioration of these pipes requires inspection robots capable of accessing the interior of pipes to prevent failure. Previous pipe-climbing robots have been designed with 4 properties in mind; adaptability, speed, flexibility, or low weight but rarely have all four. The hypothesis for this project was that, by combining motorized wheels and a tensegrity structure, a robot could satisfy all four of the engineering goals. This was accomplished by attaching wheeled components to the nodes of a 3-bar tensegrity structure with the anterior half being motorized and the posterior half passive, acting as a stabilizer. Additionally, the equilibrium form of the structure was designed to be larger than the pipe, such that the structure provides friction with the pipe. The robot's ability to climb was tested inside pipes of 4, 6, 8, and 10-inch diameter in horizontal and vertical orientations. The robot was able to climb in all pipes in the horizontal orientation with an average speed of 15.6 cm/s and all but the 4-inch pipe in the vertical orientation with an average speed of 11.8 cm/s. The robot was lightweight at 132g without its tether and 163g with its tether. The main limitation of this robot is that pipes must be shut down and emptied for inspection. Future research could overcome this by applying tensegrity structures to exterior pipe climbing.

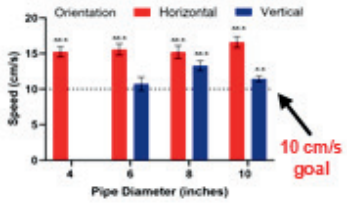
QUAD CHART

How can pipe-inspection robots be improved to make inspection cheaper and more available?

- Cracks can go unnoticed and result in **catastrophic failures**
- Downtime/**cost** goes up due to **low speeds**
- Previous robots are unable to climb in a diverse range of pipes due to:
  - High mass
  - Low diameter climbing range

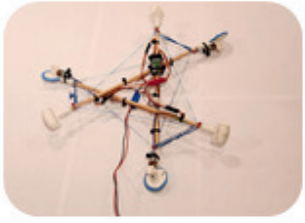


Speed results of the robot in different diameter pipes



- Robot weighs a mere **132g (162g with tether)**
- Capable of achieving significantly high speeds in vertical and horizontal pipes **(10 cm/s)**
- A high diameter range **(~150mm)** in the horizontal orientation

Our Approach: A 3-bar tensegrity based structure for improved grip and varying size



- Tensegrity structure is **flexible** in nature
- Squeezing into pipes presses against the wall and provides **friction** for wheels
  (**First robot** to do so)
- Moves with six wheels and three motors
- Controlled **wirelessly**

Interpretations and conclusions

- Can climb in a **diverse** group of pipes, reducing need of **multiple robots**
- Fails due to lack of equilibrium
- Can be fitted with a **variety of sensors** like X-Ray, cameras, & LIDARs





ALBERT HUANG

IMPROVING SINGLE PHOTON SOURCES WITH A 2D MATERIAL: THE INFLUENCE OF CY5 EXCITON COUPLING ON THE PHOTOLUMINESCENT EMISSION OF MOS2



AWARDS	BASF Expanding Knowledge in Science Award (WESEF), AIME Qualifier
EXTRACURRICULARS	Violin, Science Olympiad Exec, Track and Field, AAPIA, Robotics, Tutoring

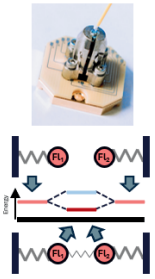
PROJECT ABSTRACT

Molybdenum disulfide (MoS2) is a 2D material widely studied for its direct bandgap at the monolayer scale and excitonic photoluminescence. A largely unexplored property of 2D materials is the ability of their excitons to couple with external molecules, which would change the emission spectrum. Exciton coupling could potentially be exploited to create more efficient room temperature single photon sources. These single photon sources would make quantum computing considerably faster and more efficient. In this study, MoS2 was spin-coated with Cy5 fluorophores and observed with angled PL, where the excitation laser was directed at a shallow angle to the sample. Although the PL spectra of the coated MoS2 were weaker than the bare MoS2 spectra, the weakness could not be entirely attributed to coupling because the Cy5 may have photobleached and prevented the MoS2 from emitting light. Some of the coated MoS2 spectra exhibited peak splitting, but peak splitting was not seen in all of the spectra, probably because of the imbalance between the concentration of unbleached Cy5 and excitons within the MoS2. This imbalance would cause the coupled emissions to be overpowered by standard emissions from the MoS2 and Cy5. Overall, our findings suggest that there is exciton coupling between the MoS2 and Cy5.

QUAD CHART

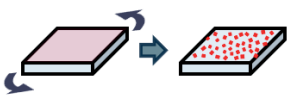
Research Problem and Question

- Single photons can be used as qubits in quantum computing and for quantum communication
- However, many single photon sources can only operate at cryogenic temperatures
  - This makes them cost and space-prohibitive
- Fluorescent molecules can "exciton-couple," theoretically leading to more efficient emission
  - An increase in emission efficiency may allow them to be used as single photon sources at higher temperatures
- 2D semiconductor materials like MoS_2 form excitons that could couple with a fluorophore's exciton, a property that has not been explored
- Can we couple the exciton of a 2D material with the exciton of a fluorophore?

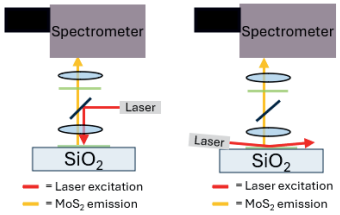


Methods

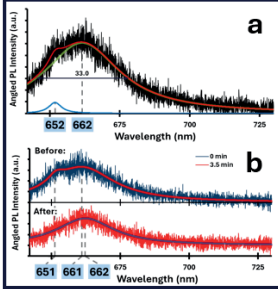
Coat MoS_2 > Photoluminescent Spectra



- MoS_2 was spin coated using 102.3nM Cy5 solution
- Coating and coupling was assessed using PL spectroscopy



Results



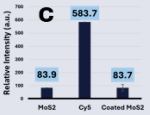
Major Findings:

- MoS_2 peak: 663nm; Cy5 peak: 659nm

a) Peak splitting
- New blue-shifted peak at 652nm
- Slightly redshifted main peak

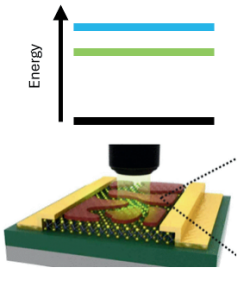
b) Loss of splitting after laser exposure
- Due to Cy5 photobleaching
- Suggests that peak splitting is a Cy5 dependent process

c) Weaker PL intensity after Cy5 coating
- This may or may not be due to exciton coupling, it could be due to Cy5 photobleaching or a thinner coating.



Discussion and Conclusion

- Peak splitting **strongly indicates** that exciton coupling is occurring because it confirms the existence of new energy level
- Cy5 dependency **further supports** exciton coupling hypothesis
- Peak splitting may be due to a form of molecular aggregation or charge transfer
- Aggregation can increase emission efficiency for use of a single photon source
- Charge transfer could improve the sensitivity of an MoS_2 photodetector



ADAM KAMAL



QUANTUM APPROACH FOR ENERGY DISTRIBUTION OPTIMIZATION

AWARDS	Visionary Engineering Award WESEF, 3rd Place Somers Science Fair in Engineering
EXTRACURRICULARS	Swimming

PROJECT ABSTRACT

Electric grids power modern civilization and are highly inefficient, leading to energy loss, unnecessary greenhouse gas emissions, and higher costs. This study explores a quantum computing-based algorithm to enhance energy distribution, to evaluate the application of quantum computing techniques in optimizing energy distribution and improving grid performance. To achieve this, a Trainable Fidelity Quantum Kernel was constructed using the ZZFeatureMap and optimized by the SPSA algorithm. This kernel was used to train QSVC for binary classification of energy usage with controls including a reduced dataset of 100 samples. In the time-series data analysis, a VQC was implemented with a TwoLocal ansatz of three qubits with minimal repetition to handle this task efficiently. In addition, for energy optimization, a quadratic program was formulated using Docplex and solved by QAOA with the COBYLA optimizer, adjusting parameters concerning feasibility. The model was able to detect every scenario that needed optimization with a sensitivity of 1.0. It also showed great performance in correctly classifying when optimization was unnecessary, with a specificity of 0.9375. From this, quantum models show immense potential to enhance grid performance directly by preventing blackouts, reducing energy waste, and lowering costs associated with it. These improvements have the potential for scalability to benefit both local and global energy infrastructures. To build upon what I have accomplished, studies should focus on utilizing larger datasets and considering renewable energy sources. Furthermore, advancing nascent quantum hardware and algorithms will refine these models for practical deployment in energy systems.

QUAD CHART

Why Does this Project Matter?

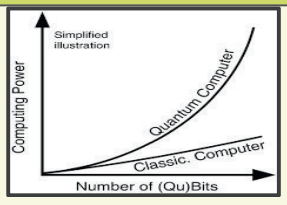
General Problem: Despite 90% of countries utilizing electric grids, the U.S. loses **5-10% and** less developed areas **30%** of generate energy

Specific Problem: Current implementations struggle with larger data sets

Aim and Novelty: Develop a quantum based machine learning framework that leverages QKT and QSVC for greater results than classical.

Data and Results

- QSVC Specificity: .9375
- QSVC Sensitivity: 1



Methodology

1. Set up
   a. Data Set + Computer
2. Data Preprocessing
   a. Data Cleaning, encoding, scaling
   b. Label Creation
3. Training
   a. QKT + QSVC
4. Testing algorithm against classical

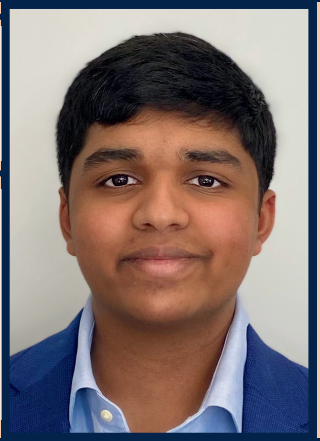
Conclusion and Impact

Electric Companies + Governments need implementations that improve with larger data sets
This can have the effect of:

- Cutting Electricity Prices - .5 cents per kWh
- Reducing Unnecessary Greenhouse Gas Emissions

RISHI KUMAR

LEVERAGING R FOR ENHANCED DETECTION IN FIBROMYALGIA: IDENTIFYING KEY BIOMARKERS THROUGH A NOVEL APPLICATION OF DIFFERENTIAL EXPRESSION ANALYSIS DEA- LIMMA VOOM



AWARDS	New York State JSHS FINALIST, NYSSEF Finalist Honorable Mention, WESEF Finalist
EXTRACURRICULARS	Nursing Home Volunteer, CVAC Memeber, Teen of Impact Leader, ESL Teacher, Co-Captain of Debate

PROJECT ABSTRACT

Fibromyalgia affects 480 million people worldwide and is diagnosed through symptomatic assessments, which lack consistency, particularly in male patients. This study aimed to identify biomarkers for fibromyalgia using Limma Voom, a method optimized for large and broad expression ranges. This study predicted that HTR2A and COMT genes and Neuronal signaling pathways would be the most enriched in the Fibromyalgia group and the protection. The fibromyalgia group's structure looked at over- and under-expressed gene dysfunction and the distinction between males and females. In contrast, Protection is structured with over-expression in control and under-expression in fibromyalgia patients, and a distinction between males and females. Differential Expression Analysis identified RN7SL1, SNORD17, and SNORA73B as significantly expressed in both fibromyalgia and protection groups (and respective subsets), suggesting these biomarkers are not gender-specific. Pathway Enrichment Analysis (PEA) revealed the neuroactive ligand-receptor interaction as the most enriched pathway, while Gene Set Enrichment Analysis highlighted neurodegenerative and immune response pathways in fibromyalgia. Protective pathways included (NETS), immune response, and mitochondrial dysfunction. Gender differences were evident, with males enriched in axon guidance and females in chemokine signaling and neurodegenerative pathways. These findings underscore critical processes underlying fibromyalgia and highlight potential biomarkers for diagnostic and therapeutic applications. Future research should validate and asses these biomarker through clinical factors.

QUAD CHART

Problem & Objectives

Problem

No specific lab tests for diagnosis Fibromyalgia (Fitzcharles, M.-A., et al., 2013)

Objectives

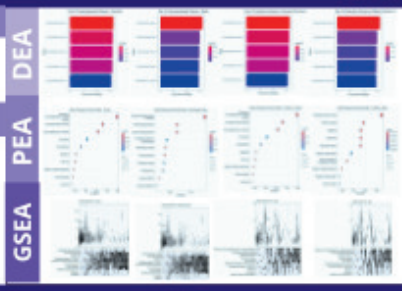
- Identify biomarkers
- Analyze pathways
- Explore Protection

Hypothesis

HTR2A & COMT genes are significant biomarkers

Neuronal pathways are differentially expressed

Results



- logFc > 15
- Overlap in Genes

- Distinct across sex
- Neuro Role

- Neuro & Immune Role

Methodology

DEA Limma Voom

- Identifies significant biomarkers
- Examines broader Gene Expression



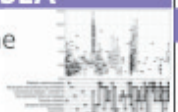
PEA

Analyzes Significant Pathways (KEGG)



GSEA

Finds Gene Clusters



Conclusion

Findings

- HTR2A & COMT not significant
- Neuro & Immune roles enriched
- Biomarkers not distinct across sex

Applications

- Biomarker Diagnosis
- Sex Distinct Diagnosis

EVE LANSFORD



BENEFITS, BARRIERS, AND ACCESSIBILITY IN VIDEO GAMES: A FOCUS GROUP STUDY OF COLLEGE STUDENTS WITH DISABILITIES

AWARDS	Somers Science Fair 1st place in behavioral sciences
EXTRACURRICULARS	Mathnasium tutor, volunteer at Maria Fareri Children's hospital, SHARE Casa ESL tutor, crochet club member, piano

PROJECT ABSTRACT

According to an annual survey, video games are one of the most popular hobbies in the United States. Along with this rise in popularity, there has been an increased effort to make video games more accessible for everyone, specifically for those with disabilities. Though physical barriers have been explored among college gamers with disabilities, there is limited research on the psychological and emotional barriers that gamers with disabilities face. Our study aims to examine how video games impact college students with disabilities in the areas of benefits, barriers, and accessibility. We conducted 3 focus group interviews with college students (n=12). Semi-structured questions were centered around the three areas. Data analysis was conducted based on reflexive thematic analysis and we utilized the Self-Determination Theory to explore motivations behind gaming. We identified three themes: (1) benefits, with sub-themes of social benefits, symptom relief, and skill improvement (2) barriers, with sub-themes of intrinsic barriers of physical, cognitive, and mental barriers; and extrinsic barriers of gameplay and environmental barriers (3) accessibility, with sub-themes of in-game and external/hardware features. The findings can be applied to video games by developers to make gaming more accessible for those with disabilities and enhance the experience for everyone. These three themes shed light on how gaming can improve the well-being for those with disabilities. Overall, this study provides unique insights on the benefits, barriers, and accessibility features of video games experienced by college aged students with disabilities.

QUAD CHART

Research Question

Overview: Video games are a popular hobby in the US, and the primary age group is college students. Recently, there's been an increased effort to make video games more accessible for those with disabilities. The goal of this project was to explore how video games impact college students with disabilities.

Research questions:

- Q1. What are the perceived benefits of gaming?
- Q2. What challenges hinder gamers with disabilities from fully enjoying the experience?
- Q3. What accessibility options are most desired or used by gamers?

