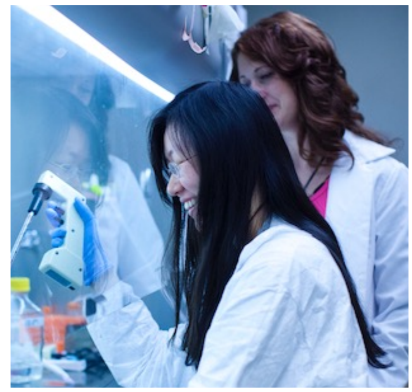
10th Annual
SUMMER RESEARCH SYMPOSIUM



Ten years of undergraduate research excellence and community engagement

UROC Undergraduate Research Opportunities Center
UC MERCED

Welcome Keynote: 8:30AM in Classroom & Office Building (COB 1) Room 120
Oral Presentations: 9:00AM - 3:00PM in Classroom & Office Building (COB 1), 2nd Floor
Poster Sessions: 11:30AM - 1:30PM in Kolligian Library Lantern (KL 155)

Sponsored by the Undergraduate Research Opportunities Center

A special thank you to all our partners that contributed to making the 2016 UROC Summer Undergraduate Research Institute possible:

UC LEADS
UNIVERSITY OF CALIFORNIA
LEADERSHIP EXCELLENCE THROUGH ADVANCED DEGREES PROGRAM

LOUIS STOKES CAMP
CALIFORNIA ALLIANCE for MINORITY PARTICIPATION
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UNDERGRADUATE STUDENT TRAINING IN ACADEMIC RESEARCH

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Accelerated STEM Pathways through Internships, Research, Engagement, and Support

Applications in Modern Materials
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MACES
MERCED NANOMATERIALS CENTER FOR ENERGY AND SENSING

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TENTH ANNUAL

UCMERCED

UNDERGRADUATE SUMMER RESEARCH SYMPOSIUM

AUGUST 5, 2016

UNIVERSITY OF CALIFORNIA

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MERCED, CA 95343
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THE OFFICE OF UNDERGRADUATE EDUCATION

August 2016

Dear Symposium Participants,

Welcome to UC Merced and the 10th Annual UROC Undergraduate Summer Research Symposium! We are so pleased you have joined us on this important anniversary, and we are proud to say the Symposium has grown from 5 presenters in summer 2006 to more than 80 this summer - amazing progress in just ten years.

The UROC Undergraduate Summer Research Symposium was developed to provide an opportunity for undergraduate students from the Central San Joaquin Valley and beyond to showcase their research in a professional setting. In addition, the Symposium lets faculty and members of the public engage with the valuable, high-quality research being conducted by emerging scholars.

Over the past 10 years, UC Merced's undergraduate research training programs, including UC Leadership Excellence through Advanced Degrees (UC LEADS), the Louis Stokes California Alliance for Minority Participation (NSF CAMP), and Maximizing Access to Research Careers (NIH MARC), have mentored hundreds of students, preparing them for graduate study through in-depth experiential learning and encouraging them to consider a broad range of career options in the academy, industry, government, and community-based organizations. The Undergraduate Summer Research Symposium is an important element of those programs.

Student Scholars, this event offers all of us the opportunity to share the excitement of your research and to encourage you to continue to work toward your goals. The fact that you are part of the Symposium means you have tremendous potential to make important contributions to the global scientific community.

Faculty Mentors, thank you for your participation and support. The Undergraduate Summer Research Symposium would not exist without your engagement and willingness to give generously of your time and energy. More important, you are making a difference in the lives of developing scholars.

UC Merced is very proud to host this event and we appreciate the opportunity to share our beautiful campus with you. We hope the Symposium is both fun and inspiring, and we wish our Scholars continued success in pursuing their academic goals.

Sincerely,

Elizabeth J. Whitt
Vice Provost and Dean for Undergraduate Education
Professor, Sociology

Ten Years of Undergraduate Research Excellence

The Undergraduate Research Opportunities Center (UROC) was established in the 2013-14 academic year, but its roots can be traced back to 2005. Back then, UROC was simply a desk at the McNair Scholars office in the Kolligian Library building. In the early days, UC Merced fostered the research engagement of a small cohort of students to participate in nationally recognized programs such as the National Science Foundation's Alliance for Graduate Education and the Proffesoriate (NSF AGEP) and the US Deparment of Education's Ronald E. McNair Postbaccalaureate Achievement Program (McNair Scholars). Each of these programs showed early signs of success in preparing students for their next journey in life. They provided students at our campus the opportunity to dream big and achieve new milestones, such as having our first Bobcat accepted to medical school, our first Ph.D. at Harvard, our first Ford Foundation Fellowship recipient and our first entrepreneur who started their own education focused company.

These programs continued to thrive, but each one relied on different pockets of money, coming from different sources, and managed by different people. To address these challenges, UROC was established, with a mission of encouraging and facilitating faculty-mentored undergraduate research projects across all schools and academic disciplines. Over the course of its life, UROC has implemented a variety of new initiatives designed to strengthen the recruitment, retention and graduation of undergraduate students, especially first-generation and underrepresented minority students. To date, UROC has mentored over 300 students, increasing the rate at which UC Merced undergraduate students are applying and enrolling in doctoral programs across the nation. We hope the future brings us continued momentum to be able to expand our programs' scope and engage even more students than we have in our first ten years.

First Lady Michelle Obama with UC Merced McNair Scholars and other graduates of the Class of 2009.

A History of Achievements

Over the years, UROC has nurtured many motivated students who want to prepare for and excel in graduate school. UROC Scholars take their academic work seriously, work hard to maintain good grades, and are actively engaged in faculty-mentored research opportunities. This last component is central to UROC's recipe for success: each student is paired with one faculty mentor that provides direct guidance and mentorship. The one-on-one approach is more akin to consulting or coaching than it is to typical research advising. UROC is not a mere program for research internships, it is a bootcamp for high-achieving scholars. Reflecting on ten years of research excellence, below are some of their personal stories.

