26th Annual Gemstone Honors Program Thesis Conference

Friday, April 11, 2025
University of Maryland, College Park

GEMSTONE
HONORS COLLEGE
UNIVERSITY OF MARYLAND

Thesis Conference Schedule

Time	Team	Link
8:00 a.m.	ANDRR	https://go.umd.edu/ANDRR
9:00 a.m.	ECHO	https://go.umd.edu/ECHO
10:15 a.m.	HEM(O-)	https://go.umd.edu/HEMO
	QCRYPT	https://go.umd.edu/QCRYPT
12:00 p.m.	EXO	https://go.umd.edu/GEMS_EXO
	BMM	https://go.umd.edu/BMM
1:30 p.m.	ASQ	https://go.umd.edu/ASQ
	BELI	https://go.umd.edu/BELI
	MetaBio	https://go.umd.edu/MetaBio
2:45 p.m.	FUNGI	https://go.umd.edu/TeamFUNGI
	GAHSP	https://go.umd.edu/GAHSP
	SUPA'HOT	https://go.umd.edu/SupaHot
4:00 p.m.	SCOOT	https://go.umd.edu/GEMS_SCOOT
	SUPERBUG	https://go.umd.edu/SUPERBUG

ANDRR: Affordable computer vision: modular, open source detection platform for UAVs

Research Team
Ethan Linsider, Computer Science
Jacob Stern, Architecture, History
Jay Rana, Computer Engineering, Robotics
Nathan Roy, Aerospace Engineering

Faculty Mentor
Dr. Anil E. Deane, Associate Research Professor, *Institute for Physical Science and Technology*; Director, *Laboratory for Computation and Visualization, UMD*

Librarian
Mr. Milan Budhathoki, GIS and Data Librarian, *University Libraries, UMD*

Discussants
Dr. Max Ehrlich, Adjunct Professor, *Computer Science, UMD*
Mr. John Slaughter, Director, *UAS Research and Operations Center, UMD*
Mr. Josh Gaus, Lead Engineer, *UAS Research and Operation Center*
Ms. Mckenzie Turpin, Test Engineer, *UAS Research and Operations Center, UMD*

Research Description

Search and rescue operations following natural disasters are critical for saving the lives of individuals trapped and in need of aid. However, many of the technologies used in search and rescue (helicopters, planes, boats, etc.) can be prohibitively expensive for nations with low GDP. This issue is only exacerbated by the higher number of deaths due to natural disasters in such nations due to less resilient infrastructure. Unmanned Aerial Vehicles (UAVs) have the potential to replace more expensive technologies in the search for endangered individuals and analysis of at-risk hardware without endangering rescue personnel. While advancements in low-cost UAVs for commercial and hobby use in addition to the development of lightweight computer vision (CV) software and dedicated processors have set the stage for low-cost search and rescue UAVs, stand-alone UAV costs and part scarcity still pose challenges. Team ANDRR developed a real-time CV module for UAVs to aid in natural disaster relief using a wide range of compatible commercially available parts wherever possible. By conglomerating existing systems into a single effective and easy-to-use unit, we were able to identify individuals in real-time at low cost. The development guide and software for the module are provided to provide increased access to real-time CV processing for search and rescue and other operations.

Acknowledgements

Team ANDRR would like to thank Dr. Anil Deane for his expertise, lab space, and equipment for use in developing and testing our system. A special thank you to our discussants Max Ehrlich, John Slaughter, Joshua Gaus, and Mckenzie Turpin. We would also like to thank the Gemstone program staff for their support and advice over the course of our project, as well as the F3 facility and Dr. Ivan Penskiy for providing flight test support.

ECHO: Hearing Aid Audio Processing Model Benchmarking with Binary Environmental Classification

Research Team

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Chelsea Reyes, Finance, Operations Management & Business Analytics
Lily Li, Computer Science, Mathematics; Philosophy minor
Perfect Sare, Neuroscience; Spanish minor
Pruthav Patel, Electrical Engineering
Rahul Nair, Computer Science
Rajit Mukhopadhyay, Computer Engineering
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Discussants