Methodology

- 3 focus groups, 60 minutes each
- Participants were in college/graduate school, have a disability, and have experience playing video games
- Reflexive thematic analysis used for analysis
  - Read through focus group transcripts and extracted themes and codes

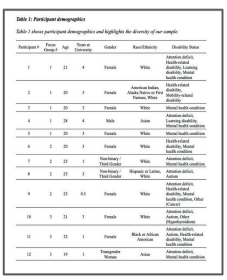


Table 1: Participant demographics

Table 1 shows participant demographics and highlights the diversity of our sample.

Participant #	Focus Group #	Age	Years at University	Gender	Race/Ethnicity	Disability Status
1	1	21	4	Female	White	Attention deficit, Health-related disability, Learning disability, Mental health condition
2	1	20	3	Female	American Indian, Alaska Native or First Nations, White	Health-related disability, Mobility-related disability
3	1	20	3	Female	White	Mental health condition
4	1	20	4	Male	Asian	Attention deficit, Mental health condition
5	1	20	3	Female	White	Mental health condition
6	2	20	3	Female	White	Health-related disability, Mental health condition
7	2	22	1	Non-binary / Third Gender	White	Attention deficit, Mental health condition
8	2	21	3	Non-binary / Third Gender	Hispanic or Latino, White	Attention deficit, Autism
9	2	21	0.5	Female	White	Attention deficit, Health-related disability, Mental health condition, Other (Crohn's)
10	3	21	3	Female	White	Attention deficit, Autism, Other (Hypothyroidism)
11	3	22	1	Female	Black or African American	Attention deficit, Autism, Health-related disability, Mental health condition
12	3	19	1	Transgender Woman	Asian	Attention deficit, Mental health condition

Results

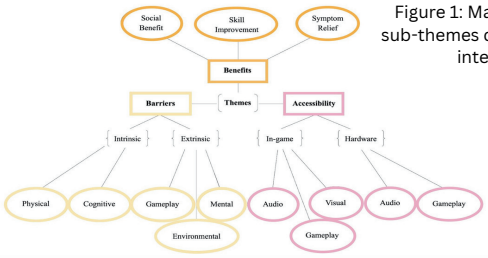


Figure 1: Main themes and sub-themes derived from the interviews

Interpretation and Conclusion

- Using gaming as a tool to help students with disabilities
  - Improve their social skills, provide symptom relief, and improvement skills
- Addressing barriers and accessibility features described could improve gaming experience for those with disabilities
  - Could increase benefits described
  - Lead to more inclusive gaming

MEREDITH LEVINE

ZOOPLANKTON OFF THE NORTHEAST COAST: A STUDY ON THEIR ABUNDANCE IN RELATIONS TO OCEAN CONDITIONS



AWARDS	3rd Place Environmental Science at Somers Science Fair and 4th Place Environmental science at WESEF
EXTRACURRICULARS	Event assistant at World Cup Gymnastics, animal shelter volunteer, babysitter, and enjoys listening to music in free time.

PROJECT ABSTRACT

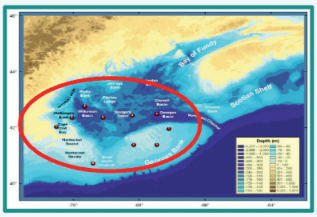
Zooplankton are magnificent organisms that help maintain the stability of marine ecosystems. As of recently, there have not been updated studies on the usage of Neuston nets tracking zooplankton, leaving a gap in the research. We aimed to establish a relationship between salinity and temperature and the abundance of zooplankton in specific locales. Our primary means for getting data was our deployments of the Neuston net we had aboard the ship. The Neuston net was performed to collect hands-on, real time data of the zooplankton. We did not find a sufficient relationship between temperature and abundance. However the data I collected showed relativity between the salinity and abundance as the salinity was statistically inconsistent. This created a somewhat gap in my research as I must now aim to further research salinity and its relationship, hopefully in an area with consistent salinity. We concluded that there is more of a correlation between temperature and zooplankton and that when there is an increase in temperatures (usually lingering around 24-25 degrees C), there should be more zooplankton in the neuston. This research is becoming more applicable as our Earth's oceans are rising and heating. Climate change upon us and zooplankton play a major role in monitoring these changes. To stray away from zooplankton research would be to danger our ocean environments and endanger the species we rely so heavily on.

QUAD CHART

INTRODUCTION

Zooplankton are magnificent organisms that help maintain the stability of marine ecosystems. They are the primary food source for whales, serving as a **link between trophic levels** (R.E. Morse, 2016). While active in their role of regulating the trophic levels, they are also quite sensitive to environmental changes. Because of their sensitivity, they are also used as **indicators of ocean conditions** (Peterson, 2009).

Problem : Lack of research in areas in which we sailed.
Goal : The overall aim of this study was to address and observe the number of zooplankton in the areas in which our boat sailed (Pictured to the right).
Hypothesis : Zooplankton would be more abundant in regions with higher temperatures and consistent salinity as opposed to colder areas with various salinity. Zooplankton such as copepods have been known to have an increase in their migration speeds as a result of higher temperatures (Wade, 2000).



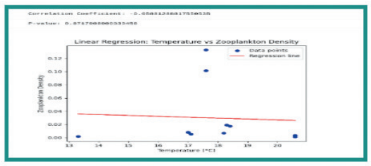
These locales house many organisms that humans rely on for survival. Within their ecosystems lie crustaceans, malacostracans, and bivalve molluscs, all of which are primary means of food for **nearly 57,040,408 people** (Census Reporter, last updated in 2022).

DATA AND RESULTS

ANOVA Result
- Significant difference between the varying salinities (**.018****)
- Salinities were inconsistent, **rejecting to support hypothesis**

Measure	Value
Salinity greater than 31.20	31.49, 32.32, 31.52, 31.67, 31.32
Salinity less than 31.20	31.18, 30.85, 30.8, 31.03, 30.82
T-statistic	3.88
P-value	0.018

Regression Test Result
- No significant relationship between zooplankton density and temperature (**.087**)
- Outliers in data



The results **deviated from our expectations but they provided a good starting point for further research.** It was surprising to receive results that did not support our general hypothesis in regards to the higher temperatures being optimal for zooplankton. Being ectothermic, zooplankton metabolic rates are heavily influenced by temperature.

METHODOLOGY

Mentor v. Student
I had the privilege of being a heavy participant in the methodology, managing the net prep and its cleaning. In addition to this, I was also able to utilize the microscope and sort through our biomass sample. My mentor implemented the data collected on to spread sheets for analysis.

Neuston Tow
To collect the biomass/zooplankton we utilised a Neuston Tow net that trailed across the ocean's surface. The net required supervision and was to only be used when the ship was sailing at a specific speed (2 knots).

Microscope Work
Upon getting the neuston into a sieve, we took a sample to use for further analysis. We put this sample under a microscope and counted in 100s (100 counts), marking tallies for each zooplankton.

Data Analyses
ANOVA T-test (salinity)
Linear Regression Test (temperature & abundance)







APPLICATIONS

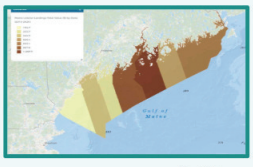
Humans are indirectly reliant on zooplankton further pushing the need to understand their behavioral patterns and populations. Pushing aside or turning a blind eye to zooplankton research and how they are influenced by changing ocean environments is unacceptable for the world we are living in.

Indicator Species
- Due to their sensitivity, zooplankton are excellent tools in the prediction of other species migration
- Indicate changing ocean conditions

Boosting Biological Carbon Pump
- Feed on phytoplankton and after digestion, cycle carbon into environment
- Copepods among other zooplankton have fast-sinking fecal pellets

Engineering Zooplankton
- Genetic modification
- Selective breeding
- Enhance populations that sink carbon more efficiently
- Help particular zooplankton (pteropods) with shells

Study at Dartmouth :
Spraying clay on surface to form balls of clay and carbon (flocs) in which zooplankton will feed on



Food Source
- Numerous organisms rely on zooplankton for food
- Small fish
- Whales
- Jellyfish
- **Lobsters**
- Crustaceans



SAMUEL MULLEN



EVALUATION OF THE TARGET BINDING FRACTION OF [89ZR]ZR-RADIOLABELED ANTI-CEACAM6 FOR FUTURE PANCREATIC DUCTAL ADENOCARCINOMA THERANOSTICS

AWARDS	NYSSEF Finalist and Honorable Mention, NSPA Pacemaker US Final 8
EXTRACURRICULARS	Soccer, Violin, Science Greeley, Table Tennis, Hiking

PROJECT ABSTRACT

Pancreatic ductal adenocarcinoma(PDAC) is an extremely deadly malignancy with a survival rate of less than 10%. Current PDAC diagnostic and therapy techniques are not very effective and there is currently no available PDAC theranostic. Theranostics are targeted and combine diagnosis and therapy into one pharmaceutical. 89Zirconium-Anti-CEACAM6 is a potential theranostic that targets CEACAM6, which is overexpressed on PDAC tumors. The goal of the study is to find the target binding fraction(TBF) of 89Zr-Anti-CEACAM6 to CEACAM6 using Ni-NTA bead based binding assay. The Ni-NTA beads were coated with CEACAM6, and then Anti-CEACAM6 was radiolabeled by DFO chelated 89Zr. 89Zr-Anti-CEACAM6 was added to all of the study arms. The beads and supernatant were isolated and the radioactivity was measured with a gamma counter. The TBF was calculated by dividing the amount of radioactivity on the beads by the radioactivity in the supernatant. It was found that the average TBF was 3.69%, the blocked TBF was 4.46%, and there was 2.22% non-specific binding. Dissociation of 89Zr-Anti-CEACAM6 was the likely reason behind the low TBF, as 89Zr-DFO can be unstable during experimentation. The dissociation would have resulted in Anti-CEACAM6 and 89Zr separating, as a result 89Zr was no longer able to bind to CEACAM6. Due to the low TBF of 89Zr-Anti-CEACAM6-89 to CEACAM6, future research should look into the optimization of the radiolabelling reaction and the use of a different radionuclide such as 64Cu, which is used in theranostics for prostate cancer.

QUAD CHART

Introduction and Background

Pancreatic Ductal Adenocarcinoma(PDAC)

- Pancreatic cancer is the fourth largest cancer related cause of death
- Approximately 90% of pancreatic cancer cases are classified as PDAC
  - Survival rate of less than 10%
- Current diagnosis and therapy options are not very effective
  - Theranostics combine therapy and diagnosis

Targeting CEACAM6

- CEACAM6 is overexpressed on PDAC tumors
- Anti-CEACAM6 has a high binding affinity for CEACAM6
  - Use Anti-CEACAM6 to deliver [^{89}Zr]



Results and Analysis

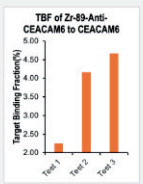


Figure 1: Average TBF of 3.69% of [^{89}Zr]-Anti-CEACAM6 to CEACAM6.

Table 1: Low amount of radioactivity on Ni-NTA beads.

	Control			Test			Blocking		
	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3
Beads	70.95	45	57.19	58	99	106	105	117	114.24
Supernatant	2450.4	2413.11	2488.39	2437.18	2215.77	2078.18	2396.98	2297.4	2195.13
Wash 1	77	47.24	93	80.24	65	77	97	86.24	99.24
Wash 2	14	13	20	4.24	1	7	13	17	11

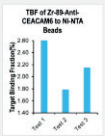


Figure 2: Low average non-specific binding of 2.22% to Ni-NTA beads.

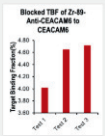
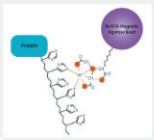


Figure 3: Average TBF of 4.46% with excess non-labeled Anti-CEACAM6.

Methodology

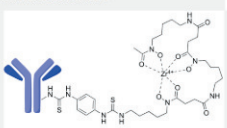
1: Coat Ni-NTA beads with CEACAM6

2: Chelate [^{89}Zr] with DFO and then bind DFO to Anti-CEACAM6



3: Add [^{89}Zr]-Anti-CEACAM6 to all arms in the study and then incubate

4: Collect beads, supernatant and two washes and add to gamma counter





5: Divide radioactivity of beads by radioactivity not on beads

Discussion and Conclusion

Discussion

- The low TBF was likely due to the dissociation of the radioligand
- H_1 not supported, H_2 supported
- Future research could look into a cell based assay and ensuring the strong binding of ^{89}Zr and its chelator DFO

Conclusion

- [^{89}Zr]Zr-Anti-CEACAM6 had a low average TBF of 3.69% to the CEACAM6 coated Ni-NTA beads
- Results provide useful insight for the creation of the first ever PDAC theranostic

STELLA MYERS

VALIDATING A NOVEL DIGITAL FACE-NAME PLATFORM FOR MEMORY ENHANCEMENT IN THE COGNITIVELY HEALTHY: A BASELINE FOR MILD COGNITIVE IMPAIRMENT APPLICATION



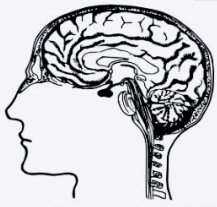
AWARDS	1st Place Medicine (Somers), 3rd Place Medicine (WESEF), International Research Olympiad Semi-Finalist 2025
EXTRACURRICULARS	EMT at CVAC & Youth Corps Member, "Enchords" Acapella Group, Sailing Instructor & Racer, Burke NeuroAcademy

PROJECT ABSTRACT

Mild Cognitive Impairment is a transitional stage for more severe conditions like Dementia and Alzheimer's disease, and previous research has shown that memory training exercises have shown promise in mitigating symptoms. We hypothesize that the use of a digital platform for repetitive face-name pair recall- FNAME-CogniFuse-will significantly improve memory retention in cognitively healthy individuals.The platform's training model involved three key stages: an Encoding phase where participants learned face-name pairs, a 15-minute Break phase for memory consolidation, and a three-part Recall phase to test associative memory, free recall, and confidence ratings. A structured training program using FNAME-CogniFuse was conducted with 24 participants under 18. The results demonstrated an average of 34% overall increase in memory recall accuracy (p-value of .0017) from the baseline to the final session. In recognition accuracy, we observed a 36% improvement (p = 0.0014). Free recall accuracy showed an 11% decline, though it was not significant. Answer confidence increased by 48% (p = 0.003). Notably, demographic analysis revealed a 59.63% average increase in memory scores for White participants and a 23.79% average increase for Asian participants, though this difference was not significant. The results revealed that the platform effectively enhances associative memory and answer confidence, suggesting its potential as an accessible cognitive training tool. Therefore, the FNAME-CogniFuse platform has significant potential as both an at-home cognitive training tool for healthy individuals and, with further validation, a clinical tool for MCI patients.

QUAD CHART

Research Question

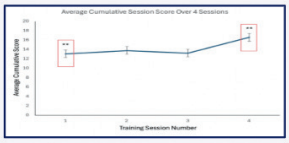


Mild Cognitive Impairment (MCI)
a neurological conditon that precedes dementia and severely effects memory retention & function

Face-Name Training
(repeatedly matching names with faces) has shown strong potential at treating MCI but lacks development & accessibility

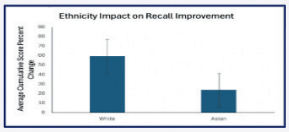
Does the **novel digital *face-name training* platform *FNAME-CogniFuse*** significantly enhance **recognition accuracy, recall accuracy, and confidence (3 key memory domains)** in cognitively healthy individuals?