Kristal Cunningham, Materials Science Engineering
CAMP Program, 2013 Cohort

"UROC mentors are relentless when it comes to ensuring their scholars have the tools they need to get to the next level in their career."

Kristal Cunningham participated in both the PG&E Engineering Summer Scholars Program and the CAMP Program as a member of the UROC community. She is currently a third year Ph.D. candidate, studying Materials Science and Engineering at the University of California, Los Angeles and is a recipient of the prestigious LSAMP Bridge to the Doctorate Fellowship. In Krystal's own words, her path to graduate school "would not have been possible without UROC. In preparing me for graduate school, not only did UROC provide me with research experience, but I was also able to gain access to GRE classes and workshops to prepare for the graduate school application process." Her work focuses on reverse-engineering ancient materials to understand the properties, production, history and identify geographical origin. Her project revolves around a blue cobalt pigment (Co-Al) used in antiquity and exploration of its properties to inspire new materials for modern applications in the aerospace industry. Krystal's advice to current and future UROC scholars is simply "anything is possible". She recalls, "Before UROC, graduate school seemed very unattainable. But UROC provided me with support, guidance and opportunities which shaped my outlook on possibilities. I would have never imagined that I would be in a PhD program at UCLA, but I am. This past spring, I was studying for my preliminary exams and I kept thinking 'I'm not supposed to be here' but upon passing my preliminary exams that advanced me to a PhD candidate, all I could think of was everyone who helped me get to that point, and UROC was one of them."

Sarah Sanders, Psychology
McNair Scholars Program, 2011 Cohort

"I would not have earned my master's degree and currently be in a doctoral program, had it not been for the McNair Scholars Program and UROC."

Sarah Sanders joined the UC Merced McNair Scholars Program, with a clear goal of pursuing a career in Mental Health Sciences. She is currently a fourth-year Ph.D. candidate in the University of Akron's Collaborative Program in Counseling Psychology, an MA/PhD Program, and she earned a Master's degree in August 2015. Like many UROC students, Sarah grew up in the Central San Joaquin Valley and is the first-generation in her family to attend college. She believes that her involvement in the UROC community not only prepared her to become a competitive applicant for graduate school, but also "prepared me mentally for the challenge of adjusting to graduate school through both professional development seminars and personal relationships with mentors". The most rewarding aspects of her doctoral program are being able to provide personal and career counseling to individuals. Her current research explores the perceptions of body image among Mexican American women, and PTSD assessment with survivors of domestic violence. This fall she will start a practicum in neuropsychological assessment at a local children's hospital. Her advice to students is to "Take every opportunity you can even if it means stepping out of your comfort zone. Whether it is approaching a potential mentor to join their projects, forming a GRE study group, exchanging and editing personal statements with peers, or volunteering for a group in your interest area".

Fredy Cisneros, Mechanical Engineering
USDA Scholars Program, 2013 Cohort

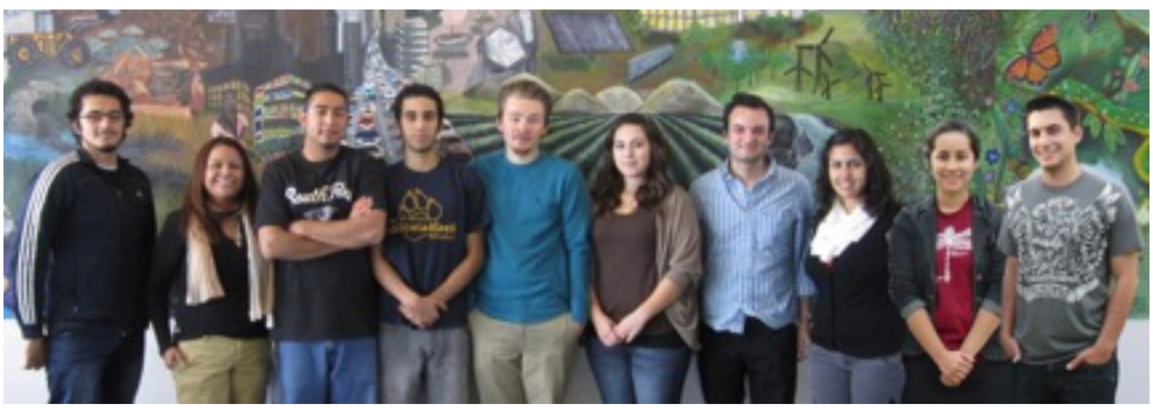
"UROC helped me gain technical experience through research. This was critical because employers these days seek well-rounded, experienced candidates."

Freddy Cisneros participated in both the USDA and CAMP Scholars programs through UROC. He is currently employed at the US Department of Energy's Sandia National Laboratories and is a recipient of Sandia's Masters Fellowship Program. The fellowship covers his ongoing graduate studies in Mechanical and Aerospace Engineering at UC Davis and guarantees a research position upon completion. Since first joining UROC, Fredy was focused on joining the research workforce and embarked on advanced training to achieve his dream. His advice to current and future scholars is to, "…keep working hard in their relative field because your hard work really does pay off in the long run" and his personal history certainly proves that point.

A Bright Future Ahead

The story of UROC has been one of hard work and astounding success. Earlier this year Yuriana Aguilar, a UROC alumnus, was the first undocumented student to obtain a Ph.D. at UC Merced. She is continuing her journey as a postdoctoral fellow in cardiovascular research at Rush University in Chicago, Illinois. Her dream is to become a professor and researcher and develop new technologies to aid in the treatment and prevention of heart conditions. Her story mirrors that of UROC; perseverance over adversity and a dedication to helping underserved communities.