Dr. Brian Beaudoin, Associate Research Professor, *Institute for Research in Electronics and Applied Physics, UMD*
Dr. Eric Hoover, Assistant Professor, *Hearing and Speech Sciences, College of Behavioral and Social Sciences, Brain and Behavior Institute, UMD*
Dr. Jonathan Simon, Professor, *Electrical and Computer Engineering, The Institute for Systems Research, Biology, Brain and Behavior Institute, UMD*
Dr. Matthew Goupell, Professor, Director of Ph.D. Program, Co-Director of Undergraduate Honors, *Hearing and Speech Sciences, College of Behavioral and Social Sciences, Brain and Behavior Institute, UMD*

Research Description

Currently existing hearing aid audio processing models are trained to filter out noise and amplify specific sounds such as speech. However, real life environments contain a multitude of kinds of sound that is either preferred or needs to be heard by users, yet cannot exhaustively be defined within the model. Our project proposes a way for hearing aid audio processing models to account for these unknown sounds without explicit definition. We developed an open source audio dataset that contains full-environmental audio that is categorized by a set of 4 binary features (indoors, crowded, walking, speaking) that are applicable to any audio environment. Our team collected audio data using over the ear microphones at different locations centered around the UMD College Park campus. Additionally, we constructed a benchmarking platform for future researchers to compare the efficiency of different models in different environments on our dataset. The platform tests models on 6 different metrics (e.g., Noise Floor, Signal to Noise Ratio, Dynamic Range, and Crest Factor). Our results from testing various audio processing models show that the use of different audio processing models result in significant distinctions in performance across multiple metrics within various noise environments.

Acknowledgements

We would like to express our gratitude to Dr. David Lovell, Dr. Allison Lansverk, Leslie Lizama, our librarian, Shaunda Vasudev, and the Gemstone Honors Program for their invaluable guidance and support. Most importantly, we extend our deepest appreciation to our mentor, Dr. Sahil Shah, for his insightful guidance and unwavering dedication to our success. A special thank you to Kevin Zhou for his contributions as a member of our team for three years. We are grateful to our discussants, Dr. Jonathan Simon, Dr. Eric Hoover, Dr. Brian Beaudoin, and Dr. Matthew Goupell, for their time and professional insights. We sincerely appreciate our generous donors, whose contributions made this research possible. Finally, thank you to our family, friends, and the Gemstone community for their continuous support and encouragement.

HEM(O-): Assessing the Biomechanical Properties of ErythroMer for Particle Integrity in an ex vivo Organ Perfusion System

Research Team

Claire Kettula, Bioengineering
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Jackson Lang, Computer Science; Statistics minor
Joel Bannerman, Bioengineering
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Faculty Mentor & Co-Mentors

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Dr. Antonio C. Renaldo, Research Associate, *Bioengineering Experimental Core, University of Maryland School of Medicine, Center for Blood Oxygen Transport and Hemostasis (CBOTH)*
Dr. Stephen Rogers, Assistant Professor, *Pediatrics*, *University of Maryland School of Medicine, Center for Blood Oxygen Transport and Hemostasis (CBOTH)*

Librarian

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Discussants

Dr. Alisa Clyne, Professor, *Bioengineering, UMD*
Dr. Bistra Iordanova, Professor, *Swanson School of Engineering, University of Pittsburgh*
Dr. Deborah Goldberg, Senior Lecturer, *Bioengineering, UMD*
Dr. Regina Adao, Laboratory Lead Research Specialist, *University of Maryland School of Medicine*
Ms. Elizabeth McAslan, Associate Scientist, *Kalocyte*

Research Description

Our goal was to investigate the viability of an oxygen carrying nanoparticle, ErythroMer (EM), as an alternative perfusate supplemental ex vivo perfusion solution to extend the lifespan, functionality and therefore potential accessibility of donated organs, specifically kidneys. This was accomplished by assessing the shear stability of ErythroMer through three scientific aims: quantification of EM peak shear tolerance, shear tolerance over time, and impact of suspension medium on shear tolerance. To quantify EM peak shear tolerance, our initial goal was to identify the shear at which greater than 10% of the hemoglobin payload within EM was released, indicating significant particle failure. Next, we performed a time course assessment of EM stability at maximal perfusion pump shear to identify whether EM could withstand the prolonged shearing required for organ perfusion solutions (i.e., ensuring structural integrity of the particles over time). Finally, we investigated the impact of EM suspension medium on shear tolerance to address whether plasma protein albumin affected EM's integrity. Our data collection was successful in ensuring EM particle's ability to be used as a perfusion solution within an organ pump system. To conclude, the use of oxygen carriers, specifically EM, in a pump or perfusion system can be further explored to expand the uses for this exciting, developing technology.