Results & Analysis



Memory Enhancement

Significant cumulative memory improvement from Session 1 to Session 4.
Session 1 → Session 4: Average cumulative scores increased significantly (**p < 0.01**), with a clear upward trend.

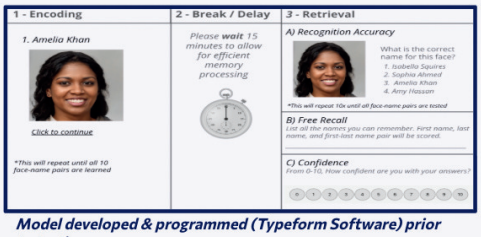


Name Familiarity - AI BIAS

Ethnicity significantly influenced recall improvement:
White participants: **~59.63% improvement**
Asian participants: **~23.79% improvement**

Differences suggest **potential AI platform bias or cultural familiarity** influencing face-name recall

Methodology



Model developed & programmed (Typeform Software) prior to testing
All face-name pairs used are AI-Generated

Participants

N = 79 cognitively healthy individuals (<18 years, diverse backgrounds)
Recruited from Science Research Program & trained in classroom

Training Procedure

4 structured training sessions conducted using the FNAME-CogniFuse model
Analysis: t-tests and ANOVA → Microsoft Excel

Conclusions

Main Conclusion:
FNAME-CogniFuse significantly enhances associative memory and user confidence, validating its potential for memory training in cognitively healthy individuals.

Novel Insights:
A **novel platform for face-name training** was successfully created and tested. Results revealed **demographic disparities** in performance, highlighting impact of cultural familiarity

Future Directions:
1. **Enhance** platform features by adding **more cognitive parameters** and **customization options**.
2. **Expand testing** to a **broader and more diverse participant population** to ensure inclusive and generalizable results.

LORELAI NOCCA



ASSESSING PROCESS PARAMETERS FOR THE SIMULTANEOUS HYDROLYSIS AND FERMENTATION OF UPCYCLED CHEESE WHEY PERMEATE: RECOVERING GALACTOSE AS A FOOD INGREDIENT

AWARDS	2nd Place Biochemistry (WESEF) & George D. Yancopoulos Young Scientist Award (WESEF)
EXTRACURRICULARS	Track and Field - Varsity Golf - Speech and Debate

PROJECT ABSTRACT

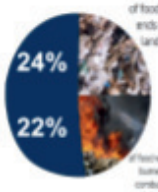
Wasted food materials contribute heavily to the environment's declining condition. Upcycling cheese whey permeate for the recovery of galactose and ethanol as an individual food ingredient has been researched however, our understanding regarding galactose remains incomplete. The research goals were to discover the optimal settings for process parameters during simultaneous hydrolysis and fermentation to maximize the recovery and purity of galactose. JMP 17.0 (SAS institute) software was used to create regression models using a significance level of < 0.05 to understand the impacts of the individual process parameters on galactose. The first regression model was made with the purpose of explaining the individual effect of enzyme/substrate ratio (IU/g lactose), inoculation rate (log CFU/mL), and time (days) on final recovered galactose levels at 30 degrees Celsius and an initial lactose concentration of 84.47 g/L. An additional column defining a new dependent variable labeled "galactose purity" was created to support or refute the second hypothesis. A second regression model was made based on the galactose purity column. When comparing the baseline control settings with the optimal parameter settings found, it was determined that a 23.42% increase in galactose recovery is possible. With optimal process parameters, galactose can continue to be produced at higher levels, contributing to the exploitation of applications including individual galactose as a sweetener in the food industry and as an aid in the production of biofuel.

QUAD CHART

Introduction

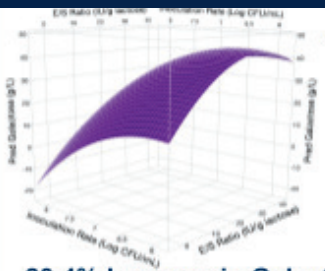
Background:

- 85% of milk used for cheese production is discarded as cheese whey permeate (CWP)
- Approximately 1.3 billion pounds of food waste per year
- Estimated $1 trillion as a result of food waste

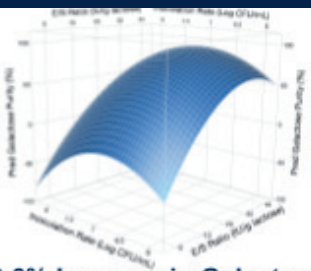


Research Question: What is the individual effect of different process parameter settings on upcycled galactose volume and purity?

Results



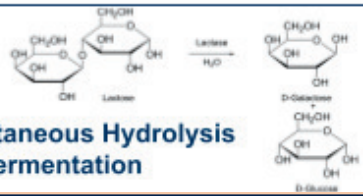
23.4% Increase in Galactose Recovery



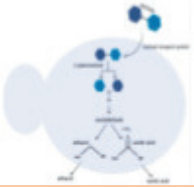
22.6% Increase in Galactose Purity

Methodology

Linear Regression Models → Prediction Profilers → Surface Plots



Simultaneous Hydrolysis and Fermentation



Conclusion

Novelty: First optimization of process parameter settings during simultaneous hydrolysis and fermentation of upcycled CWP to obtain maximum purity and yield of galactose

Future Research:

- Identify the optimal process parameters across a wider range of settings
- Investigate the effect of other fermentation products on galactose recovery
- Design process for extraction and purification of galactose

KATHLEEN PASKOWITZ

IMPROVING AQUATIC HEALTH: WASTEWATER TREATMENT PLANT UPGRADES AND THEIR INFLUENCE ON DISSOLVED OXYGEN IN A NY ESTUARY



AWARDS	NASA Earth System Science Project Award
EXTRACURRICULARS	Tutoring, field hockey, Sustainability Advisory Board

PROJECT ABSTRACT

In NY, Jamaica Bay estuary's wastewater treatment plant (WWTP) was found to contribute 89% of 15,785 kilograms per day of nitrogen being loaded into the estuary. The WWTP in Jamaica Bay has been undergoing constant upgrades for decades, with the most recent one finished in 2018, installing specific technology for nutrient removal. However, our understanding of how much these upgrades have actually benefited Jamaica Bay remains incomplete. In this study, we will analyze dissolved oxygen levels in order to find the effect of the WWTP on the health of the estuary. All data came from the New York Department of Environmental Protection (NYDEP), collected using Winkler's Titration and analyzed using linear regression analyses. We then calculated oxygen saturation values in order to evaluate how much respiration is being performed by finding apparent oxygen utilization (AOU) values. A significant decrease in AOU values were found ($p = 2.33E-06$), suggesting a shift from cellular respiration to photosynthesis and an increase in dissolved oxygen in the water. From the data set provided by the NYDEP, dissolved oxygen levels were found to increase over time ($p = 3.08E-15$). Therefore we conclude that the WWTP upgrades were successful in decreasing nitrogen inputs and increasing the level of dissolved oxygen present in the water. All around the world, this research can be used to decrease pollution in bodies of water around the world. Our research will help us combat global climate change and take us one step closer to achieving a healthier environment.

QUAD CHART

Introduction

Problem

It is unclear how the wastewater treatment plant upgrades affect **phytoplankton** and **changes in dissolved oxygen** in the estuary.

Hypothesis

Lower nitrogen inputs to an estuary will result in higher levels of dissolved oxygen



Methodology

Variables

Independent Variable:
- WWTP upgrades

Dependent Variables:
- Dissolved oxygen concentrations
- Salinity concentrations
- Temperature
- Oxygen saturation values

Data Collection

Oxygen Saturation Values:
- Water quality sondes

Salinity, Temperature, Dissolved Oxygen:
- Winkler's Titration Method
- Collected throughout 1909 - 2023
  - Monthly





Results

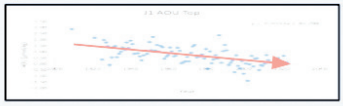
Analysis

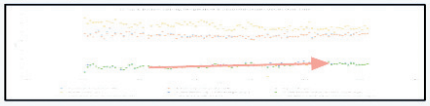
Oxygen Saturation Values:
- Plugged values into equation
  - Determined AOU values

All data was run through linear regression analyses to find significance

Interpretation

- Decreasing + negative AOU values
- **Shift** from *respiration* to *primary production* → increasing concentration of dissolved oxygen
- Increase in dissolved oxygen





Conclusion

Hypothesis = supported

Applications

- **Apply** conversion technology to other WWTPs around the world
- **Develop** monitoring & *preventative measures* designed to keep pollution at *low levels*
- **Increases** water quality
  - Beneficial for humans
- Further understand the role nitrogen has in pollution

SHAWN QIU



LONG-TERM EFFECTS OF COVID-19 ON KIDNEY TRANSPLANT PATIENTS: A 3.5-YEAR POST-INFECTION ANALYSIS

AWARDS	2025 Wharton High School Data Science Competition Finalist, Published Author in *Diagnostics*
EXTRACURRICULARS	Research intern at Albert Einstein College of Medicine, Book Donation Association club (club founder) at Horace Greeley High School

PROJECT ABSTRACT

Background: Although kidney transplant recipients (KTRs) who are immune compromised have been reported to be at high risk of acute adverse COVID-19 outcomes (i.e., mortality and critical illness), long-term outcomes of KTRs after COVID-19 are unknown. Methods: This study retrospectively evaluated 1,815 KTRs in the Montefiore Health System from January 1, 2016, to January 12, 2024. COVID-positive patients were identified with positive polymerase chain reaction (PCR) tests, while COVID-negative patients served as controls. The control group established baseline results for comparison. Final matched cohorts, adjusted for observation time, consisted of KTR with COVID-19 (n=510) and matched KTR without COVID-19 (n=510, controls). Primary outcomes included all-cause mortality and changes in estimated glomerular filtration rate (eGFR) from 30 days to 3.5 years after the index date. Kaplan-Meier survival analysis and Cox proportional hazard ratios assessed mortality risk. Generalized estimator equations were used to evaluate changes in eGFR over time. Results: No significant difference in long-term all-cause mortality (aHR=0.66, p=0.057) was observed between groups. However, eGFR declined significantly more in KTR with COVID-19 (-1.80 units/year [-2.45, -1.15], p<0.001) than in non-infected KTR (-0.98 units/year [-1.50, -0.46], p<0.001). Conclusion: SARS-CoV-2 infection was associated with an accelerated decline in eGFR with follow-up time up to four years post-pandemic, suggesting significant long-term implications for graft health. These findings underscore the importance of vigilant monitoring of kidney function post-COVID-19 in this vulnerable population. DOI: Diagnostics 2025, 15(9), 1091; https://www.mdpi.com/2075-4418/15/9/1091/review_report

QUAD CHART

Research Goal

- To investigate the prolonged effects of COVID-19 on kidney transplant recipients in the post-pandemic era
- To compare the long-term outcomes of COVID-19 transplant patients with a non-COVID-19 infected cohort
- Most studies on COVID-19's impact on kidney transplant patients only focus on short-term effects
- No prior research compares long-term outcomes (>3 years) of COVID-19 transplant patients

Results

COVID-19 infection is associated with an accelerated decline in eGFR

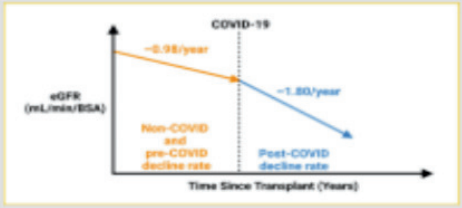
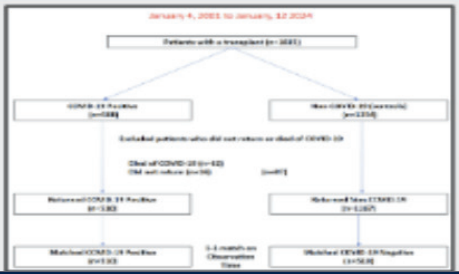


Figure 1. Graphical representation of results from generalized estimating equations regression model tracking changes in eGFR

Methods



statsmodels

matplotlib

LIFELINES

Discussion/Conclusion

Hypothesis was supported: COVID-19 has long-term effects on eGFR decline in KTR

Thromboembolic complications in COVID-19 patients may contribute to long-term kidney damage

COVID-19 is known to cause sequelae leading to microthrombi formation.

EVE RUTMAN

PRE-EXISTING CONDITIONS AS PREDICTORS OF PNEUMATOSIS INTESTINALIS IN PEDIATRIC PATIENTS: A SYSTEMATIC REVIEW



EXTRACURRICULARS	Mt. Kisco Volunteer Ambulance corps, Captain of Varisty Field Hockey, Hostess at The Kittle House, Executive position of SHARE, Volunteer of New Castle Field Hockey

PROJECT ABSTRACT

Pneumatosis Intestinalis (PI) affects 0.03% of the world's population, but has a mortality rate of 37% . Researchers have previously found that PI may be caused by pre-existing conditions that cause trauma to the pediatric body. Searching for these pediatric conditions that have a higher rate of leading to dangerous outcomes in PI has yet to be done, which led to the aim of this project. A search on pubMed with the key words "pneumatosis intestinalis pediatric" with fitting filters. Data was recorded in excel under 24 different variables that ranged from pre-existing conditions to outcomes of PI. 3 variables were excluded for insufficient data. The rest were put into RStudio and analyzed using the chi-squared method. Our results showed that there was no significant correlation between any conditions and outcomes; none of the pre-existing conditions had a p-value below 0.05. The specific outcomes tested were death and surgical intervention, the more concerning variables. We concluded that there are most likely no pre-existing conditions that will lead to PI. This finding takes stress off of doctors and patients because it means that having a certain condition doesn't necessarily mean they have a higher chance of developing PI. By learning which conditions have a higher chance of leading to secondary PI, which is more fatal, earlier actions can be done to manage the patients. This novel way of studying PI can advance pediatric management on a universal scale.