We envision UROC's influence growing beyond the limits of the UC Merced campus. In the coming years, we hope to develop tools and resources for students to actively engage with neighboring communities through the transfer of knowledge, conducting research, and fostering learning. UROC Scholars will continue to be UC Merced's ambassadors to the Central Valley, strengthening relations and establishing connections to encourage the next generation of scholars. We also see a future in which UROC expands to include students outside of UC Merced, creating opportunities for high school and expanding those for community college students. Ten years from now, our vision is that UROC will become a hub for learning, mentoring, and research for all undergraduate students in the Central San Joaquin Valley. These success stories are a testament to the impact UROC has had in creating opportunities for students to grow.



UC LEADS Scholars 2009-10 Cohort *(From Left to Right)*
Juan Lopez Arriaza: Currently Postdoc at NOAA SWFSC; Completed PhD in Applied Mathematics and Statistics, UC Santa Cruz; NSF GRFP Fellow, NSF GROA Recipient and Eugene Cota-Robles Fellow
Janna Rodriguez: PhD Candidate in Mechanical Engineering, Stanford University; Entrepreneur and Inventor; National Ford Foundation Fellow; NSF GRFP Fellow
Josue Lopez: Manufacturing Engineer, Jennings Technologies; MS in Aerospace Engineering, San Jose State University
Adrian Garcia: PhD Candidate in Materials Engineering, UC Irvine; NSF GRFP Fellow
David Larson: PhD Student in Mechanical and Aerospace Engineering, UC San Diego
Desiree Sigala: PhD Student in Nutritional Biology, UC Davis
Norma Cardona: Program Manager, Merced Union High School District; Master's of Arts in Public Administration, CSU Stanislaus
Jesse Anaya: Program Coordinator, Redwood Community Health Coalition
Yuriana Aguilar: Currently Postdoc at Rush University; Completed PhD in Quantitative and Systems Biology, UC Merced
Aaron Ortiz: Physical Therapist, AccentCare Inc.; Completed Doctorate of Physical Therapy, UC San Francisco

UC Leadership Excellence Through Advanced Degrees (UC LEADS)

The following student scholars are part of UC Merced's Leadership Excellence through Advanced Degrees (LEADS) Program. The goal of the UC LEADS research and graduate preparation program is to educate California's future leaders by preparing promising students for advanced education in science, technology, engineering and math (STEM) fields. The program is designed to identify upper-division undergraduate students with the potential to succeed in these disciplines, but who have experienced situations or conditions that have adversely affected advancement in their fields of study.

For more information, please visit http://uroc.ucmerced.edu/uc-leads

Population Structure and local adaptation through the X chromosome

Jesus Campos Gatica, Emilia Huerta-Sanchez, PhD
School of Natural Sciences, University of California, Merced.

Interest in human evolutionary biology, is the understanding of natural selection and demographic history's influence on DNA sequence variation in humans. We will investigate how selective pressures and demographic factors have affected the observed genetic variation on the X chromosome. Most of what we know about population genetic analysis involves autosomes; this is because both males and females possess the same number of autosomal chromosomes. Through the usage of public data sets provided by the 1000 Genomes Project we will run different analysis, through which we will be able to observe any similar population structure between the X chromosome and the autosomes. In the investigation signals of local adaptation in the X chromosome will make it possible to understand what genetic phenotype they are responsible for in terms of genetic variation. We hypothesize to be able to obtain the same levels of population structure observed in the autosomes with the X chromosome. Moreover, study of the X chromosome may reveal the genomic signatures of recessive deleterious mutations, undergoing strong negative selection, that are a significant component of inherited human disease.

Thermal Management System for Lithium-Ion Batteries in Vehicles Using Minichannel Tubes

Ebelin Hernandez, Ahmed A. Merrouni, Trenton Berner, Juan Rodriguez, Stephen Chan, and Angel Sepulveda,Yanbao Ma, PhD
School of Engineering, University of California, Merced.

Thermal management for lithium-ion batteries in electric vehicles (EVs) and hybrid electric vehicles (HEVs) is required for optimal performance. In extreme climates, electrode degradation affect the reliability and performance of the Li-ion batteries. Current thermal management consist of air cooling due to its simple design, low cost, and maintenance control. The issue with air cooling systems is its sensitivity to temperature. Air cooling may not be sufficient enough to cool or heat the Li-ion batteries at a desirable temperature range. The objective of this study is to design, develop and test a new cost efficient, compact thermal management system using aluminum minichannel tubes. The setup utilizes an active, parallel, liquid cooling thermal management system. This is done so by connecting four aluminum minichannels (137×20×2 mm) to two cylindrical metal tubes, one on each side. The metal tubes are thus connected in parallel along a plastic tube. A pump is used to circulate liquid coolant throughout the system. The first set of results concluded in an ambient temperature of 45°C. The developed thermal management system by aluminum minichannel tubes was capable to keep the battery's average temperature in the optimal operating range (below 35°C). Furthermore, the current thermal management system is compact and cost effective, however, further developments are under- study in order to adapt it with various battery sizes.

Micro-Patterning Lipid Bilayers on Paper

Victor Hernandez, Anand B. Subramaniam, PhD
School of Engineering, University of California, Merced.

Cellulose is an abundant natural and sustainable resource that is of great interest in the research community due to its versatility and biocompatibility. The purpose of this project it to demonstrate this versatility at the microscale by depositing lipid membranes. A nanopaper substrate was used to support the lipid membrane. We use microcontact printing from poly(dimethyl)siloxane stamps to deposit circular and line features from 5mg/mL of the lipid mixture dioleoylphosphatidylcholine:TopFlour cholesterol at 99:1 mole percent. We were able to transfer features of about 40-80 micrometers onto the nanopaper surface. To test for the presence of the bilayer, we conducted fluorescence recovery after photopbleaching (FRAP) to measure the mobility of the transferred lipid film. In some cases, we observed recovery after photobleaching, which confirmed that a bilayer or monolayer was formed. The majority of our experiments however showed no recovery which suggests that a continuous bilayer was not formed on the paper surface. Further optimization was needed to demonstrate that nanofibrillated cellulose can be used with lipids for bio-medical application and biomaterials research.