Acknowledgements

We would like to thank our incredible mentors Dr. Allan Doctor, Dr. Stephen Rogers, Dr. Antonio Renaldo, and our librarian Leah DiCiesare. Thank you to our discussants, Regina Adao, Alisa Clyne, Deborah Goldberg, Bistra Iordanova, and Elizabeth McAslan for their useful critique and expert guidance. We would also like to thank all of our LaunchUMD Donors for their generosity, as well as Dr. David Lovell, Dr. Allison Lansverk, Brianna Lucas, and all of the Gemstone Honors Program for their support. Finally, we would like to thank the Do Good Institute for their encouragement and financial contributions to our research.

QCRYPT: Quantifying Lattice Cryptosystem Security in the Presence of Side Information

Research Team

Adnan Benchaaboun, Computer Engineering
Alex Yelovich, Computer Science, Mathematics
Avery Parker, Computer Science, Mathematics
Ayman Chowdhury, Computer Science
Julian Javillo, Computer Science
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Faculty Mentor

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Librarian

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Discussants

Dr. Anamaria Costache, Associate Professor, *Norwegian University of Science and Technology*
Dr. Daniel Apon, Computer Scientist, *NIST*
Dr. Gorjan Alagic, Associate Research Scientist, *QuICS; University of Maryland Institute for Advanced Computer Studies (UMIACS), Computer Science, UMD*
Dr. Yi-Kai Liu, Adjunct Associate Professor, *QuICS; University of Maryland Institute for Advanced Computer Studies (UMIACS), Computer Science, UMD*

Research Description

Lattice-based cryptosystems are the leading candidates for safe and efficient cryptography that is secure from threats posed by quantum computers. We examined how the security of these cryptographic systems is affected by the presence of additional "side information" about the secrets in the system. We built on previous literature that models this side information through a geometric lens, through the usage of "hints" that constrain the possible locations of a secret in a state space. Our work extended this mathematical framework by providing a computer implementation of algorithms to find a maximal inscribed ellipsoid, which allows one to more conservatively estimate the effect of side information. We also investigated and quantified a novel technique for embedding lattice cryptosystems into this geometric state space. Additionally, our team applied this improved mathematical framework towards two concrete lattice cryptosystems, CKKS and Kyber. For CKKS, the team determined the optimal amount of noise-flooding required to make the system secure while maintaining acceptable computational precision. For Kyber, the team took information gained from a machine's power usage while running the algorithm and used it to determine information about the secret key. Overall, our research provides more information about the overall security of the algorithms that protect people's privacy in an increasingly interconnected world.

Acknowledgements

We would like to thank our mentor, Dr. Dachman-Soled, for helping us grow as researchers.

Additionally, we would like to thank Dr. Hunter Kippen, Dr. Jonathan Katz, Dr. Flavio Bergamaschi, Dr. Anamaria Costache, Rui Tang, Hari Kailad, and Russell Chiu for assisting in the research for this thesis.

EXO: Firefighting Exoskeleton to Reduce Stress and Strain

Research Team

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Discussants

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Mr. David Scheirman, Battalion Chief, *Sherwood, OR*
Mr. Donny Boyd, Firefighter, *Montgomery County Fire Department*

Research Description

Since its inception, the profession of firefighting has carried extreme risks of injury to firefighters. Technological advancements have given firefighters increased protection from heat and smoke with the development of fire jackets, pants, and SCBA equipment, however this increase of weight from protective gear has itself become the most prominent source of injury for firefighters. In the past few years, exoskeletons have seen introduction into the manufacturing industry to reduce the physical strain of carried loads on employees. Our team's research focuses on developing a similar exoskeleton specifically designed for use by firefighters to reduce the number of injuries they endure from heavy turnout gear. The research hinges around developing a heat resistant, inexpensive, comfortable, and practical exoskeleton as well as a look into creating proper protocol for the deployment and usage of the exoskeleton with input from current and former firefighters.