QUAD CHART

Research Question

- Pneumatosis Intestinalis(PI) is abnormal presence of gas in the gastrointestinal tract
- Patient's **personal history is mandatory** to discover an underlying cause of PI
- **Unknown cause** leading researchers to look for medical signs of PI

Objective: Discover which type of pre-existing condition has a significant (p<0.05) impact on either surgical intervention or death

Data Analysis and Results

- Overall, sample had the **highest % of GI conditions** and high reports of **abdominal pain**
- **No statistically significant values**

Condition	X-squared value	P value
Healthy	0.31219	0.5763
Hematologic	1.06750	0.3015
Oncologic	0.31219	0.5763
GI Condition	0.56250	0.3530
HSCT	0	1

Condition	X-squared value	P value
Healthy	0.1385	0.6863
Hematologic	0.24175	0.6229
Oncologic	0.11512	0.7344
GI Condition	0	1
HSCT	1.7874	0.1812

Limitation: There was limited data recorded from articles; Data not consistently given

Methodology

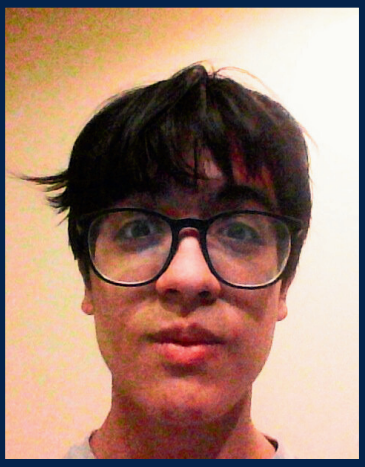
- Searched for articles on **PubMed** with the filter: **2014-present**
- General data collected and recorded if article was usable
- Usable articles put into separate Excel sheet with **24 variables (including 5 conditions)**
- Used **Chi-Square test** in RStudio to conduct statistical analysis and measured each condition with the outcome(s) of surgery and death



Interpretations and Conclusions

- **Hypothesis was not supported** because **P > 0.05.** Additionally, most patients didn't have hematologic condition
- **Supported previous research** saying that underlying conditions didn't have a significant effect on outcomes
- Hints towards a potential cause by eliminating these conditions as options
- **GI conditions were found in most cases**, meaning it could be a medical sign

HADRIAN SANDT



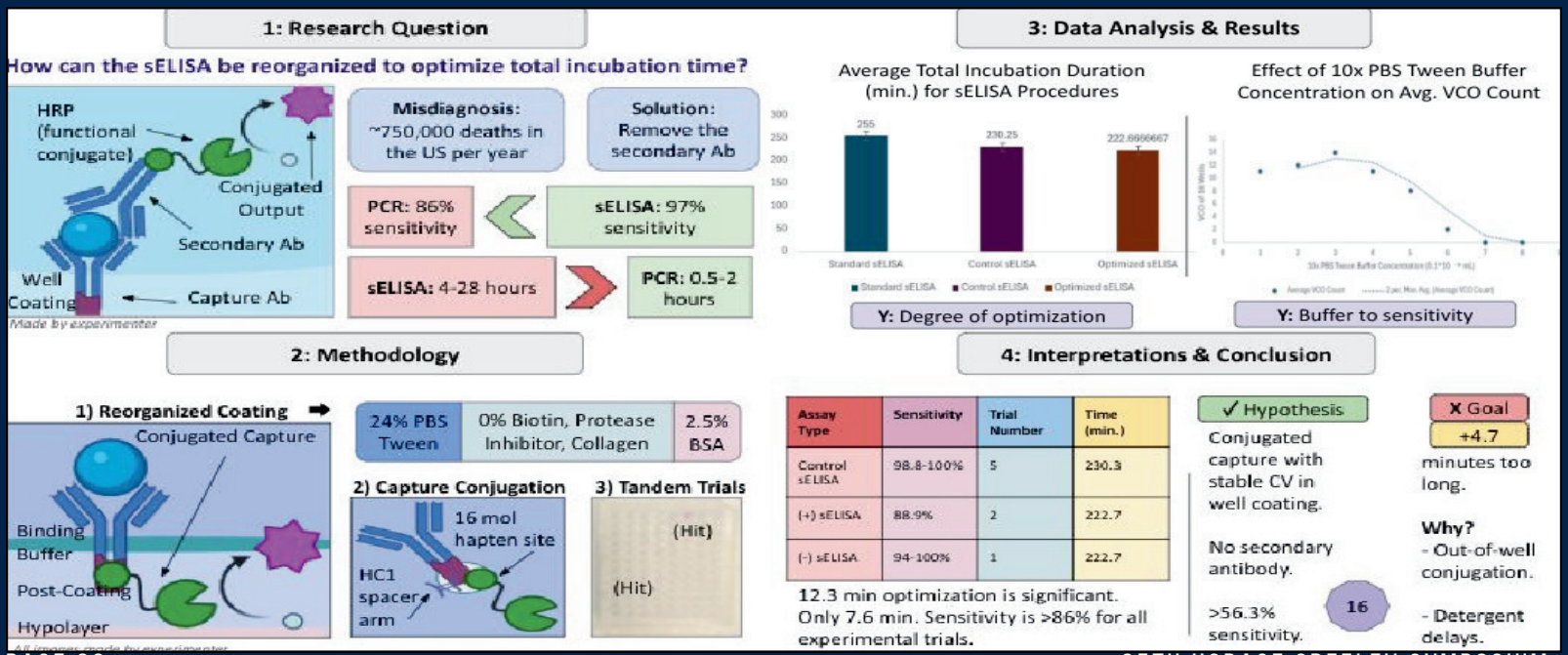
OPTIMIZING THE SANDWICH ELISA: SUBTRACTING THE SECONDARY ANTIBODY WHILE RETAINING PRECISION

EXTRACURRICULARS Car Club, Daguerreotype Restoration, Game Design

PROJECT ABSTRACT

The sandwich enzyme linked immunosorbent assay (sELISA), statistically, has the highest precision, sensitivity, and specificity of all discovered methods of pathogen identification. The sELISA involves two antibodies, a capture and secondary, both of which bind to an analyte, typically an antigen-- forming a sandwich. An enzyme conjugated to the secondary antibody is activated by the bind, metabolizing a chromogen in the solution, producing a visible color output. This study uses the fundamental concept of a buffer-based reaction to store the analyte within the well coating. By providing an improved method of the sELISA as a model, eventually, it will undergo further optimization, lowering in costs while retaining its gold-standard sensitivity and specificity. Changes were tested in "tandem trials" to determine whether the capture had adhered to the buffer, bound to the analyte, and remained conjugated to produce a visible output. Three of three tandem trials had an accurate sensitivity bound. The amount of time or resources saved was negligible, dropping below statistical significance with an average value of 14.2% against the required 16% of standard sELISA efficacy. However, all specialized accessory salts and acid for the secondary antibody can be replaced by sodium or removed entirely from the coating. With a greater number of concentration trials, statistically valid optimization could be achieved, revolutionizing both the sELISA and diagnostic procedures for everyone.

QUAD CHART



UMA SHARMA

EXPLORING GENDER DIFFERENCES IN AUTISM SPECTRUM DISORDER DIAGNOSIS: ANALYZING SOCIAL COMMUNICATION AND REPETITIVE BEHAVIORS IN THE ADOS-2



AWARDS

Somers 2024 2nd Place (BES); WESEF 2025 1st Place (BES) & The Transforming Lives Award for advancements in Autism research.

EXTRACURRICULARS

Varsity Softball; Mental Wellness Club, President; PJLC at the Northern Westchester Hospital, Advisory Board; Colorful Minds (art program for kids), Founder; NAMI Next Gen Council Member; Work2BeWell National Student Advisory Council Member; Letters for Rose Club Member

PROJECT ABSTRACT

The male to female ratio of Autism Spectrum Disorder (ASD) diagnoses is currently 4:1. Many female ASD patients deal with misdiagnosis or underdiagnosis, making it harder for patients to receive adequate and effective treatment. Current diagnostic criteria for ASD gravitates toward male data , which raises the question of efficacy of pre-existing diagnostic criteria. This study identifies a current gap in pre-existing diagnostic questionnaires such as the Autism Diagnostic Observation Schedule (ADOS-2), which are not able to sufficiently capture the social camouflaging behaviors exhibited by female ASD patients. An in-depth literature review of symptoms more present in females than males was conducted, including a meta-analysis of symptoms that would be categorized under “Camouflaging Symptoms”.

Across all four domains (Total Score, Communication, Social Affect, and Stereotypical Behavior), there were no significant differences found between male and female scores (p-value>0.05). Although the number of males was over eight times more than the number of females for each domain, the standard error was double in the female group compared to males. This fluctuation in the female scores could be attributed to the “Camouflage Phenomenon”. Additionally, the lack of significance could indicate that the ADOS-2 fails to accurately represent the female presentation of ASD symptoms. Future research should determine where modifications to the ADOS-2 are necessary to be able to more accurately capture female-specific ASD symptoms.

QUAD CHART

Introduction

- Autism Spectrum Disorder (ASD): neurodevelopmental condition with challenges in social behavior and communication.
- Little understanding of **female-specific ASD traits.**
  - Specifically **camouflaging**
- Diagnostic tools are **historically male-centric**
  - Autism Diagnostic Observation Schedule (ADOS-2)
- Results in **underdiagnosis and misdiagnosis in females**

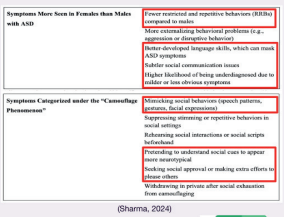


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Objective: Determine if there are **significant differences between male and female scores on the ADOS-2** in order to determine whether **modifications to the ADOS-2 are necessary to more accurately diagnose female patients.**

Methodology

1. Determined **which symptoms were more seen in female than male ASD patients**, then further categorized **camouflage behavior**



(Sharma, 2024)

2. Data: Publicly sourced (GitHub)ADOS-2 scores for males and females in four in Modules 3 and 4 of the ADOS-2:
Total Score, Communication, Social Affect, and Stereotypical Behavior

- Module 3: n = 148 males; n = 16 females
- Module 4: n = 162 males; n = 17 females

GitHub

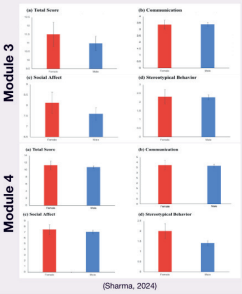
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3. Data Collection: Excel was used for two-sample t-tests to compare the significance of the scores between males and females

- $p < 0.05$

Google Images

Results



(Sharma, 2024)

- **No statistically significant differences** found
- **The hypothesis was not supported** ($p > 0.05$)



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Variance:

- **Higher standard error of the mean (SEM): females** (SEM = 1.22) compared to males (SEM = 0.41)
- **Greater variability in female scores** and significantly smaller sample size
- **ADOS-2 may not effectively capture diverse symptom profiles**

Discussion and Conclusions

- **No significant differences found** between males and females
- **The hypothesis was not supported**
- **Increased variance and SEM within female patients** could indicate ADOS-2 ineffectiveness



Shutterstock

Limitations: small female sample size, solely quantitative, did not account for other variables (age or comorbidities)

- **Improve diagnostic criteria** for female patients with ASD
- Pave the way for **other disorders to expand diagnostic criteria**
- Explore social and emotional domains and their impact on scores
- **Modify ADOS-2 questions** to more accurately align with differences in behavior between males and females.

SAM STRYKER



A COMBINATION OF BAYESIAN INFERENCE WITH ZERO-NOISE EXTRAPOLATION FOR QUANTUM ERROR MITIGATION

AWARDS	3rd Place Computer Science (WESEF), 1st Place Computer Science (Somers Science Fair)
EXTRACURRICULARS	Volunteer Firefighter at CFD, Track & Field (Winter/Summer), Cross Country, Science Olympiad, Robotics, Tutor, Mathnasium Instructor

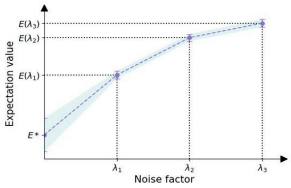
PROJECT ABSTRACT

New thousand-qubit quantum systems represent a major advancement over previous quantum devices, significantly increasing computational potential. However, these systems still face fundamental challenges, particularly noise, which limit their practical usability. Despite their size, they remain incapable of supporting full quantum error correction (QEC) methods, necessitating the use of quantum error mitigation (QEM) strategies to improve computational fidelity. This paper introduces a novel technique that leverages Bayesian inference to improve the accuracy and precision of zero-noise extrapolation (ZNE). By constructing a noise model of the *ibm_kyiv* quantum backend, a chosen quantum circuit was simulated and a Gaussian probability distribution of expectation values at each noise level was generated. These prior probability distributions were then used to correct the hardware trials performed on the *ibm_kyiv* quantum hardware using Bayesian inference. It was found that the Bayesian updating ZNE technique produced expectation values with a 86% lower mean absolute error (MAE) compared to the standard procedure. This technique also achieved a 95% reduction in variability and tightened confidence intervals while better fitting its extrapolation function. Based on these results, it was concluded that integrating Bayesian inference with ZNE enhanced the accuracy and precision of quantum computations on current NISQ quantum devices while not increasing quantum resource utilization. This technique offers a crucial interim solution for improving the performance of quantum algorithms in the absence of full quantum error correction, bridging the gap towards the realization of fault-tolerant quantum computing on future, larger-scale systems.

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Introduction

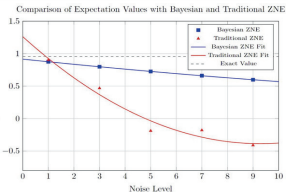
Quantum computers susceptible to error from quantum noise
Techniques like zero-noise extrapolation can reduce noise No past studies have combined this with Bayesian inference to improve accuracy and precision



Results

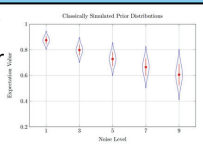
87% Reduction in MAE
- Raw = 1.2612
- Corrected = 0.9151
- Noise-free = 0.955

> 95% Reduction to standard deviation at all points
93% improvement to confidence interval
Supports hypothesis



Methodology

Created a noise model that almost exactly matched the ibm_kyiv quantum computer
Ran 20,000 shots per noise level to use as priors
Ran a trial with 9,000 shots per noise level on ibm_kyiv
Used the priors from the simulation to improve the points gathered from ibm_kyiv



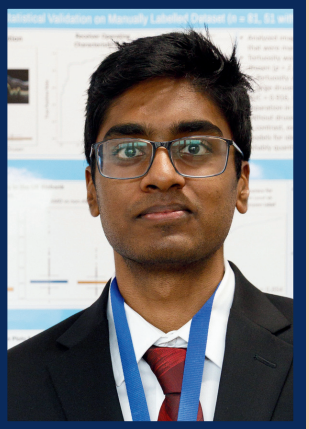
Conclusion

Better fault-tolerance necessary for practical quantum computing
Fault tolerant quantum computing will revolutionize many fields
- Medicine, materials science, environmental science, etc.

Future research should look into the usage of different prior generation methods ensuring scalability

NAVEEN TALLA

AUTOMATED QUANTIFICATION OF DRUSEN FROM RETINAL OCT SCANS



AWARDS	2nd Place Somers Science Fair, 3rd Place WESEF (Comp. Bio)
EXTRACURRICULARS	Violin, Track, Science Greeley, Table Tennis, Ping Pong

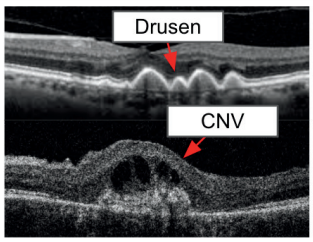
PROJECT ABSTRACT

Age-related macular degeneration (AMD) accounts for nearly 9% of all cases of blindness. Dry AMD, the most common form of AMD, is characterized by the formation of deposits within the retina known as drusen. Identifying factors driving dry AMD progression depends on the ability to accurately and efficiently quantify drusen. Recent research has shown that retinal pigment epithelium (RPE) curvature can be used to differentiate between eyes with early and late stage AMD. In this study, we developed a technique to calculate RPE tortuosity, as a measure of RPE curvature, from optical coherence tomography (OCT) data in the UK Biobank. An initial analysis of a dataset containing manually annotated OCT scans (n = 85) revealed that RPE tortuosity was significantly greater in eyes with drusen (p=2.610-8). Additionally, RPE tortuosity could distinguish between eyes with and without drusen with AUC = 0.916. Subsequently, tortuosity values for all OCT images in the UK Biobank (N = 56,088) were computed and incorporated into a genome wide association study (GWAS) to identify genetic variants associated with tortuosity. Our analysis identified genetic variants previously associated with AMD such as CFH and ARMS2, as well as unknown variants related to photoreceptor layer thickness, including RP1L1. This study introduced a novel technique to compute RPE tortuosity as a measure of RPE curvature, provided statistical validation that greater RPE tortuosity corresponds to drusen presence, and identified genetic variants that could be further studied to gain a understanding of drusen formation and avenues of therapeutic treatment.