A Population Genetic Analysis of Variation in the X Chromosome

Lesly Lopez, Emilia Huerta-Sanchez, PhD
School of Natural Science, University of California, Merced.

A key focus in human evolutionary biology is understanding the effects of natural selection and demographic history on DNA sequence variation. While previous studies emphasize autosomal chromosomes, we will investigate the sex chromosome using the public data sets from 1000 Genomes Project. Specifically, we will test whether we observe similar levels of population structure in the X chromosome and the autosomes. Using X-chromosomes, we expect to recapitulate the same levels of population structure observed in the autosomes. In other species, differences between males and females have been reported. To date, no genetic differences between males and females have been observed in humans. Here, we will examine whether there are any apparent differences in the X chromosome of females and males. Finally, we will look for signals of local adaptation on the X chromosome. Through comparisons of the X chromosome with the autosomes, we can better discern how population genetic processes have influenced human genetic variation. Moreover, study of the X chromosome may reveal the genomic signatures of recessive deleterious mutations, undergoing strong negative selection, that are a significant component of inherited human disease.

Preliminary design for an Acrylic Based Microfluidic PoC device

Jesus Partida, Anand Bala Subramanian, PhD
School of Engineering, University of California, Merced.

Point-of-Care (POC) diagnostics is a recent field which has emerged in order to address the lack of affordable healthcare in most third world countries. The goal of this project is to fabricate a prototype of a module of a microfluidics based POC device to be used to test individuals for up to eight different diseases. This would allow for individuals who live in areas where who lack medical professionals to have a better prognosis. The device was fabricated by using a Polydimethylsiloxane (PDMS) base molded by an acrylic piece and adhered to a glass slide via plasma treatment. Testing was done by running fluid through the channels with a syringe pump and seeing if fluid would flow through it evenly with no leaks. Preliminary results are expected to yield equal fluid flow through all of the channels with no leakage due to the vacuum seal created from adhering the PDMS to glass. These preliminary results should show that this model should be an effective prototype to improve on and conduct even more quantitative testing with the end result being incorporated into a final product. This project will further add to the advancements and applications within the field of both POC devices and microfluidics.

Tribology, Lubricant Performance and Additive Effectiveness

Daniel Sanchez Garrido, Ashlie Martini, PhD
School of Engineering, University of California, Merced.

Mechanical component systems require lubricants to meet or exceed rigorous industry standards in order to achieve energy efficiency. Lubricant performance is defined by its ability to maintain lubricating properties under various conditions and environments. Fully formulated oil is a lubricant that consists of base oil mixed with additives such as a Detergent Inhibitor (DI) Package and Viscosity Index (VI) Improver. The DI contains several chemicals, including a foam inhibitor to help control the formation of foam and VI to maintain acceptable viscosity index. Furthermore, lubricants are filtered in an attempt to achieve acceptable levels of cleanliness. However, they cannot be filtered too much as it could undesirably filter out additives. The goal of this study is to optimize the formulation of base oil, additives and filtration cycles in order to pin point the optimal performance conditions for fully formulated oil. Testing was performed to analyze the lubricant performance via a custom-built blending and filtration station. Additives such as the DI and VI packages were found to enhance the properties of the base oil. Lubricants with high performance levels will improve mechanical energy efficiency by reducing friction and component wear. In essence, the incorporation of additives along with an ideal number of filtration cycles will enable optimization of both the effectiveness and performance of fully formulated oil. Hence, this work contributes to mechanical engineering by addressing the issue of energy inefficiency due to friction and lack of lubrication.

Continuous Model of Penguin Huddle Dynamics

Tanya Tafolla and Francois Blanchette, PhD
School of Natural Sciences, University of California, Merced.

Penguins in Antarctica huddle during severe windy weather in order to preserve energy. In order to understand how they manage to survive the harsh conditions, we describe a mathematical model for the huddles to represent the heat flux as a continuous function. In order to obtain the flux, we have to calculated the wind around the huddle and how the heat distributes. The wind distribution is obtained through complex mapping. Once our domain is simplified, we map the outside of our domain to the inside in order to have a finite area or the wind distribution. Having a finite area will be practical for numerical techniques because the temperature inside the disk is solved numerically using spectral methods. From the temperature profile, the flux is obtained at every point. Thus, we can start deforming the huddle boundary with the velocity proportional to the heat flux in an area preserving manner. Once we have a new position of the huddle, we can iterate the position to continue the next evolution in time. Our model will contribute to the fundamental understanding of penguins.

California Alliance for Minority Participation (CAMP)

The following student scholars are participants in UC Merced's CAMP program. The Louis Stokes California Alliance for Minority Participation (CAMP) in Science, Technology, Engineering and Math, is a statewide initiative funded by the National Science Foundation (NSF) to strengthen the quality and quantity of underrepresented students receiving baccalaureate degrees in science, technology, engineering and mathematics studies at the University of California (UC). CAMP offers extensive resources and unique opportunities for students to excel in their respective fields of study. The CAMP program began at UC Irvine in 1991; currently, nine UC campuses participate in the program.