Acknowledgements

We would like to thank our mentor, Dr. Peter Sunderland, for his support and guidance throughout our Gemstone experience. We would also like to thank our panel discussants Mr. Donny Boyd, Mr. David Scheirman, Dr. Fernando Raffan-Montoya, and Dr. Craig Carignan, for their time. We would like to thank Dr. David Lovell, Dr. Allison Lansverk, Stephanie Do, and all of the Gemstone Staff for their support. Finally, we would like to thank Mr. Benjamin Beiter, all of our firefighter participants, the Globe Manufacturing Company LLC, the National Institute of Technology, and the ASTM International Exo Technology Center of Excellence for their assistance in providing us with resources valuable for constructing and testing our device.

BMM: Examining Contributors to Black Maternal Health Experiences in Prince George's County, Maryland

Research Team

Aden Eskinder, General Biology; Humanities, Health, and Medicine minor
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Sidney Redwood, Bioengineering
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Discussants

Dr. Catherine Maybury, Faculty Specialist, Horowitz Center for Health, *School of Public Health, UMD*
Dr. Ndidiamaka Amutah-Onukagha, Associate Professor**,** *Public Health and Community Medicine, Tufts University*
Dr. Tracy Zeeger, Assistant Dean, Office of Public Health Practice and Community Engagement, *School of Public Health, UMD*
Ms. Liz Marshall, Lecturer, *English, UMD*
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Research Description

Black women in the United States face a maternal mortality rate three times that of white women, a disparity mirrored in Prince George's County, Maryland, despite its status as one of the wealthiest majority-Black counties in the nation. In 2019, the Prince George's County Health Department reported that between 2008 and 2017, the county's pregnancy-related maternal mortality rate (28.6 deaths per 100,000 live births) exceeded the state average (26.9), with Black, non-Hispanic mothers experiencing the highest rate (37.4 per 100,000 live births). Implicit bias among healthcare providers has been identified as a contributing factor to these disparities. Despite growing calls for reform, there continues to be a lack of standardized cultural humility and implicit bias training in allied health professions. This study explores how maternal access to healthcare and provider cultural competency training influence maternal health disparities in Prince George's County. Using a mixed-methods approach, the research team surveyed and interviewed two key populations: Black mothers ages 18 -34, residing in Prince George's County, Maryland, and maternal health providers practicing in the District of Columbia, Maryland, and Virginia (DMV) region. By examining patient-provider interactions and gaps in medical education, this research aims to inform policy and

curricular reforms to improve Black maternal health outcomes.

Acknowledgements

We extend our deepest gratitude to Dr. Sylvette La Touche-Howard for her invaluable mentorship, continuous support, and expertise throughout our research journey. We also thank Dr. Tracy Zeeger, Dr. Catherine Maybury, and the University of Maryland School of Public Health for providing us with essential resources and opportunities to share our research.

We are grateful to Taylor Palmer and the members of the Prince George's County Health Action Coalition for welcoming us to informative meetings and supporting the dissemination of our study. Thank you to Dr. Ndidiamaka N. Amutah-Onukagha and the Maternal Outcomes for Translational Health Equity and Research (MOTHER) Lab for supplying instrumental data that helped shape our research. Special thanks to the University of Maryland Capital Region Medical Center and Prince George's County Memorial Library System for aiding us with participant recruitment.

We sincerely appreciate the funding support from our generous donors from the University of Maryland Libraries, Launch UMD, and bake sale consumers. We are thankful for Ms. Emily Deinert, our team librarian, whose guidance was immeasurable in establishing a strong foundation for our thesis.

Lastly, we are especially grateful to the Gemstone Honors Program–Dr. David Lovell, Dr. Allison Lansverk, and Ms. Leslie Lizama–for providing us with the opportunity to lead a meaningful undergraduate research project.

ASQ: Fast Prediction of Full Quantum Dynamics with Deep Recurrent Neural Networks

Research Team

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George Witt, Computer Science; Physics
Jander Kugelman, Bioengineering
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Discussants

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Dr. Maksym Morawski, Lecturer, *Computer Science, UMD*
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Mr. Shams Mehdi, Graduate Student, *Biophysics, Institute for Physical Science and Technology, UMD*