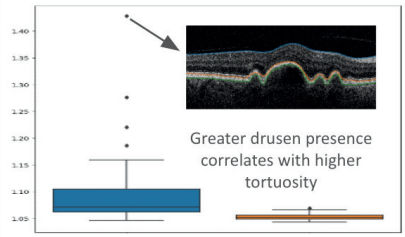
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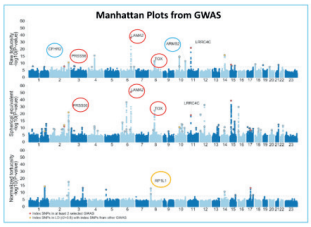
Introduction and Background

- AMD Accounts for nearly 9% of all cases of blindness in the US
- OCT is used to visualize structural changes in the retina
- **Goal:** Develop a computational technique to rapidly analyze OCT images in the UK Biobank



Results & Analysis

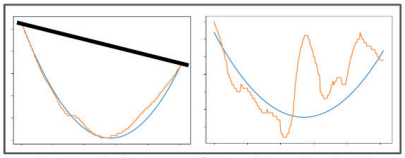




Methodology

Extracted & Filtered Segmentations → Curve Fit (Blue) → Tortuosity Calculation → Genome Wide Association Study

- Retinal layer segmentations created by 3D TopCon OCT Scanner (2009)



- Computed tortuosity from UK Biobank
- Identified genetic variants related to drusen growth

Conclusion

- Hypothesis supported:
  - Tortuosity was significantly higher in eyes with confirmed drusen presence
- Normalization by overall curvature reduced signal for genes associated with retinal curvature but lost some AMD signals
- **Applications:** Pharmaceutical development and testing

EMMA TONG



INVESTIGATING THE RELATIONSHIP BETWEEN SGLT2 INHIBITORS AND KLF2 PROTEIN LEVELS IN DIABETIC RENAL PATHOPHYSIOLOGY

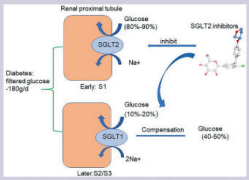
AWARDS	3rd Place Medicine & Health Somers, 3rd Place Medicine & Health WESEF
EXTRACURRICULARS	Art student at ASL, Greeley swimming, political researcher

PROJECT ABSTRACT

SGLT2i is a popular treatment for diabetic kidney disease because it inhibits SGLT2, which contributes to kidney damage. Similarly, KLF2 is known to reduce the progression of kidney failure. The two may have some unknown relationship since they are on opposite sides of the eNOS gene: KLF2 upstream and SGLT2 downstream. We hypothesize empagliflozin, a type of SGLT2i, will increase the abundance of KLF2. To test this, we gave diabetic mice a dosage of either EMPA or water for eight weeks and then sacrificed them. We immunostained their kidneys to see the abundance of KLF2, did PAS staining to determine the mesangial matrix index and quantify the amount of kidney damage, and used weekly samples of urine to calculate the ACRs to see the kidney's filtration abilities. The EMPA group experienced an increase in KLF2 abundance as signified by the greater amount of fluorescence, 22.22%. Also, the mesangial matrix index decreased by 61.23% compared to the control after three weeks of the treatment but the ACR data was inconclusive. KLF2 is associated with both a smaller mesangial area and with lower ACR levels. Therefore, the fluorescence and mesangial matrix index indicate a greater amount of KLF2 within the EMPA mice and support our hypothesis. Future research should continue exploring this relationship through other means of KLF2 quantification to gain additional perspectives. These results gave us insights into the mechanisms by which SGLT2i prevents kidney damage, making us one step closer to finding a cure to this debilitating condition.

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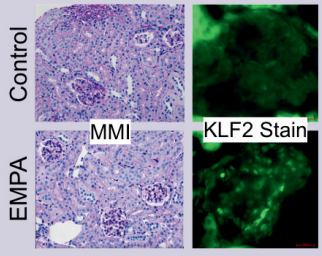
Research Question

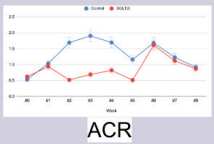


- Diabetic kidney disease result of kidney damage from extra glucose
- Both SGLT2i and KLF2 help prevent further kidney damage in DKD model and share eNOS gene
  - Known relationship could open up new treatment

Will the presence of SGLT2i increase the abundance of KLF2 protein?

Results

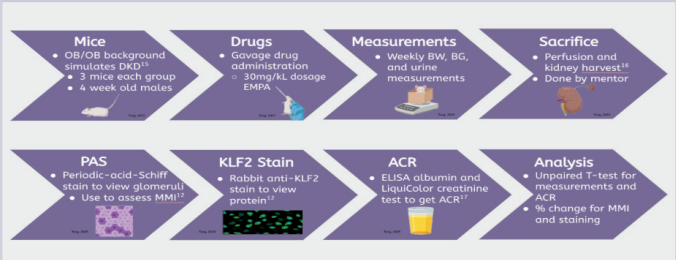




ACR p-value <0.05 wk 5

MMI SGLT2i → -61.23%
KLF2 SGLT2i → +22.22%

Methodology



Discussion

- ACR almost no significant difference but obvious disparity in trends from W1- W5
  - Could be attributed to OB/OB gene nature
  - Less means better kidney function (KLF2 indicator)
  - Partially supports
- MMI 61.23% decrease → less damage (indicator of KLF2) → supports
- KLF2 22.22% increase → more KLF2 → supports
- Hypothesis **partially supported**

SYDNEY TSAO

EZH2 MODULATION OF EMT EXPRESSION INDEPENDENTLY OF ITS METHYLTRANSFERASE ACTIVITY BY REGULATING SKP2 PROTEIN EXPRESSION



AWARDS	2nd Place in Cellular and Molecular Biology at WESEF
EXTRACURRICULARS	The Greeley Voice, SHARE, Greeley HOSA, Varsity XC

PROJECT ABSTRACT

EZH2 has long been implicated in tumorigenesis through its enzymatic activity, primarily via H3K27me3-mediated silencing of tumor suppressor genes. Recent studies, however, suggest that EZH2 can also regulate cellular processes such as EMT independent of its methyltransferase function. One such process involves the modulation of SKP2, a key regulator of the cell cycle, which influences the stability of various proteins involved in EMT. While the role of EZH2 in regulating EMT through SKP2 is emerging, the molecular mechanisms underlying this regulation remain poorly understood. In this study, we aimed to explore the relationship between EZH2 and SKP2, focusing on the methylation-independent functions of EZH2 in EMT regulation. We were able to validate previous literature that associated increased levels of EZH2 and SKP2 with increased levels of the mesenchymal marker ZEB1 and decreased levels of the epithelial marker Claudin-1. Interestingly, we found that there was an unexpected increased p27 expression levels in the presence of SKP2. This alludes to a more complex EZH2-SKP2-CKI regulatory mechanism that should be explored further. In addition to refining transfection protocols, future studies should examine additional EMT markers, such as E-cadherin, N-cadherin, and Vimentin and explore the modulation of CKIs p21 and p57. Investigating this pathway allows for the development of novel strategies for inhibiting EMT and metastasis.

QUAD CHART

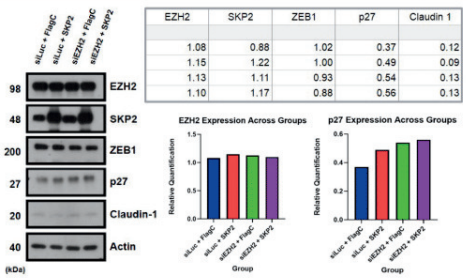
RESEARCH QUESTION

Problem:
- EZH2 regulates SKP2 expression independently of its methyltransferase activity, both proteins are individually linked to EMT
- Unclear whether EZH2 drives EMT through SKP2 in a methylation-independent manner

Question:
- Does EZH2 modulate EMT expression through SKP2 expression?

Goals:
- Investigate whether EZH2 modulates EMT markers through SKP2 rather than histone methylation
- Establish direct connection between the EZH2-SKP2 pathway and EMT

ANALYSIS AND RESULTS



EZH2	SKP2	ZEB1	p27	Claudin 1
1.08	0.88	1.02	0.37	0.12
1.15	1.22	1.00	0.49	0.09
1.13	1.11	0.93	0.54	0.13
1.10	1.17	0.88	0.56	0.13

ZEB1 and Claudin-1 expression:
- Confirms previous literature
- ZEB1 upregulated, Claudin-1 downregulated

p27 expression:
- Increase → more complex EZH2-SKP2-p27 pathway

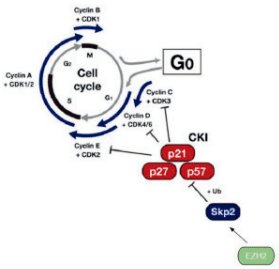
METHODOLOGY

1. siRNA transfection
2. SKP2 plasmid transfection
3. Cell lysis
4. BCA assay
5. SDS-PAGE
6. Western blot
7. Chemiluminescence
8. Data analysis — Prism

CONCLUSION

Major findings:
- SKP2 overexpression led to unexpected p27 increase, suggesting a more complex pathway than previously thought
- SKP2 interacts with other cell cycle regulators/transcription factors not fully explored

Future research:
- Reconduct study with viable siRNA sample
- Investigate modulation of CKIs p57 and p21



RUDOLF TSENG



VALIDATING KEPLER-20G USING TTVS AND ORBITAL RESONANCES: A COMPARATIVE STUDY WITH TESS FOR HIDDEN EXOPLANETS

AWARDS	• WESEF 3rd place award in Physics and Astronomy • NYSSEF States Finalist and Honorable Mention
EXTRACURRICULARS	Rock climbing, Violin, Science Olympiad, FRC Robotics, 3d Printing, Astronomy

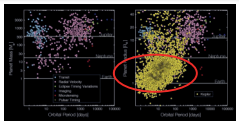
PROJECT ABSTRACT

The discovery of Neptune-mass exoplanets that orbit closer to their host star than Mercury does to the sun is one of the most important discoveries from NASA's Kepler mission. Previous planetary formation models did not predict the existence of these planets and their origins still remain hotly debated. A highly controversial exoplanet, Kepler-20g in the Kepler-20 system is a non-transiting Neptune-mass exoplanet. This study uses a novel approach, utilizing transit timing variations and orbital resonances to clear up the confusion around the existence of Kepler-20g. Orbital resonances can be applied to the Kepler-20 system along with using the masses and the distance of close approach of Kepler-20g on each planet, the gravitational effect of Kepler-20g on each planet can be determined. The gravitational effect determined can be combined with the number of close approaches of Kepler-20g with each planet to find which planet displays a transit timing variation that can be detected. It has been found that Kepler-20c is the most gravitational affected by Kepler-20g in one approach with a relative force of 21224.73. However, over a year, Kepler-20b exhibits the greatest gravitational effect from Kepler-20g. This is because Kepler-20b has a shorter orbital period of 3.7 days compared to Kepler-20c's orbital period of 10.6 days, meaning that Kepler-20b will on average be closer to Kepler-20g. Kepler-20c exhibits a greater gravitational effect in one approach due to its larger mass of 13.6±2.3 M compared to Kepler-20b's mass of 9.5±1.5 M .

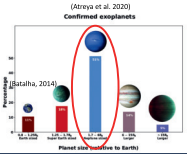
QUAD CHART

Introduction

- Newly discovered exoplanets challenge traditional planetary evolution models
- **Close-in Neptune-mass** exoplanets are common in exoplanet surveys but poorly understood in formation models
- **Kepler-20g**: Neptune-mass (21.0 ± 3.4 M⊕), 0.1387 ± 0.0027 AU orbital radius, crucial for planetary formation models if proven to exist
- Utilize a novel methodology that combines Transit Timing Variations and Orbital Resonances to validate Kepler-20g



(Atreya et al. 2020)



Results

Planet	Relative gravitational force from Kepler-20g on each planet	Normalized ratios of relative gravitational force From Kepler-20g on each planet
Kepler-20b	7417.46	0.35
Kepler-20e	551.7	0.026
Kepler-20c	21224.73	1
Kepler-20f	7000	0.33
Kepler-20d	13928.57	0.66

Planet	Time-averaged force from Kepler-20g over a year (T_{af})	Normalized ratios of the time-averaged force from Kepler-20g
Kepler-20b	660154	1
Kepler-20e	27033	0.04095
Kepler-20c	488169	0.739477
Kepler-20f	560000	0.85
Kepler-20d	83571	0.12659

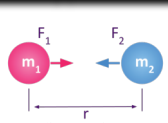
	KOI-984b
Relative force of gravity from KOI-984c	27.33
Synodic period with KOI-984c (days)	5.356
Close approaches with KOI-984c over a year	68
Time-averaged force with planet c over a year	1858.44

Major Findings

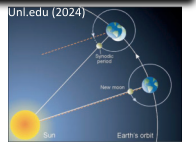
- Kepler-20b is most affected over a year by Kepler-20g
- Kepler-20c is most affected in one close approach by Kepler-20g
- Known TTVs **support the calculated results on KOI-984**
- The novel methodology was supported

Methodology

1. Calculate Kepler-20g's gravitational effect on neighboring planets
2. Calculate the synodic period with Kepler-20g
3. Calculate the number of close approaches in a year with Kepler-20g and Time Averaged Force
4. Comparative analysis with KOI-984



Created by Tseng in Google Drawings



$$F_g = G\frac{m_1 m_2}{r^2} \qquad \frac{Y}{S_d} = C_y$$

$$F_G \times C_y = T_{af}$$

Conclusion

Problem

- Multiple studies present conflicting evidence on Kepler-20g's existence
- Unclear role of Neptune-mass exoplanets in planetary evolution

Goal

- Confirm Kepler-20g's existence using TTVs and orbital resonances
- Apply methodology to KOI-984 to validate the methodology

Major findings

- Hypothesis remains **inconclusive**
- Developed a methodology for predicting TTVs and hidden exoplanets
- Methodology was supported by the results on KOI-984

BRADY WANG

GENERATION OF ANTIBODY OLIGONUCLEOTIDE CONJUGATES USING A NOVEL CONJUGATION CHEMISTRY



AWARDS	NYSSEF Finalist (3rd Place in Biochemistry), WESEF (1st Place in Biochemistry), **ISEF Finalist**
EXTRACURRICULARS	HGHS Speech and Debate Team Co Captain, Cooks in free time

PROJECT ABSTRACT

Oligonucleotides, especially siRNAs, have been identified as a point of interest in recent research due to their capability for precision targeting of "undruggable" targets. siRNAs, which are 19 to 23 nucleotide-long RNA duplexes, bind to and guide the RNA Induced Silencing Complex (RISC) in the cytoplasm, leading to degradation of specific targeted mRNAs. Despite advancements in oligonucleotide chemistry, delivery to extrahepatic tissues remains a challenge. Current FDA-approved delivery systems such as lipid nanoparticles (LNPs) and trivalent GalNAc, primarily target the liver. Antibodies, however, are emerging as a promising modality for targeted extrahepatic delivery of oligonucleotides. Antibody oligonucleotide conjugates (AOCs) leverage antibodies' receptor-based uptake for precise delivery of siRNA to targeted regions of the body. However, current chemistries for AOC generation are either inefficient or non-site specific. My research introduces a novel site-specific conjugation technology for generating AOCs. This method combines an enzymatic transglutaminase reaction with an Inverse Electron Demand Diels-Alder (IEDDA) reaction. Specifically, a tetrazine linker is added to the antibody via transglutaminase, followed by purification through size exclusion chromatography (SEC). The siRNA is then conjugated to the antibody-linker using IEDDA and purified with SEC, achieving an oligonucleotide to antibody ratio (OAR) of ~1, confirmed by UV-Vis and then hydrophobic interaction chromatography. Aggregation was minimal (<5%), and endotoxin levels were low (<0.5 EU/mg). This novel conjugation chemistry successfully generates AOCs, which will be tested in vivo for knockdown efficacy. Future applications include applying this chemistry to generate other modalities such as antibody-tethered lipid nanoparticles (Ab-LNPs).