For more information, please visit http://uroc.ucmerced.edu/camp

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Function-Based Identification of Secondary Metabolite Producers with the use of a Metabolic Probe

Cecilya Barba,[1] Devin Doud[2], and Tanja Woyke, PhD[2]
School of Natural Sciences, University of California, Merced.[1]
Microbial Genomics Program, DOE Joint Genome Institute.[2]

Bacterial secondary metabolites are of great significance to humans since they are the source of the antibiotics we use daily to fight bacterial infections. One challenge that we face is the emergence of multi-drug resistant bacteria, mainly due to improper and widespread use of antibiotics. This phenomenon poses a threat to human health as bacterial resistances are developing faster than discovery of new antibiotics. However, a potentially large reserve of novel secondary metabolites has remained obscured within uncultivated microorganisms. This is because many of these organisms have not been screened for their ability to produce secondary metabolites due to our inability to isolate and characterize them in the lab. Using flow cytometry, we aimed to create a cultivation-independent function-based method to fluorescently identify and sort microorganisms that might be producing secondary metabolites. Following sorting, the genomes from these microorganisms can then be analyzed using single cell genomics. To identify secondary metabolite producers, we applied a fluorescent vitamin analog probe to specifically label a catalytic domain in the non-ribosomal peptide synthase (NRPS). NRPSs' are common cellular machinery for the production of secondary metabolites in bacteria. Using Photorhabdus luminescens and Escherichia coli, we demonstrated that only active secondary metabolite production results in a detectable increase in cell fluorescence by integration of the probe. Future application of this method could result in the identification of uncultivated, and potentially novel, secondary metabolite producers in the environment.

Benzylation of Heterocyclic Compounds via a Radical Process

Ramiro Barraza, David Delgadillo, Peter Mai, PhD and Ryan Baxter, PhD
School of Natural Sciences, University of California, Merced.

Heterocycles are key building blocks for the synthesis and development of novel pharmaceuticals. The synthesis of these biologically active molecules and their analogs often require costly multi-step sequences. In our lab, we have developed a method for the benzylation of heterocyclic compounds via a single step radical process. An iron(II) catalyst and persulfate oxidant generate the benzyl radical, which readily adds into various heterocycles. This reaction is run under an oxygen atmosphere providing a mild and direct way of benzylating heterocycles.

Thermal Management of Micro-/Nanoelectronics and Energy Storage Systems

Trenton Berner, Ahmed Alami Merrouni, Angel Moran Sepulveda Junior II, Ebelin Hernandez, Juan Rodriguez, and Stephen Chan, Yanbao Ma, PhD
School of Engineering, University of California, Merced.

Depleting sources of fossil fuels and high levels of air pollution increase the need for alternative clean energy. Electric vehicles (EVs) are environmentally friendly sources of transportation. They use the electricity stored in lithium ion batteries as fuel and they produce zero toxic emissions. However, the safety, performance and lifetime of lithium ion batteries are heavily dependent on their thermal management systems (TMSs). TMSs regulate the operation and storage temperatures of lithium ion cells, commonly through air cooling. Air cooling TMSs are cost-effective and compact systems, however, lithium ion cells degrade when their temperatures exceed 50 °C. This research involves designing and testing a cost-effective active liquid TMS, utilizing multichannel pipes to efficiently cool lithium ion battery cells while maintaining a compact mechanical structure. The design consists of four aluminum multichannel pipes connected to an aluminum pipe at each of the ends, having a parallel input and output for each cell, taking the shape of a latter. With the distribution of four multichannel pipes on the front and rear face of each cell, the temperature of the battery is expected to remain between 15 °C and 35 °C for optimum performance. Introduction of this affordable yet efficient TMS design that preserves the performance and lifetime of lithium ion cells will positively impact the EV industry.

An Interactive and Programmable 3D Educational Presentation System

David Cabral, Renato Farias, MD, and Marcelo Kallmann, PhD
School of Engineering, University of California, Merced.

The universe can be perplexing to contemplate over and having an interactive tool as a presentation for a solar system can help people gain a better idea of how planets can interact with each other. The presentation tool can be helpful for learning about basic planet interaction because of the it's interactive capabilities; such as being able to put in your own solar system models to see what orbits can occur in that solar system. Presenting a solar system with orbiting planets was accomplished with the use of physics equations relating to orbits and utilizing transformation matrices to have the planets moving. Knowledge of transformation matrices and tools in OpenGL and Free Glut were used to build the code for the presentation tool. As my code for the presentation tool is finished, it could receive data in a certain format and it can output a presentation of a solar system. After a person is done conducting their own questions in the presentation tool, it can prove to be an effective learning tool on planet interaction by answering people's questions on how planets can interact in certain scenarios.

Experimental Evaluation of MongoDB on the TPC-H Benchmark

Alexander Crosdale, and Florin Rusu, PhD
School of Engineering, University of California, Merced.

Relational databases – once highly prized for their quering capabilities and transaction management – are now being supersede by a new paradigm, NoSQL (Not Only SQL), that targets their shortcomings of scalability and big data performance issues. The most popular NoSQL representatives are MongoDB and Cassandra, open-source projects with strong enterprise support. TPC-H (Transaction Processing Performance Council- Ad-hoc), the de facto decision support benchmark system for business analytics, was used to determine the viability of MongoDB. The TPC-H schema was mapped to the MongoDB schema-less representation and the 22 TPC-H queries are written in the MongoDB query language. Several configurations are investigated, both for schema representation as well as for the queries. For schema representation the configurations that were considered were a fully denormalized (embedded) model and a fully normalized (referenced) model. MongoDB was compared against Cassandra – the other popular NoSQL database – and SQLite, the most popular embedded relational database. The results reveal that using the denormalized model for mongoDB yielded greater flexibility in querying because the queries were ran against a single collection. MongoDB performed effectively with moderate amount of data, but as documents in the collection increased in size complications will arise. In conclusion, Cassandra proved to be the better database due to the fact that it was more scalable than MongoDB, and its consistency and

The Effects of Additives on the Formation of Foam in Lubricating Oils

Jorge De Haro, and Ashlie Martini, PhD
School of Engineering, University of California, Merced.