Research Description

Numerical simulations of interacting quantum systems are computationally very intensive, typically requiring resources that scale exponentially in the system size - such as the number of quantum particles. A plausible approach to overcome this unfavorable simulation time is to train deep neural networks over short timescales and use them to infer dynamics over much longer timescales. We demonstrate that such a speedup is possible using deep recurrent neural networks, including LSTM and Transformer-based networks, by predicting the quantum dynamics of a transverse interacting Ising Model with up to 8 spins. We further evaluate these physical models on square and triangular lattice Heisenberg models, the fermionic Hubbard model, and the Jaynes-Cummings model. Unique to our work, we predict the full wavefunction dynamics of the systems, which can then be used to calculate the evolution of physical observables over time. We present sample predictions for our models and compare the efficacy of the different approaches with varying hyperparameters, spins, and Hamiltonian parameters, at best accurately predicting up to 90% of a single period with 10% of a period for context. We use this to determine the primary quantum model frustrations that impair model training the most; this pinpoints areas where active work is needed on new ML training techniques. We anticipate that our work will provide insights towards extending the coherence time of quantum systems such as qubits and spins by determining the issues that stand in the way of network training and prediction on realistic Hamiltonians.

Acknowledgements

We thank our mentors, Dr. Avik Dutt and Dr. Mohammed Hafezi, for their expert guidance and our librarian, Jordan Sly. Thank you to our discussants Dr. Maksym Morawski, Dr. Fardina Alam, Greeshma Oruganti, and Shams Mehdi. We also thank the UMD Zaratan HPC systems staff for their support with data management and all of our LaunchUMD Donors for their donations. Finally, we thank Dr. David Lovell, Dr. Allison Lansverk, and everyone in the Gemstone program for their support.

BELI: Investigation of Gut Motility Throughout the Menstrual Cycle Utilizing the Smart Underwear

Research Team

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Eliya Behailu, General Biology
Grace Sarkar, Neurobiology and Physiology
Kara Gardiner, Neuroscience, Behavioral and Cognitive Track; Science, Technology; Ethics Policy minor, Violin Performance minor
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Maggie Grant, Cell Biology and Genetics
Nakati Sany, Cell Biology and Genetics
Nayantara Anders, Economics and Criminology
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Discussants

Dr. Jessica A. Mong Professor, Assistant Dean for Graduate and Postdoctoral Studies, *University of Maryland Baltimore, School of Medicine*
Dr. Johanna B. Holm, Assistant Professor, *Microbiology and Immunology University of Maryland Baltimore, School of Medicine*
Dr. Justicia Opoku-Edusei, Senior Lecturer, *Biology, UMD*
Dr. M. Sue Reynolds, Senior Lecturer, Assistant Professor, *Behavioral and Community Health, School of Public Health, UMD*
Dr. Santiago Botasini, Visiting Assistant Professor, Researcher, *Cell Biology and Molecular Genetics, UMD*

Research Description

Female reproductive hormones fluctuate significantly throughout the menstrual cycle, influencing gastrointestinal motility and function. These changes in gut motility contribute to gastrointestinal symptoms such as flatulence, diarrhea, and constipation. When transit time is faster, fewer carbohydrates are absorbed in the small intestine, leading to increased microbial fermentation and gas production in the large intestine. Given the established effects of reproductive hormones on gut motility, we hypothesized that we would detect increased gut microbial gas production during menstruation, when estradiol and progesterone are lowest and transit time is fastest. However, due to a lack of tools to measure gut microbial gas production longitudinally, the literature lacks a formal test of this hypothesis. Therefore, we used a novel tool, the Smart Underwear device, to measure gut microbial gas production as a proxy for intestinal transit time. Participants wore the device for a total of nine days over the course of one menstrual cycle during three windows. On device wearing days, participants logged the meals they consumed. Additionally, participants used Luteinizing Hormone

test strips in the middle of their cycle to confirm ovulation timing and precisely map menstrual cycle phases. We extracted and analyzed the data from our returned Smart Underwear devices to measure gut microbial gas production as an indicator of intestinal transit time at different phases of the menstrual cycle, providing the first longitudinal measurements of gut microbial gas production across the menstrual cycle.

Acknowledgements

We would like to thank Dr. Brantley Hall for his guidance and unwavering support for the last three years. We are better researchers because of him, and for that, we are truly grateful. Also, special thanks to Dr. Santiago Botasini for his assistance in extracting the device data and to the members of the Hall Lab for their support. We would also like to extend our gratitude to our librarian Amber Pierdinock-Weed, and our discussants, Dr. Johanna B. Holm, Dr. Justicia Opoku-Edusei, Dr. M. Sue Reynolds, and Dr. Jessica A. Mong. Team BELI would like to thank the Gemstone staff, Dr. David Lovell, Dr. Allison Lansverk, Leslie Lizama, Brianna Lucas, and Jannelle Dang, as well as our Gemstone peers for joining us on this journey. We would also like to thank the Do Good Institute for their funding and support throughout the course of our research. Finally, we would like to especially thank our participants who provided their time and commitment to this study.