QUAD CHART

Q1: Research Question

Small Interfering RNA

- **Therapeutic Potential:** Has the potential to treat diseases that were previously considered "undruggable" through its specific gene silencing capabilities
- **Challenges:** Unable to achieve cellular uptake due to size and charge

Antibody Oligonucleotide Conjugates

- Antibody conjugated (attached) to siRNA
- **Use:** Allows for specific delivery and specific cellular uptake of siRNA using antibody's properties
- **Challenges:** Current chemistries used for AOC synthesis are unstable, causing unintended release of siRNA. Additionally, most methods are non site-specific making it incredibly difficult to control OAR

Goal: Discover a novel method to generate stable site specific Antibody Oligonucleotide Conjugates

Q2: Methodology

- **Step 1: Linker Installation**
  - Tetrazine linkers installed on single arm mAb through a transglutaminase enzymatic reaction at the 2 Q295 positions of the Fc region
  - Confirm linker installation using Q-TOF to check the mass of the antibodies before and after installation
  - Purify antibody linker conjugate using Size Exclusion Chromatography (SEC)
- **Step 2: AOC Conjugation**
  - Conjugate antibody linker to siRNA (with ALO handle) through IEDDA Click Chemistry
  - Purify final AOC product with SEC
- **Step 3: Characterization and Quality Control**
  - Measure OAR through uv-vis Nanodrop technology and a derivation of the Beer-Lambert Law
  - Confirm OAR by using Hydrophobic Interaction Chromatography (HIC)
  - Measure protein aggregation using analytical SEC
  - Measure endotoxin levels using Endosafe

Q3: Data Analysis and Results

Fig 1. Mass Spec Profile After Linker Installation

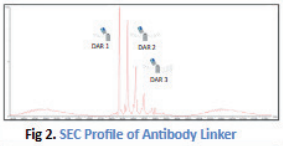


Fig 3. SEC Profile of Final AOC

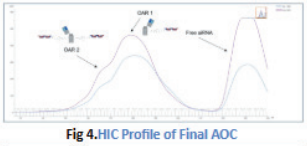


Fig 2. SEC Profile of Antibody Linker

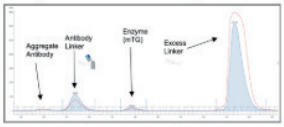
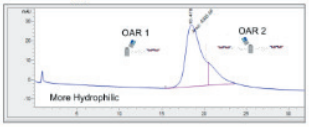


Fig 4.HIC Profile of Final AOC



Q4: Interpretation and Conclusions

Figure 1: First 2 peaks represent 1 and 2 linkers on Q295 position, next peak represents additional linker binding to Q55 position

Figure 2: Successful purification of antibody linker conjugate using SEC

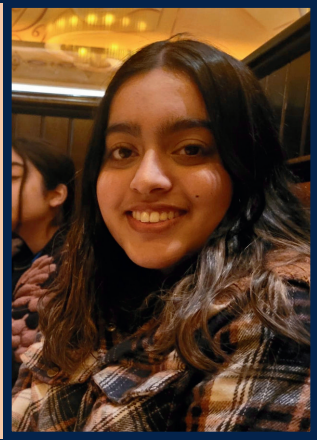
Figure 3: Successful purification of AOC & partial separation of OAR 1 and OAR 2 using SEC

Figure 4: OAR 1 and OAR 2 curves from HIC. After finding the area of these curves, a weighted average was performed to determine the final OAR was 1.18



Conclusion: This technology, that I **co-conceived and has been filed in a provisional patent**, enables siRNA conjugation to targeting ligands like **peptides and antibodies**. Moreover this method conjugates antibodies with **lipid nanoparticles** for targeted delivery of siRNA to extrahepatic tissues (CNS, heart, lung, adipose, muscle).

SYEDA WANIA



INVESTIGATING THE INFLUENCE OF THE TUBERCULOSIS PATIENTS WITH VITAMIN D DEFICIENCY: A PRE- AND POST- COVID-19 COMPARISON

EXTRACURRICULARS

Founder and president of Alzheimer's Awareness Club, volunteer at Fast Feet NYC, communications for National Science Bowl

PROJECT ABSTRACT

The COVID-19 pandemic has resulted in notable changes to the number of new cases and death rates of tuberculosis patients. Approximately 4.1 million of tuberculosis cases in 2022 are either undiagnosed or not counted in official statistics. Since the number of TB cases and deaths is predicted to rise over the coming years, developing an accurate test for patients is crucial during the COVID-19 pandemic. Those with vitamin D deficiency are more likely to die if their cases are misinterpreted. During the pre- and post-pandemic periods, they never used applied machine learning to diagnose and detect sensitivity for tuberculosis patients with vitamin D deficiency. My hypothesis is that the algorithm employed in this work is predicted to provide a reliable and efficient method for identifying TB cases in the post-pandemic period. I trained two models using two different datasets that I collected. One covered the time before the COVID-19 pandemic, while the other covered after the COVID-19 pandemic. Furthermore, a statistical analysis was conducted using area under the curve (AUC) and receiving operating characteristic (ROC) curve. Confusion matrices were also used to calculate the diagnostic accuracy, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and likelihood ratios. Excellent accuracy was demonstrated in the pre-pandemic model's sensitivity and accuracy was 0.92, respectively. The sensitivity, specificity, and total accuracy of post pandemic was also 0.91, respectively. In conclusion, this study created a free and open algorithm that works well for identifying common post-pandemic tuberculosis patients with vitamin D deficiency. Additional studies are needed for testing this algorithm through different populations that do have higher rates of vitamin D deficiency.

QUAD CHART

Introduction

- **Problem** → Detection and sensitivity undefined
- **Goal** → Improve diagnosis of pre- and post-pandemic
- **Hypothesis** → Algorithm will improve diagnosis

Results

Model	AUC	Accuracy	Precision	Sensitivity	F1 Score	PPV	NPV
Logistic	0.932	0.842	0.861	0.861	0.861	0.861	0.817
Neural Net	0.914	0.806	0.851	0.797	0.824	0.851	0.754

Performance Color Scale: Excellent (≥95%) · Very Good (≥90%) · Good (≥85%) · Fair (≥80%) · Needs Improvement (<80%)

Table 1: A comparison of neural network and logistic regression model's performance metrics for pre-pandemic and post-pandemic model

Methodology

Datasets → **Algorithm** → **Statistical Analysis**

- **Pre-pandemic:** 2018 **Post-pandemic:** 2024
- **1 =** Having tuberculosis **0 =** Not having tuberculosis
- **Performance** of diagnostic tests

Discussion & Conclusion

Discussion

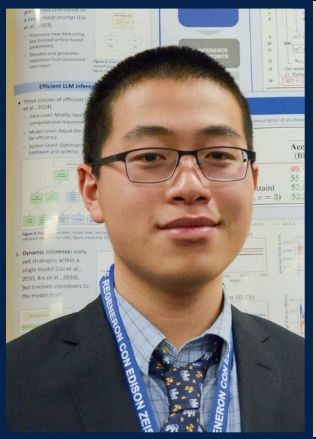
Tuberculosis + vitamin D deficiency = helpful for useful biomarker

Conclusion

Future Research: Test model on high populations

RYAN ZHANG

ENERGY-OPTIMAL INFERENCE IN LANGUAGE MODEL ZOOS WITH SERVICE LEVEL GUARANTEES



AWARDS	WESEF 2nd Place in CS, Somers 1st Place in CS
EXTRACURRICULARS	FRC Robotics President, Programming Club & History Club Co-President

PROJECT ABSTRACT

Open-weight large language model (LLM) zoos allow users to quickly integrate state-of-the-art models into systems. Despite increasing availability, selecting the most appropriate model for a task still largely relies on benchmarks and educated guesses. Providers prioritize cost efficiency, while users focus on output quality, often formalized in Service Level Agreements (SLAs). Currently, no automatic method exists to select models from a zoo in an energy-cost-optimal way while satisfying service-level agreements for commercial use cases. The overall goal of MESS+ is to find the most suitable LLM for each inference request, minimizing energy consumption while meeting SLA performance requirements. The online decision problem is based on the Lyapunov Drift-Plus-Penalty Framework, where control parameters are introduced to allow the end user to adjust priority of efficiency and the minimum average accuracy over requests. A virtual queue tracks SLA violations, and requires predicting the accuracy of each model for the request, obtained by probablistic exploration of a linear classifier per model using online stochastic gradient descent. Service levels, such as silver, gold, and platinum plans, were explored to reflect real-world commercial applications. For an SLA requiring high accuracy, MESS+ is 2.5x more energy efficient than random selection while maintaining SLA constraints. Compared to always selecting the largest model, MESS+ reduces energy consumption by 3.5× and 4.6× for the translation and summarization tasks, respectively. MESS+ demonstrates effectiveness in routing requests to the most appropriate model, allowing inference providers to meet service-level guarantees efficiently, while catering to users with quality-sensitive workloads.

QUAD CHART

Introduction

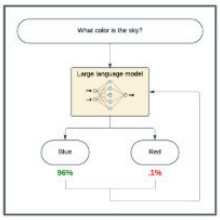
> *Deep learning infrastructure providers* and *end users* are confronted with abundance of models (**model zoo**)

Research Goal

My algorithm will be able to dynamically select a model with reduction of energy consumption, while maintaining performance levels.

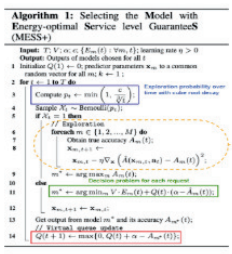






Framework





Overall Control Problem:
E Energy consumption (joules) for a model.
A Accuracy model's response (requires feedback signal).
Y Binary variable; 1 if a model is chosen.
α SLA minimum accuracy requirement.

$$\min_{1_{Y(t)}\forall t,m} \frac{1}{T}\sum_{t=1}^{T}\sum_{m=1}^{M} y_m(t)E_m(t),$$
$$\text{s.t.} \quad \frac{1}{T}\sum_{t=1}^{T}\sum_{m=1}^{M} y_m(t)A_m(t) \geq \alpha,$$
$$\sum_{m=1}^{M} y_m(t) = 1, \forall t \in \{1,\ldots,T\},$$
$$y_m(t) \in \{0,1\}, \forall t, m.$$

Challenges:
1. Objective and constraints are correlated over time
2. Characteristics of future requests cannot be predicted

Findings

> ***MESS+*** *satisfies the SLA with requirement α while consuming the least energy among all compliant strategies*

> *Up to 2.5× energy savings (baseline), 4.6× (largest model).*

MESS+ cuts energy consumption of an inference service by up to 2.5× while meeting user performance needs.

Model	WMT14 ($\alpha = 0.52$)			CNNDailyMail ($\alpha = 0.315$)		
	Accuracy (BLEU)	Energy (Joules)	Meets α	Accuracy (ROUGE1)	Energy (Joules)	Meets α
TinyLlama	49.1 ± 0.6	44.639 ± 0.6	No	30.9 ± 0.3	142.080 ± 1.4	No
Llama-2 13B	55.1 ± 0.4	527.870 ± 5.1	Yes	32.2 ± 0.3	750.285 ± 7.5	Yes
Random with constraint	52.0 ± 0.0	280.426 ± 3.0	Yes	31.5 ± 0.0	416.466 ± 4.3	Yes
MESS+ ($V = 0.1, c = 3$)	52.2 ± 0.2	**149.399** ± 1.3	Yes	31.5 ± 0.1	**163.836** ± 1.5	Yes

Conclusions

Problem
Goals
Results

> Users and inference providers have different priorities
> No LLM router is available with a focus towards SLAs

> Create a novel algorithm for automatic model selection in model zoos for language inference services on a per request basis

> MESS+ effectively routes to most appropriate model ensuring accuracy and minimizing energy use
> Lower operating costs for inference providers
> Useful for users with quality sensitive workloads

SOPHOMORE CLASS OF 2027

INTRODUCTION TO RESEARCH

"YOU CANNOT HOPE TO BUILD A BETTER WORLD WITHOUT IMPROVING THE INDIVIDUALS. TO THAT END, EACH OF US MUST WORK FOR OUR OWN IMPROVEMENT."

-MARIE CURIE

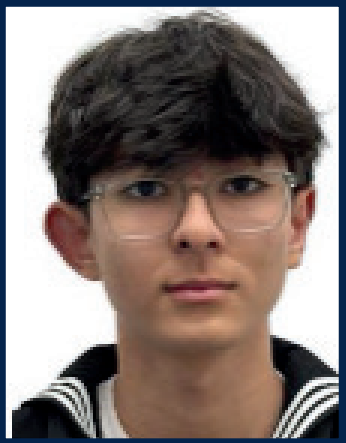
BROOKE ACKERMAN

EXPANDING THE ROLE OF GLP-1: CARDIOVASCULAR IMPACT IN OBESE PATIENTS WITHOUT COMORBIDITIES



EXTRACURRICULARS Varsity Basketball, Jv Lacrosse, Jv Soccer, Executive Roll In S.H.A.R.E Club, Peer Leader, Life Guard

DAVID ALLEN



OPTIMIZING CFDNA RETENTION USING RECEPTOR-SPECIFIC PRIMING AGENTS, LIKE AT3S, FOR EARLY PANCREATIC CANCER DETECTION.

EXTRACURRICULARS Petty Officer First Class in the U.S. Naval Sea Cadet Corps, a Star Scout in BSA, Varsity Ski Team, Track Team, Stage Band, and competitive marksmanship team

RIYA ARON

ENGINEERING BIO-INSPIRED SUTURES: EXPLORING SURGICAL THREADS WITH ARTIFICIAL SPIDER SILK



EXTRACURRICULARS Competitive dance, science olympiad event supervisor, growing + donating produce to a local food pantry in the SRC, SAMES, & chess

JACKSON BARR



FORECASTING WIN PROBABILITY IN NCAA LACROSSE THROUGH LOGISTIC REGRESSION USING TEAM PERFORMANCE METRICS

EXTRACURRICULARS science reserach

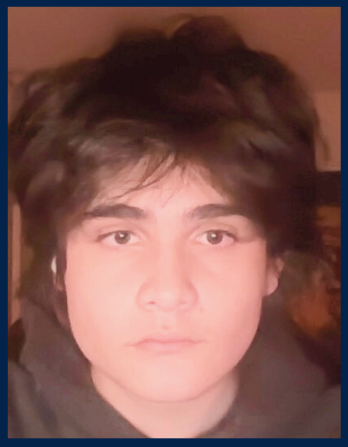
KAI BRAND

FUSION-READY METALS: SIMULATING ALLOY DURABILITY FOR NUCLEAR REACTOR APPLICATIONS



EXTRACURRICULARS science research

CHRISTOPHER CORREAI



NATURALISTIC AUDITORY BOUNDARIES DEFINE EVENT SEGMENTATION

EXTRACURRICULARS In addition to science research, I also participate in debate, track and field and the school newspaper.