The tendency of foam to develop within a lubricating oil leads to degraded lubricating properties and an overall increase in energy losses. In an effort to develop energy efficient mechanical and hydraulic systems, it is imperative to reduce the amount of foam which develops within a lubricating oil without dissipating other lubricating properties. Such lubricating oils must meet industry standards for foam and cleanliness and are formulated by mixing additives such as foam inhibitors, detergent inhibitors, and viscosity index improvers with a base oil in a custom-built blending station equipped with a light-based particle counter and a filter. Since the additives are seen as contaminants by the particle counter, the lubricant passes through the filter so that it meets stringent cleanliness standards. However, filtration removes additives, resulting in an increase in the tendency of foam development. To determine whether the filtered formulation meets foam standards, samples are pulled from the blending station at various filter passes. The samples are then foam tested, which includes pumping air into a measured amount of oil through a diffusing stone and measuring the height of the foam that forms as well as the time it takes for the foam to collapse. In order to meet both standards for different formulations of base oil and additives, different combinations of filter passes and weight percentages of the additive(s) are tested.

Generation of homozygous deletion strains of select genes in Candida albicans and exploration of their roles in response to host mucin

Jose Delgado, Megha Gulati, PhD, and Clarissa J. Nobile, PhD
School of Natural Sciences, University of California, Merced.

C. albicans is a member of the normal human microbiota and resides asymptomatically at different mucosal surfaces in the body. A change in the microbiota, such as from the use of antibiotics, or by host immune compromisation, can allow C. albicans to proliferate and cause infection. One of the major virulence traits of C. albicans is its ability to form biofilms, dense communities of microorganisms that are adhered to a surface and are resistant to antimicrobial agents. All wet epithelial surfaces of the human body are lined with mucus, whose main glycoprotein is mucin. Host mucins are known to suppress filamentation and biofilm formation in C. albicans. We recently performed an RNA-seq experiment to compare the transcriptional profile of C. albicans in the presence and absence of mucin. Genes that were most highly upregulated or downregulated were selected as candidates for gene knockouts. As C. albicans is a diploid fungus, homozygous deletion strains are being generated to knockout both alleles of the gene of interest. The roles of these genes in response to mucin will be evaluated by growing the C. albicans mutant strains in the presence and absence of mucin. Further, these strains will be tested for their abilities to form biofilms and for virulence in animal models of infection. This work will provide the first mechanistic insight into how C. albicans responds to host mucin.

Designing a Silk-based Sustained Release Delivery System for Small Molecule Anti HIV Drugs

Jocelyne Fadiga, Li Zhang, PhD, and Patricia LiWang, PhD
School of Natural Sciences, University of California, Merced.

Over 28 million of people living with HIV in sub-Saharan Africa account for 66% of worldwide HIV infection. Several inhibitors synthesized show promise as microbicides, which can be topically applied by users to prevent sexual transmission of HIV. However, transport to tropical regions and adherence to therapy still constitute major drawbacks to constraining the disease progression. Strict and consistent adherence to antiretroviral therapy (ART) is critical for suppressing disease, improving quality of life and allowing patient survival. For many viral infections that cause serious and chronic diseases such as HIV infection, lack of adherence may lead to emergence of drug resistance in patients, loss of virologic control, and even death. It has recently been recognized that many people are not able to adhere to a strict daily regimen for prevention, necessitating the development of a sustained release strategy. We selected sunset yellow as a proxy for the Non Reverse Transcriptase Inhibitor (NRTI) Tenofovir, a FDA-approved inhibitor of the enzymatic action of HIV reverse transcriptase. Using this model, a silk-based system was developed to continually release the dye over the course of several days. Silk fibroin was extracted from silk cocoons, solubilized in LiBr and dialyzed. Aliquots of the silk solution were mixed with determined quantities of dye and water, plated on 24-well plates, lyophilized, water-vapor annealed for optimized periods of time and dried at 37°C. The release was tested and measured by spectrophotometry. Progress made on silk-based

Understanding Oral Health in Merced County

Kesia Garibay, and Mariaelena Gonzalez, PhD
School of Social Sciences, University of California, Merced.

Oral health is a neglected Public Health concern, and poor oral health can affect one's overall health, as research shows periodontal disease is linked to systemic diseases. Understanding oral health practices and access to care is particularly important in rural and minority communities, because these communities experience disproportionate exposure to oral health risk factors, and access to oral health-care is often limited. The purpose of this study was to examine oral health in Merced County. Preliminary results are presented here. 240 adult participants were recruited from 4 sites in Merced County. Participants were given a self-administered surveys containing questions on self-care, access to care, and oral health symptoms. The majority of the survey respondents were female, Latino, and had not receive a college degree. The majority of respondents reported brushing their teeth at least once a day, but reported they had not flossed more than twice in the last seven days. About 40% of the respondents had not been to the dentist within the last year, and 31.4% reported they had needed oral health care, but could not get it. 22% of the participants reported bleeding gums, and 13% reported current toothache pain. A significant amount of our sample reported early symptoms of gingivitis, tooth decay/sensitivity and a lack of access to care. Interventions regarding oral health preventative care and expansion of access to oral health care is needed in Merced County.

Metabolic Engineering of Yeast for Terpenoid Production, Eucalyptus Terpenoid Atlas Project

Rodrigo Garcia,[1] Yasuo Yoshikuni[2], PhD and Jing Ke,[2] PhD
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Terpenoids are naturally produced by many plants and microorganisms from (isopentyl pyrophosphate) IPP and (dimethylallyl pyrophosphate) DMAPP in the mevalonate pathway. The two precursors make up a terpenoid family consisting of over 55,000 compounds, traditionally used as fragrances, insecticides and pharmaceuticals. These molecules have shown to be important precursors for many antibiotics and biofuels. Conventional terpenoid extraction methods present low yields for a high cost, however through metabolic engineering of this biochemical pathway in model organisms the optimization of terpenoids has been achieved. Through Gibson Assembly cloning and CRISPR/Cas9 technology, genes of Eucalyptus grandis were transformed into competent cells of S. Cerevisiae. Through the addition of galactose and CuSO4, as inducers in the pathway, the production of our desired terpenoid was optimized. We focused on the production and analysis of different sesquiterpenes (C15H24), three isoprene unit terpenoids. The addition of IPM (isopentyl myristate) to our engineered S. Cerevisiae strains enabled sesquiterpene analysis through GC-MS, helping us determine what type of terpenoids were made and which strain was the most efficient in production.