MetaBio: Investigating Combination of Photodynamic Therapy and AXL Inhibition for Improved Treatment Outcomes of Glioblastoma Multiforme

Research Team

Anna Shaw, Biological Sciences: Cell Biology and Genetics
Dilan Gangar, Bioengineering
Farah Farrag, Biological Sciences: General Biology
Jennifer Yeon, Biological Sciences: Neurobiology and Physiology
Louise R. Mitchelmore, Biological Sciences: Neurobiology and Physiology, Psychology
Nada Jamal Fadul, Biological Sciences: Neurobiology & Physiology

Faculty Mentor

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Librarian

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Discussants

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Research Description

Glioblastoma multiforme (GBM) is notorious for its aggressive behavior, brain invasion, and poor prognosis, with a median survival of less than 18 months. Limited treatment options contribute to GBM's status as one of the deadliest cancers. The intricate tumor composition and invasion of vital brain areas render it resistant to standard therapies, necessitating novel approaches to extend post-diagnosis survival. Intraoperative photodynamic therapy (PDT) has emerged as a promising technique, involving the administration of a photosensitizer before surgery and red light application afterward to target residual tumor cells. Recently, an excipient-free nanoparticle formulation of verteporfin (NanoVP) photosensitizer was developed for PDT of GBM, demonstrating superior efficacy in reducing tumor burden and extending animal survival compared to existing photosensitizers. We explored the combined effects of NanoVP-PDT and clinically promising AXL inhibitors on GBM cells. Phospho-AXL, which is highly expressed in GBM tumors and correlates with shorter overall patient survival, represents a compelling therapeutic target for small-molecule inhibition. In this study, we investigated the anti-GBM effects of combining NanoVP-PDT with AXL inhibitors in vitro as a new treatment approach to combat GBM.

Acknowledgements

We would like to thank our incredible mentor, Dr. Huang Chiao Huang, for his unwavering support, expert guidance, and dedication to our research. We also extend our gratitude to the members of Dr.

Huang's Optical Therapeutics and Nanotechnology Laboratory, especially Dr. Sumiao Pang and Ms. Rebecca Hays, for their valuable contributions and support of our work. Thank you to our thesis discussants, Dr. Anthony Kim, Dr. Carla Arnau Del Valle, Dr. Sumiao Pang, and Dr. Burt Nabors, for their insightful critique and expertise. We would also like to thank all of our LaunchUMD donors for their generosity, whose contributions made this research possible, as well as our team librarian, Ms. Nedelina Tchangalova, for her assistance. Finally, we would like to thank Dr. David Lovell, Dr. Allison Lansverk, and the entire Gemstone Honors Program for their leadership and support.

FUNGI: Investigation of Fungal Extracts as Anti-Biofilm Agents

Research Team

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Annette Eldo, Neuroscience; Spanish minor
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Catalina Gibney, Environmental Science and Policy-Biodiversity and Conservation Biology
Leah Crowley, Biological Sciences: General Biology; Sustainability Studies minor
Lili Bao, Biological Sciences: Physiology and Neurobiology; Nonprofit Leadership and Social Innovation minor
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Ranita Chowdhury, Biochemistry; Astronomy minor
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Faculty Mentor

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Librarian

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Discussants

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Dr. Jannette Harro, Research Assistant Professor, *Microbial Pathogenesis, University of Maryland School of Medicine*
Dr. Tristan Wang, Postdoctoral Fellow, *Oncology and Diagnostic Sciences, University of Maryland School of Medicine*
Dr. Wesley Grant Lawson, Professor, *Electrical and Computer Engineering, UMD*

Research Description

Many nosocomial infections are derived from microbial growth on implantable medical devices that form biofilms. Biofilms are complex colonies of bacteria that can grow on the surfaces of medically implantable devices and typically have antibiotic-resistant properties. Currently, no commercially available FDA-approved or EPA-certified biofilm sterilants are biocompatible for medically implantable devices. This study examined potential applications of Shiitake (Lentinula edodes) and Turkey Tail (Trametes versicolor) water soluble fungal extracts as preventative antibiofilm agents. Through the isolation of extracts derived from Turkey Tail and Shiitake mushrooms, this research sought to find a sustainable, safe, and accessible method to treat biofilm infections originating from medically implanted devices to address the rise in antibiotic resistance, in addition to other practical applications. Our results show that ultrasonic-assisted aqueous Shiitake extract inhibits Staphylococcus epidermidis biofilm formation in a dose-dependent manner and displays general cytotoxicity while ultrasonic-assisted aqueous Turkey Tail extract shows no significant biofilm or growth inhibition. Further research is needed to characterize these isolates in order to determine their particular mechanisms of action.