JASON DANG

COMPARING REGRESSION-BASED DEEP LEARNING MODELS FOR ESTIMATING UPDRS SCORES FROM ACOUSTIC VOICE FEATURES

EXTRACURRICULARS I play tennis and I volunteer as a teaching assistant for a local Chinese school.



EMMA FEIG



LINKING MENARCHE TIMING AND LOWER EXTREMITY SPORTS INJURIES IN ADOLESCENTS

EXTRACURRICULARS JV Soccer, Club Soccer, JV Lacrosse, Chappaqua Volunteer Ambulance Corp Volunteer, SCOPE Club, & Renaissance Tutoring

CALEB FIJMAN

PHAGE-ENCAPSULATING ALGINATE BEADS: A TARGETED, SUSTAINABLE SOLUTION FOR REDUCING E. COLI CONTAMINATION ON FRESH PRODUCE

EXTRACURRICULARS School's track and field team, and debate team member. During my free time, I enjoy playing the piano, and on weekends, I volunteer at Phelps Memorial Hospital.



PARVATHY GOPIKRISHNA



OPTIMIZING TREATMENT EFFICACY FOR DEVELOPMENTAL DYSLEXIA: INTEGRATING THETA-BURST STIMULATION WITH THE WILSON READING SYSTEM

EXTRACURRICULARS Table Tennis, Volunteer Coach/Table Tennis Instructor, Violin, NeighborsLink Volunteer, New Castle United for Youth

ANYA GUNNAR

THE EFFECT OF GLUCAGON-LIKE PEPTIDE-1 (GLP-1) RECEPTOR AGONISTS ON TELOMERE LENGTH IN ALZHEIMER'S DISEASE

EXTRACURRICULARS I play tennis and enjoy drawing in my spare time.



MAYA HAREL



THE IMPACT OF BLACK HOLE JET PROPULSION ON STAR FORMATION

EXTRACURRICULARS SPCA Volunteer, the Community Center of Northern Westchester, and ASE; Spreading Smiles and Class 2027 co-president; school greenhouse; and Maya's Macarons.

LASYA HOTA

NOVEL INSIGHTS INTO THE ROLE OF KIZUNA: A POTENTIAL RISK GENE IMPLICATED IN NEURONAL DEVELOPMENT AND AUTISM SPECTRUM DISORDER

EXTRACURRICULARS Greeley Voice, writer, Vice President of HOSA club. Bharatanatyam, an Indian classical dance, Neighbors Link volunteer, & YoungArts writing national winner.



ANDY JI



BOOSTING ROBOTIC SWIMMING EFFICIENCY: COMPARING DEFORMABLE AND RIGID CAUDAL FIN DESIGNS

EXTRACURRICULARS Varsity ice hockey team and JV soccer team. Additionally, I volunteer at the Boys & Girls Club of Northern Westchester.

SERENE JOURDY

COMPARATIVE EFFECTIVENESS AND SAFETY OF OMALIZUMAB VERSUS SUBCUTANEOUS IMMUNOTHERAPY IN PEDIATRIC ASTHMA MANAGEMENT



EXTRACURRICULARS Varsity Swimming and Diving , Club Swimming, Volunteer Coach/Swim Instructor, Violin, and Tutor

ASHNA KHANNA



EVALUATING THE IMPACT OF PROVIDING INFORMATION ON CONSUMER WILLINGNESS TO PAY FOR SUSTAINABLE WEED MANAGEMENT PRACTICES

EXTRACURRICULARS Some activities that I enjoy outside of school are tennis, piano, dance, and baking.

ANYA KHURANA

BIOINFORMATIC ANALYSIS OF MULTI-DRUG RESISTANT TUBERCULOSIS STRAINS AND THEIR TRANSMISSION PATTERNS



EXTRACURRICULARS Greeley Debate Team member , the Math Club, Model UN, and the Peer-to-Peer Tutoring Program. She enjoys running and spending time with her dog, Sparky.

EMMA KNAPP



METABOLOMIC PROFILING OF CLOSTRIDIUM DIFFICILE METABOLITES AND THEIR IMPACT ON GUT-BRAIN AXIS FUNCTION IN AUTISM SPECTRUM DISORDER PATHOGENESIS

EXTRACURRICULARS Greeley Varsity and competitive tennis teams. Emma enjoys exploring the fine arts, particularly drawing and painting.

MADELINE LAMB

PHTHALATE CONCENTRATIONS AND DIET: IDENTIFYING SPECIFIC DIETARY SOURCES OF ENDOCRINE DISRUPTORS



EXTRACURRICULARS Executive member of the Horace Greeley Biotech club. Greeley Quill writer and illustrator, Greeley Cross Country team. Local church volunteer for children reading program.

ISABELLA LIU



THE IMPACT OF ORPHANHOOD ON DEVELOPMENTAL MILESTONES OF KITTENS (FELIS CATUS)

EXTRACURRICULARS Figure skating, Debate team, SADD club, piano, and volunteering

SHAHAK LIVNE-TARANDACH

EXPLORING THE IMPACT OF SOCIAL ISOLATION ON MU OPIOID RECEPTOR EXPRESSION AND FUNCTION IN ADDICTION



EXTRACURRICULARS I play tennis, world language & Living Environment Regents tutor, volunteer at The Harris Project, a non-profit dedicated to Co-Occurring Disorder Advocacy.

LIVIA LOW



THE IMPACT OF ENTERTAINMENT-BASED SCREEN TIME ON BRAIN DEVELOPMENT AND COGNITIVE FUNCTION IN EARLY CHILDHOOD

EXTRACURRICULARS Figure skating, skating instructor, piano, Debate team, SADD club, volunteering

ANDERSON MARCHESANO

IMPACTS OF BEECH DISEASES ON MAST QUALITY AND RATE OF PRODUCTION IN AMERICAN BEECH (FAGUS GRANDIFOLIA)

EXTRACURRICULARS Academic Challenge, Origami Club, FRC Robotics, Parliamentary Debate, Saxophone, Guitar, Band, Music Composition, Varsity Indoor &Outdoor Track and Field.



TANISH MYNAMPATI



RESOUNDING HANDS: ACOUSTIC SENSING FROM WRIST-WORN DEVICES TO TRACK HAND POSITIONS AND ACTIONS WITH OBJECTS

EXTRACURRICULARS Track and Field, Academic Challenge, SAMES, Science Greeley, Saxophone, Boy Scouts

ANDREW NAM

ROOTING FOR SUSTAINABILITY: REAL-TIME IMAGE SEGMENTATION OF COMPOST-INOCULATED ROOT DEVELOPMENT FOR OPTIMAL MICROBIAL-PLANT INTERACTIONS

EXTRACURRICULARS Sustainability Research Center Fellowship President, Chappaqua School Foundation Student Advisory Council, Writing Staff, The Greeley Voice, Varsity Boys Golf Team



CHANAKYA NAYUDU



INVISIBLE BURDENS: PSYCHOSOCIAL OUTCOMES AND MENTAL HEALTH IMPLICATIONS OF ANTIPHOSPHOLIPID SYNDROME

EXTRACURRICULARS JVA Tennis, Executive in SADD Club, Executive in SAMES Club, Founder and President of FAM Club, & Member of the New Castle United for Youth Coalition

ALEXIS OH

EXPLORING HOW VARIOUS HYDRAULIC RETENTION TIMES AFFECT DRIP HYDROPONICS-MICROBIAL FUEL CELL SYSTEM PERFORMANCE



EXTRACURRICULARS Youth Wind Ensemble of Westchester, Rye FHA, Greeley's field hockey, Beach and Ocean Protection club, AAPIA club, & Greenburgh Nature Center volunteer

SEBASTIAN OLIVEIRA



ANALYZING PLASTIC DEGRADATION EFFICIENCY OF ENZYME-DIVERSE MICROBIAL CONSORTIA VERSUS SINGLE PETASE-PRODUCING ORGANISMS

EXTRACURRICULARS Plays tennis for the JVA team. He also enjoys spending time with his family and playing chess in his free time.

ADDISON PINNOW

COMPARISON OF THE HISTORICAL BASELINE AND MODERN FUNCTIONAL DIVERSITY OF BENTHIC MOLLUSKS IN PANAMA'S SEAGRASS MEADOWS



EXTRACURRICULARS RWU marine biology camp, MIT engineering camp with National Geographic, Million Women Mentorship with Pepsi, ASE volunteer founder and organizer, varsity ice hockey

RYAN RAMIREZ



IDENTIFICATION OF NOVEL TRANSCRIPTION FACTORS REGULATING MICROBIAL FUEL CELL RELEVANT PATHWAYS IN ALGAE

EXTRACURRICULARS HGHS Track and Field Team and JV Soccer Team, along with playing club soccer for Quickstrike FC outside of school. I am also secretary of the OLAS club at Greeley.

SAKET REDDYJARUGU

FRACTIONATED DELIVERY OF AXI-CEL: A NOVEL STRATEGY TO ENHANCE CAR-T SAFETY IN LARGE B-CELL LYMPHOMA



EXTRACURRICULARS Lincoln Douglas and New York Parliamentary Debate, Science Olympiad, Chappaqua Volunteer Ambulance Corps, Track, Pep Band, & Peer Leadership

OLIVIA REGAN



THE ROLE OF PLASMACYTOID DENDRITIC CELLS IN IFN-1 OVEREXPRESSION IN RHEUMATOID ARTHRITIS

EXTRACURRICULARS I am a member of the Greeley Science Olympiad team and the SRC club. I am also a president of the Greeley Quill Club and enjoy reading.

JACOB RICKLES

VACUUM-ASSISTED SELECTIVE LASER MELTING: POROSITY REDUCTION IN 3D PRINTING METAL



EXTRACURRICULARS Outside of science research I enjoy playing on the school tennis team, skiing, whitewater kayaking and canoeing, wake surfing, and building all sorts of things.

GEORGE ROJEK



INCORPORATING PROBIOTICS WITH EXISTING NANOPARTICLE-BASED DELIVERY SYSTEMS FOR THE TREATMENT OF IBD

EXTRACURRICULARS Science Olympiad, Varsity Swim, Lifeguarding, Phelps Hospital Volunteering,

MILA RYMARCZYK

GENE SILENCING: USING ASRNA IN HUMAN VAGINAL GARDNERELLA VAGINALIS TO INDUCE PROGRAMMED CELL DEATH VIA A TOXIN-ANTITOXIN PATHWAY



EXTRACURRICULARS I am involved in extracurricular activities such as volleyball and weekly volunteering at a local arboretum. I also enjoy creative writing and reading classic literature.

CLARA SAMUELSON



EVALUATING THE SYNERGY OF DULAGLUTIDE AND APOE ANTAGONIST 6KAPOEP AS A NOVEL ALZHEIMER'S TREATMENT

EXTRACURRICULARS theater, violin, drawing, tennis, skiing, and writing

SRIHAAN SEELMAN

CORAI: PREDICTING CORAL BLEACHING USING ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING



EXTRACURRICULARS Competitive mathematics, science research, science olympiad, robotics, tennis, and run a organization focused on teaching artificial intelligence to children. **ISEF finalist**

NICHOLAS SERINI



PROCRASTINATION AND MENTAL HEALTH IN ADOLESCENTS: INVESTIGATING A BIDIRECTIONAL RELATIONSHIP

EXTRACURRICULARS I run for Greeley winter track and Greeley spring track, as well as being a tutor and participating in Science Greeley.

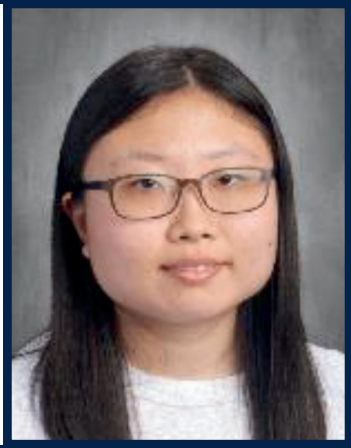
SAVANNAH SMITH

THE IMPACT OF TYPE OF HAPTIC FEEDBACK IN A TELEOPERATED ROBOTIC DEVICE ON USER PREFERENCE WHEN DISTINGUISHING BETWEEN DIFFERENT OBJECTS

EXTRACURRICULARS I often play piano after school. also play violin, as I find comfort in music. At home, I also draw both digitally and traditionally. I often do volunteering.



ERIN SUK



DETERMINING THE EFFECTS OF DIFFERENT MEDICAL FACTORS ON BIOMOLECULES USED FOR THE ESTIMATION OF THE POSTMORTEM INTERVAL

EXTRACURRICULARS Cello, Varsity Golf, GWYOA, Neighbors Link Volunteer & Schoolhouse Tutor

PRIYANKA TALLA

OPIOID WITHDRAWAL: MODULATING MICROGLIAL CAMP SIGNALING VIA PDE INHIBITION TO REDUCE NEUROINFLAMMATORY SYMPTOMS

EXTRACURRICULARS I am a violinist in the Chamber Orchestra, I play JV tennis, and I am a senior writer for the Science Greeley newsletter.



CONNIE TAO



AI VS. TRADITIONAL TEACHING: ASSESSING STUDENT LEARNING OUTCOMES AND VIEWS ON TEACHING EFFECTIVENESS

EXTRACURRICULARS Varsity volleyball, co-president of the Chinese Club. Chinese school volunteer, piano for nine years and recently developed an interest in video editing.

AADHYA VIJIL

REDUCING ANIMAL TESTING THROUGH AL-POWERED TOXICITY PREDICTION AND MOLECULAR OPTIMIZATION



EXTRACURRICULARS Violin, Piano, Biotech Club, Science Olympiad, Greater Westchester Youth Orchestra Association (GWYOA), New Castle United for Youth

ADITI VIJIL



ACCELERATING DRUG DISCOVERY LEVERAGING NATURE'S PHARMACY AND GENERATIVE AI

EXTRACURRICULARS Biotech Club, Science Greeley, Chemistry Club, Science Olympiad, New Castle United For Youth, GWYOA

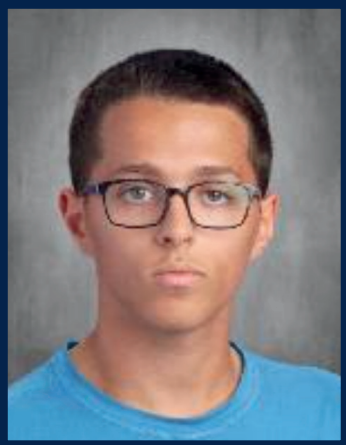
EMILY VU

GENETIC EPIDEMIOLOGY OF AMYOTROPHIC LATERAL SCLEROSIS IN UNDERREPRESENTED ASIAN POPULATIONS: A CROSS-POPULATION ANALYSIS



EXTRACURRICULARS Science Greeley Art Director, Fun & Arts Club Co-President, Greeley Voice Director Of Print Media, Middle School Math Guide Cofounder, piano & digital illustrator.

MATTHEW WEISSMAN



SIMULATION-BASED ASSESSMENT OF CYBERSECURITY MITIGATION STRATEGIES FOR MEDICAL DEVICES

EXTRACURRICULARS Cross Country, Winter Track and Field, and Tennis teams for school. When I am not in school, I play video games, hangout with friends and family, and I study cybersecurity.

MATTHEW WOHLSTADTER

THE ROLE OF SELF-EFFICACY IN ACADEMIC ACHIEVEMENT: A SOCIAL COGNITIVE PERSPECTIVE

EXTRACURRICULARS

ENOUGH Club Exec, Greeley Voice writer, incoming 25-26 Peer Leader, Hebrew School classroom assistant, and teen leadership circle mentor.