Software Testing and Web Development

Hamelmal Gobezie[1], Bryce Foster[2], Brian Bushnell[2] and William Andreopoulos, [2] PhD
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This project included testing bioinformatics tool software developed by JGI's software engineer Brian Bushnell called BBTools and making a website for the tool. Software testing is the process of finding bugs in the software and make the software bug free which ensures no bugs will be discovered first by the analysts. BBTools are currently being used in the bioinformatics field and are error free. However, new version of these tools are released very often, testing them require him to manually test everything before putting it out to the public. The project's goal was to have one script that he can run which tests all the tools automatically all at once. When ran, the program tells us which parameters have passed and which parameters have failed. This way, we save time and energy running each parameter one by one. The second part of the project was to build a website where analysts can download and read about BBTools.

Tail-Light Tracking Algorithm

Juan Guerra, Guangyu Zhong, and Ming-Hsuan Yang, PhD
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Computer vision is becoming an essential field for modern technology, especially in the automotive industry; algorithms are being generated to detect objects, such as vehicles, and keep track of their movement. Our focus is to formulate an algorithm that can not only track a vehicle, but detect the tail-lights. The algorithm will then use this information to identify the specific locations of the brake and turn lights in that region and determine whether they are on or not. Development of this algorithm will decrease the response time of autonomous driving which can improve the reaction time of regular and emergency vehicles, increasing safety on the road. Preparing the algorithm requires data on frames that contain the cropped image of a vehicle with the coordinates and state of the brake and turn lights already calculated. By feeding the algorithm this information manually, it will have access to many instances in its database; this will allow it to use the references to compute the regions of the rear lights of new vehicles. Through calculations and testing, we demonstrate the accuracy of our algorithm and show how precise it can detect the required regions.

An Analysis of the Global Population Genetics of Malaria Resistance

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The World Health Organization reports that 3.2 billion people in 95 countries are at risk of being infected with malaria. With nearly 1 million deaths per year worldwide, malaria represents one of the deadliest infectious diseases. Because malaria first infected humans thousands of years ago, genetic mutations providing natural resistance to malaria have been under positive selection. Prior studies of genes promoting resistance to malaria analyzed only targeted populations experiencing malaria in the present. However, such studies may miss beneficial mutations carried by individuals who today live in areas where malaria infections are rare. We take a global-approach by studying a large collection of whole-genome sequencing data (the 1000 Genomes project) to look for past signals of malaria resistance. In this study, we focus on five gene locations linked to malaria resistance: HBB, ABO, ATP2B4, G6PD, CD40LG. We use SamTools and the human reference genome to report on the global nucleotide diversity of these target genes. In the future, we plan to extend our studies to the complete set of over 20 genes known to confer resistance to malaria. Understanding the complete genetic diversity of genes associated with malaria resistance will provide valuable information towards developing therapeutic targets to this important infectious disease.

Identifying NK Cell Development by Sostdc1 Expression in a Cell Microenvironment or Cell Intrinsic Manner

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In the immune system, natural killer (NK) cells survey the environment for elimination of viruses and transformed cells. Preliminary data from our laboratory shows that sclerostin domain containing 1 (Sostdc1) is expressed in some rare cell types of the bone and bone marrow. Sostdc1 has been shown to control bone morphogenetic protein and canonical Wnt signaling pathways in mesenchymal stem cells. Furthermore, we have linked a bone development protein to the immune system, as we have data showing that NK cells are decreased in Sostdc1 knockout (KO) mice. We hypothesize that Sostdc1 plays a role in NK cell development through maturation. To test our hypothesis we will utilize bone marrow transplants to make chimeras using Sostdc1-KO and wild type (WT) mice to identify whether Sostdc1 regulates NK cell maturation intrinsically or in a microenvironment. Flow cytometry will be used to examine the expression levels of NK receptors between wild type (WT) and Sostdc1-KO mice. Together, we discovered that the microenvironment chimeras show a significant decrease in expression of NK cell markers, suggesting that the microenvironment acts in a similar pattern as seen in the Sostdc1-KO chimeras. We can suggest that the NK cell microenvironment is affecting NK cell development. Further molecular analysis will help provide a better mechanistic understanding of how Sostdc1 affects NK cells. This analyses will provide novel information on how regulation of Sostdc1 might be utilized to improve cancer immunotherapy.

A Testbed for Wireless Sensor Networks Within a Building

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According to the United Nations and Environment Programme, buildings use 40% of the world's energy and of that energy 50% of it goes to heating, ventilation, and air conditioning. Data provided by wireless sensor networks has contributed to lowering energy expenditures by controlling the building more efficient, e.g. only conditioning a room when a room is occupied. However, some difficulty may arise in maintaining a wireless sensor network within a building due to sensors being miscalibrated, breaking, returning erroneous data, or ceasing to function. Invalid or unreliable data could lead to incorrect results and discomfort in research participants. For these reasons, it is essential to develop a testbed to detect these faults and trace their cause. In this poster, we present an architecture for wireless sensor testbed for buildings to detect faults, analyze energy usage, and serve as a tool for researchers who want to explore different control algorithms.