Acknowledgements

We are incredibly thankful to our mentor, Dr. Myles Poulin, and his laboratory team for their invaluable guidance and time throughout our three-year research journey. Special thanks to Isabella Baxter, our librarian, for her instrumental assistance during the initial stages of our research. Additionally, we are grateful to Dr. Lansverk, Dr. Lovell, and the entire Gemstone staff for their consistent support and mentorship. Our research was made possible through the generous financial aid of LaunchUMD, the Do Good Institute, and the University Libraries Award for Outstanding Gemstone Team. Finally, we wish to express our heartfelt appreciation to our families, whose unwavering support and encouragement have been fundamental to our success.

GAHSP: Fairness Need Not Reduce Accuracy: Mitigating Racial Bias in Predictive Policing

Research Team

Aaron Lin, Computer Science
Alex Chen, Computer Science; Statistics minor
Allen Du, Computer Science
Andrea Eichstadt, Psychology
Coley Samuels, Psychology
Grace Tao, Computer Science, Mathematics
Trina Arellano, Computer Science
Rios Versace, Sociology
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Faculty Mentor

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Discussants

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Dr. Maksym Morawski, Lecturer, *Computer Science, UMD*
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Research Description

Hot spots policing—the allocation of police resources toward high-crime areas—has been revolutionized by machine learning. Instead of relying on historical crime hot spots, predictive policing algorithms allow departments to allocate officers to where crime is expected to occur next. This has led to their increasing adoption by especially large police departments, as well as modest reductions in crime. However, predictive policing algorithms have thus been shown to exhibit similar biases to traditional policing methods. A vast literature has shown that nonwhite areas are more frequently policed, and that laws are disproportionately enforced against nonwhites in these communities. This creates a problem for predictive policing; since these algorithms are trained on historical crime data which reflects these racial biases, predictions come to perpetuate racial bias into the future. As such, our team has built a new predictive algorithm which not only uses more contemporary machine learning techniques, but directly accounts for demographic fairness in its predictive judgments. Using real crime data, we then tested our model against PredPol, a state-of-the-art predictive policing software, comparing them on predictive accuracy and on racial bias in their predictions. Our results showed that our model outperformed PredPol in both predictive accuracy and fairness, demonstrating that it is possible to make policing more equitable without sacrificing the predictive accuracy of these algorithms.

Acknowledgements

We would like to give a very special thank you to our mentor Mohammad Hajiaghayi and our librarian Celina McDonald. This project would not have been possible without their guidance and support.
We would like to further thank director David Lovell and associate director Allison Lansverk. Their leadership in the Gemstone program has kept our team on track and ready for each project milestone.

SUPA'HOT: Characterizing Firebrand Motion with Optical Methods: Design and Testing of a Device for Deployment on Unmanned Aerial Vehicles

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Research Description

Wildfires have posed an increasing threat to ecosystems, communities, and infrastructure, exacerbated by climate change and expanding wildland-urban interfaces. One of the most significant yet poorly understood mechanisms of wildfire spread has been firebrand transport—burning embers lofted by convection currents that ignite new fires miles away from the main blaze. Understanding firebrand behavior has been crucial for improving fire spread models and informing mitigation strategies. In this research project, we aimed to develop a stereovision camera system designed for future deployment on unmanned aerial vehicles (UAVs) to track firebrand release and travel dynamics. Although similar systems have been developed for stationary ground use, the future integration of the system with a UAV would allow for quick data collection at any altitude or front of the fire. Our stereovision system utilized high-resolution, synchronized cameras to capture 3D trajectories of firebrands, enabling possible estimation of their velocities, lifespans, and dispersal patterns. By leveraging UAV-based sensing, our system enabled safer and more comprehensive data collection in hazardous wildfire conditions. The insights gained from our research improved wildfire spread forecasting and informed defensible space guidelines. Ultimately, our project is an important step in the development of more effective wildfire management strategies in the face of increasing risk.