HENRY XUE



DEEP LEARNING WITH SPATIOTEMPORAL ATTENTION FOR CELL IDENTIFICATION IN C. ELEGANS EMBRYOGENESIS

EXTRACURRICULARS

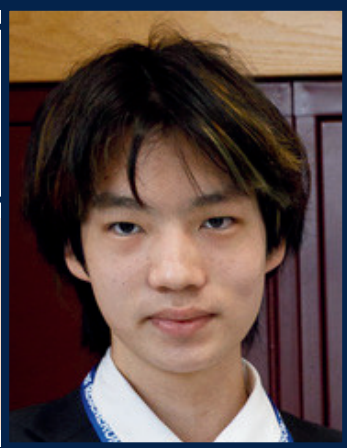
Actively involved competitive mathematics, teach workshop at WAMC math, varsity tennis, AAPIA, National Science Bowl, Math club, I think I'm in science research

KEVIN YAN

DENTBOT: A COST-EFFECTIVE, HIGH-PRECISION ROBOTIC SYSTEM FOR ORAL SURGERY

EXTRACURRICULARS

Sharron Art Center, studio artist; The Greeley Voice, multimedia staff/art content provider; Yearbook Club, art staff; Applied Programming Club, computer programmer; SHARE & ENOUGH member



EDWARD YANG



BIOMIMICRY OF ALBATROSS WING MORPHING TO ENHANCE AERODYNAMIC PERFORMANCE IN UAV DYNAMIC SOARING

EXTRACURRICULARS

In addition to science research, I also participate in various math competitions, Science Olympiad, Robotics, Track & Field, and Skiing.

welcome

ASPIRING SCIENTISTS

""SOMEWHERE, SOMETHING INCREDIBLE IS WAITING TO BE KNOWN."

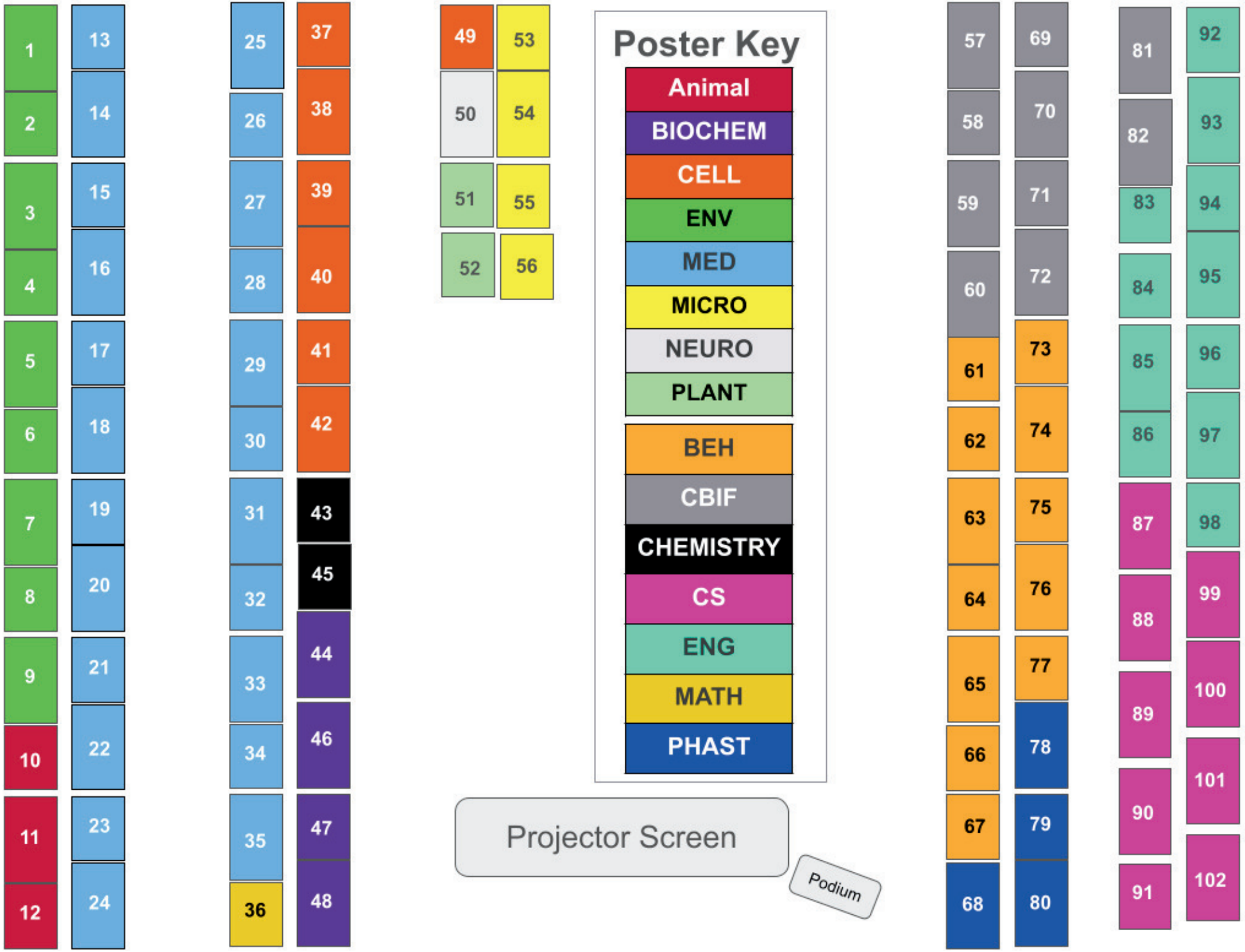
-CARL SAGAN

Kiran Agarwala
Federico Alacron Zambrarno
Fiona Allendorf
Deven Amrute
Vince Barbieri
Stella Beaton
Swaraj Bhattacharya
Vyom Bhuwan
Gabriela Brant
Austin Brennen
Evan Buhain
Victoria Cheng
Ellyanne Chlystun-Githae
Azian Choudhry
Violet Clinton
Dylan Cruet - Ghosh
Abigail Desrocher
Roxanne Duff
Zach Eisner
Sydney Ende
Yuan Fan
Faris Fatouh
Jordan Fink
Crystal Fu

Zachary Gibbs
Reece Gilvar
Avika Goel
Camila Gomez
Jasper Gottlieb
Nathaniel Grishman
Ava Gueye
Anika Gursahani
Felix Hong
Roma Huggahalli
Elizabeth Impastato
Arjun Jangi
Allen Jankovic
Hannah Kecskes
Owen Lansford
Shaili Maghen
Shayla Marshall
Allison Martineau
Jace Mathew
Cinzia Mazzini-Chin
Olivia McCann
Riley McKie
Ellen Morales Areas
Kelly Morton

Leah Mullen
Jacky Murphy
Tara Nair
Viktor Napolitano
Emily Orlandi
Meghan Pascione
Ryan Paul
Jarno Piacentini
Chloe Pil
Paloma Pourmand
Taylor Prasad
Amy Qui
Anikaith Reddyjarugu
Aarav Shah
Zarina Shahid
Tate Shalov
Devan Sharma
Julia Silletti
Harrison Simon
Nikhil Singhal
Luke Thomas
Gayathri Tupili
Arantza Urrea
Daniel Urrea

Cecilia Valdes
Arya Venkatesh
Chiharu Venkatesh
Misawa
Adela Wang
Sophia Wang
Solon Wen
Reilly Winnegar
Jackson Wong
David Yang
Lia Yedid
Athena Zhang
Yuxing (Lucas) Zhang
Ziyue Zhang


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POSTER KEY - FIND SOPHOMORES TO HEAR THEIR PRESENTATIONS FOR SOMERS SCIENCE FAIR

Number	Name	CATGORY	YR
1	Levine, Meredith	Environ	JR
2	Oh, Alexis	Environ	SOPH
3	Paskowitz, Kathleen	Environ	JR
4	Oliveira, Sebastian	Environ	SOPH
5	Margolies, Harper	Environ	SENIOR
6	Pinnow, Addison	Environ	SOPH
7	Morton, Nora	Environ	SENIOR
8	Seelman, Srihaan	Environ	SOPH
9	Tsai, Morgan	Environ	SENIOR
10	Liu, Isabella	Animal Science	SOPH
11	Garcia, Isabella	Animal Science	JR
12	Vijil, Aadhya	Animal Science	SOPH
13	Vu, Emily	Med/Health	SOPH
14	Balcetis, Jonas	Med/Health	JR
15	Talla, Priyanka	Med/Health	SOPH
16	Chen, Wendy	Med/Health	JR
17	Samuelson, Clara	Med/Health	SOPH
18	Golub, Zoe	Med/Health	JR
19	Regan, Olivia	Med/Health	SOPH
20	Guo, Kevin	Med/Health	JR
21	Reddyjarugu, Saket	Med/Health	SOPH
22	Mullen, Samuel	Med/Health	JR
23	Lamb, Madeline	Med/Health	SOPH
24	Myers, Stella	Med/Health	JR
25	Rutman, Eve	Med/Health	JR
26	Jourdy, Serene	Med/Health	SOPH
27	Tong, Emma	Med/Health	JR
28	Gunnar, Anya	Med/Health	SOPH
29	Wania, Syeda	Med/Health	JR
30	Feig, Emma	Med/Health	SOPH
31	Dhand, Roshan	Med/Health	SENIOR
32	Dang, Jason	Med/Health	SOPH
33	Song, Zirui	Med/Health	SENIOR
34	Ackerman, Brooke	Med/Health	SOPH

Number	Name	CATGORY	YR
35	Zhang, Meadow	Med/Health	SENIOR
36	Barr, Jackson	Math	SOPH
37	Hota, Lasya	Cell/Molecular	SOPH
38	Chen, Cindy	Cell/Molecular	JR
39	Livne-Tarandach, Shahak	Cell/Molecular	SOPH
40	Tsao, Sydney	Cell/Molecular	JR
41	Suk, Erin	Cell/Molecular	SOPH
42	Menon, Arjun	Cell/Molecular	SENIOR
43	Vijil, Aditi	CHEMISTRY	SOPH
44	Nocca, Lorelai	Biochem	JR
45	Brand, Kai	CHEMISTRY	SOPH
46	Wang, Brady	Biochem	JR
47	Rojek, George	Biochem	SOPH
48	Ye, Daniel	Biochem	SENIOR
49	Allen, David	Cell/Molecular	SOPH
50	Al-Mufti, Jude	Neuroscience	JR
51	Marchesano, Anderson	Plant Science	SOPH
52	Nam, Andrew	Plant Science	SOPH
53	Fijman, Caleb	Microbiology	SOPH
54	Sandt, Hadrian	Microbiology	JR
55	Knapp, Emma	Microbiology	SOPH
56	Rymarczyk, Mila	Microbiology	SOPH
57	Battu, Mukul	CBIF	JR
58	Xue, Henry	CBIF	SOPH
59	Fu, Warren	CBIF	JR
60	Kumar, Rishi	CBIF	JR
61	Correai, Christopher	Behavior	SOPH
62	Gopikrishna, Parvathy	Behavior	SOPH
63	Lansford, Eve	Behavior	JR
64	Khanna, Ashna	Behavior	SOPH
65	Sharma, Uma	Behavior	JR
66	Low, Livia	Behavior	SOPH
67	Nayudu, Chanakya	Behavior	SOPH
68	Tseng, Rudolf	Physics/Astro	JR

Number	Name	CATGORY	YR
69	Khurana, Anya	CBIF	SOPH
70	Qiu, Shawn	CBIF	JR
71	Ramirez, Ryan	CBIF	SOPH
72	Talla, Naveen	CBIF	JR
73	Serini, Nicholas	Behavior	SOPH
74	Carousso, Natalie	Behavior	SENIOR
75	Tao, Connie	Behavior	SOPH
76	Goldberg, Justin	Behavior	SENIOR
77	Wohlstadter, Matthew	Behavior	SOPH
78	Cheng, Dayuan	Physics/Astro	JR
79	Harel, Maya	Physics/Astro	SOPH
80	Huang, Albert	Physics/Astro	JR
81	Kumar, Shrey	CBIF	SENIOR
82	Xiu, Elizabeth	CBIF	SENIOR
83	Aron, Riya	Engineering	SOPH
84	Ji, Andy	Engineering	SOPH
85	Harris, Benjamin	Engineering	JR
86	Mynampati, Tanish	Engineering	SOPH
87	Chung, TingRay	Computer Sci	JR
88	Stryker, Samuel	Computer Sci	JR
89	Feng, Amy	Computer Sci	SENIOR
90	Jankovic, Sara	Computer Sci	SENIOR
91	Weissman, Matthew	Computer Sci	SOPH
92	Rickles, Jacob	Engineering	SOPH
93	Evangelinos, Katherine	Engineering	JR
94	Smith, Savannah	Engineering	SOPH
95	Ho, Audrey	Engineering	SENIOR
96	Yan, Kevin	Engineering	SOPH
97	Kamal, Adam	Engineering	JR
98	Yang, Edward	Engineering	SOPH
99	Zhang, Ryan	Computer Sci	JR
100	Chang, Benjamin	Computer Sci	SENIOR
101	Liang, Shawn	Computer Sci	SENIOR
102	Pang, Andrew	Computer Sci	SENIOR

WHAT DO STUDENTS SAY ABOUT SCIENCE RESEARCH?

"Working alongside the brightest minds in the world to make a change for the better, regardless of the field or industry. A three-year-program that provides the basis for analytic skills and research skills that set up students for success in their future, no matter what they believe their career path will be." - Amy Feng, Senior

Science Research is an opportunity to expore a topic you love without any boundaries. It is the only class at Greeley that focuses on what you can discover and achieve. The competitions add to the excitement, giving you something to look forward to and strive for." - Ryan Zhang, Junior

"Science research has been one of the most rewarding and insightful experiences. Senior year research has allowed me to dive even deeper into my topic and understand what I thought wasn't possible beforehand." - Justin Goldberg, Senior

"Science research is one of the strongest communities in Greeley. You learn so many awesome things across the fields of science that you would otherwise not be taught in school. The research internships are life changing and prepare you for the world. Science research prepares you for the real world." - Samuel Mullen Junior

"Science research has shown me the most important part of doing anything is appreciating how you got there. From analyzing journal articles in sophomore year to presenting at WESEF as a senior, I've cherished these years with my peers, growing as individuals alongside our research journey."
- Sara Jankovic, Senior

"This year, science research was a journey of perseverance—facing setbacks, chasing questions, and learning to find meaning in uncertainty. It taught me that the heart of research isn't just the results, but the relentless curiosity and hard work it takes to get there." - Rishi Kumar; Junior

"Science Research is an incredibly rewarding journey. This class lets you showcase the dedication and hard work you've invested over the summer and throughout sophomore year. For many of us, it's the first time presenting independent research, and that's truly something to be proud of! At the beginning of the year, I wasn't very confident in my work, but through collaboration with my peers and with the support of this class, I've grown to feel genuinely proud of the research I've done."
- Sydney Tsao, Junior

"Science research has been one of the most meaningful parts of my high school experience. I found a supportive and engaging community, developed confidence in public speaking and presenting, and gained hands-on experience with real scientific and lab work."
- Harper Margolies
Senior

"Science research in your senior year is a culmination of three years of hard work. It's your last chance to present at the science fairs, and your first opportunity to mentor the juniors and even judge at Somers. The most rewarding part of this year was going over classmates' poster presentations and giving class-wide pep talks. This is the year to give back!" - Roshan Dhand, Senior