Acknowledgements

Team SUPA' HOT would first like to thank our mentor Dr. Fernando Raffan-Montoya for his continued support, mentorship, and technical expertise throughout our project. His guidance was essential to our team's success and direction. We want to thank Adetola Koiki for her support in the testing setup of our firebrand characterization device and collaborative efforts in understanding stereovision applications with firebrands. We would also like to thank Dr. Arnaud Trouvé for his advice and guidance in the early stages of our project. Our thanks also go to the members of the thesis defense panel for generously dedicating their time to delve into our research and providing constructive feedback. Lastly, we would like to thank the Gemstone Program staff for their constant support over our four years in the program as well as our LaunchUMD donors who aided our project financially.

SCOOT: Improving the Accessibility of Micromobility: Intelligent Power Assist

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Research Description

Team SCOOT innovated micro-mobility technology with a novel kick-assist feature to enhance mobility for those with physical impairments. SCOOT technology was aimed to tackle the challenges of maneuvering rough terrain and inclines, which are issues prevalent in current devices as revealed by stakeholder interviews. These interviews also revealed that users struggle with comfort, stability, and durability in existing models, which are areas we are determined to improve within the project. Starting with the SuperHandy seated hoveround for its motorized wheel, we integrated a motor controller for precise movement control. Afterwards, SCOOT transitioned our technology to a knee scooter, making it more accessible and user-friendly. A knee scooter with integrated kick-assist will benefit the user by reducing the effort that needs to be exerted. By utilizing user testimonials as a foundation, SCOOT did not just create a device, but redefined mobility for the impaired and tackled one of the largest gaps in micro-mobility research.

Acknowledgements

Team SCOOT would like to extend our gratitude to our mentor, Dr. Paley, for guiding us through this project, and providing us with invaluable knowledge and resources. Thank you to the Maryland Robotics Center and Dr. Ivan Penskiy for the use of our lab space in the IDEA Factory on campus. We would also like to thank our discussants, librarians, and everyone else who contributed their expertise

and feedback to our project. We are incredibly grateful to the Gemstone Honors Program for providing us with the opportunity to participate in undergraduate research, and the staff for their continued support throughout the past four years.

SUPERBUG: Using CRISPR-Cas9 to modify gyrA to remove Nalidixic Acid resistance in clinically important pathogens

Research Team

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Dr. Steve Mount, Associate Professor, *Cell Biology and Molecular Genetics, UMD*
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Research Description

Diseases caused by drug resistant bacteria are one of the leading causes of death in the United States, and they are becoming a pressing public health concern due to the lack of new antibiotics and the evolution of multidrug resistance. Drug resistance is an inequitable quandary, disproportionately affecting minorities and people of lower socio-economic status. Resistance can be either chromosomal or plasmid-mediated. CRISPR-Cas9 gene editing has been shown in recent studies to successfully edit resistance genes to increase susceptibility to antibiotics. In the current study, we used bioinformatic analysis to design a CRISPR-Cas9 construct that could revert gyrA mediated nalidixic-acid resistance in Escherichia coli, resulting in cells sensitive to antibiotics. The overall goal was to assemble the necessary sequences into a single plasmid using a variety of molecular techniques. We constructed a series of gyrA point mutations at codon 87, and planned to target this sequence. We chose this system to test proof of principle due to the implications towards treatment of nalidixic acid resistant Escherichia coli urinary tract infections in women, which are a growing problem in the clinical realm. The following thesis describes the progress made towards building, transforming, and testing this construct.

Acknowledgements

We would like to thank our faculty mentor, Dr. Daniel Stein; our team librarian, Ms. Nedelina Tchangalova; and the Gemstone Program staff for their guidance and support throughout our research.

You are cordially invited to attend the

Gemstone Citation & Awards Ceremony

Monday, May 19, 2025 at 6:00 p.m. ET
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Please RSVP at https://go.umd.edu/gemscitation2025
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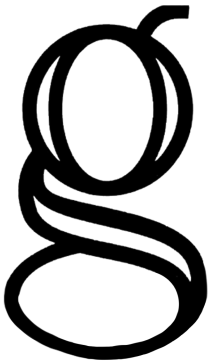

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