Exploring Protein Expansions in Fungal Dark Matter using Single-Cell Genomics

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There are an estimated 1.5 million fungal species in the world and less than 10% of estimated fungi have been described. About 98% of all described fungal species belong to Dikarya [1] while the earliest diverging lineages of fungi still remain understudied. Majority of early fungi can be referred to as “fungal dark matter,” a term used to describe fungi that is understudied and uncultivated. Within the earliest diverging lineages, 7 mycoparasitc fungi were chosen for single cell-sequencing as an attempt to describe these ‘dark matter fungi.’ Mycoparasitic fungi are best described as parasitic fungi whose host are other fungi. Using comparative genomics, multiple protein sequences from the same protein families were aligned and generated into a phylogenetic tree for analysis. Protein families were chosen based on the unique abundances of specific protein domains found in early lineages of fungi, specifically mycoparasitic fungi. Phylogenetic trees were generated to find specific protein expansions for the protein domains chosen. Protein expansions were found for protein domains Subtilase, Chitinase and Metallopeptidase.

[1] Stajich, J., Berbee, M., Blackwell, M., Hibbett, D., James, T., Spatafora, J., & Taylor, J. (2009). The Fungi. Current Biology, 19(18), R840-R845. http://dx.doi.org/10.1016/j.cub.2009.07.004

Solar Hydrogen Regenerative Cell Phone Charging Station

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Producing free energy to meet the demands of our modern world is a major issue that our society continuously confronts. The wanted outcome of this research is to produce a zero emissions cell phone charge station producing 2.5 Watts of available energy throughout a twenty-four-hour period. The system’s main components consist of a proton exchange membrane fuel cell (PEMFC), an array of photovoltaic panels (PV panels), for power production, and an electrolysis cell for hydrogen and oxygen gas production. A gravity-assisted storage tank was utilized to store the gases produced. Alongside these components are various auxiliary components which were employed to support the above systems and allow minimal intervention on behalf of the user. The key components, using standard performance measures for each, were tested individually to ensure that they could meet their respective demands in the system. Finally, the system was tested as a whole for its capability to charge a cell phone at any time of the day. The result of our research and design work showed that during day time the system provided to a cell phone a maximum of 2.5 Watts, but during night time it only produced 2.0 Watts, which is still sufficient enough to charge a cell phone. The electrolysis cell produced on average, 1.11 mL/hour. These findings show that power production in the night time should be improved and the electrolysis cell performance can be alternatively optimized. Altogether, this system demonstrates how a renewable power system can be implemented on small scale applications.

Understanding the bone cell niche in sclerostin knockout mice

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Sclerostin (SOST) is a protein secreted by osteocytes to prevent the maturation of osteoblasts into osteocytes. It is recognized that SOST is a candidate regulator of hematopoietic stem cell (HSC) fate in the mouse. However, the role of SOST and the molecular mechanisms that mediate the crosstalk between HSCs and the different bone marrow niche cells is incompletely understood. Previous data from our laboratory showed that SOST knockout (KO) mice had a higher bone mass and smaller bone marrow cavity and fewer CD45+ hematopoietic cells in the bone marrow compared to wild type controls. Paradoxically, our preliminary data indicate that HSCs in SOST-KO bones may be more proliferative than controls. Our goal is to understand the molecular mechanisms that regulate HSC proliferation in SOST-KO mice. We hypothesize that specific bone "niche cells" control HSC proliferation. To test this hypothesis, we need to optimize our bone niche cell isolation protocol in order to collect endothelial cells, osteoblasts, and mesenchymal stem cells from whole bones. Optimization of this protocol will allow us to then perform functional HSC-niche cell co-culture assays, as well as analysis of gene expression in the specific bone niche cells. The results of these studies could identify the specific niche cell in the bone that induces HSC proliferation, which could have applications for hematological diseases and immunity.

The Development of a Well-Defined Homogeneous Transition Metal Catalyst for Tetrahydroxydiboron-Mediated Alkene and Alkyne Transfer Hydrogenations Using Water

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We recently described a method to reduce unsaturated C–C bonds by transferring H atoms from water using tetrahydroxydiboron as an additive and Pd/C as a catalyst. The heterogeneous nature of Pd/C makes experimental investigations of the hypothetical catalytic cycle of this reaction difficult. Below, we describe our efforts to develop a well-defined homogeneous transition metal catalyst for the water/tetrahydroxydiboron H atom transfer system, using unactivated alkynes and alkenes as model substrates. The bulk of our method development focused on tertiary phosphines and solvent selection for a homogenous palladium catalyst. The more nucleophilic phosphine ligands were more effective at promoting hydrogenation. Semi-hydrogenation for alkenes was also realized by proper solvent selection affording good chemoselectivity with minimal over reduction. Excitingly, we are seeing unexpected E:Z stereoselectivity contrasting our homogenous catalyst with standard semihydrogenation catalysts.

DNA Damage: A Precursor to Cancer Progression

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Stem cells have the ability to divide and differentiate into specialized cells that repair damaged and aged tissues. One of the main focal points of cancer research today involves understanding the mechanisms surrounding stem cell regulation and function, however, the process of abnormal cellular transformation is still poorly understood. Identifying the early stages of the cellular transformation seen in cancer, as well as the key events driving this process, could give insight into the earliest stages of cancer development. In this study, a novel approach and a model organism, the planaria flatworm Schmidtea Mediterranea, were used to identify the earliest possible event in the cascade that leads to abnormal proliferation/cancer. The deletion of the tumor suppressor gene PTEN enabled us to study the connection between DNA damage and hyper proliferation, the hallmark of all cancer cells. We have Identified DNA damage as a precursor to cancer development and an early event driving the cellular transformation process. Future experiments utilizing the deletion of the PTEN gene could reveal new target genes that play a critical role in the process enabling abnormal cell proliferation.

The Role of the Mushroom Body on Ethanol Reward Behavior

Harpreet Randhawa, Greg Engel, PhD and Fred Wolf, PhD
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The mushroom body is believed to be the main site of olfactory learning and association in insects such as Drosophila Melanogaster. In particular, it is involved with the behaviors of these organisms when they are exposed to ethanol. We find that by changing the expression of genes within these brain structures, through use of UAS/Gal4 drivers, flies exhibit changes in their patterns of sedation and tolerance when exposed to ethanol. Further testing with different combinations of UAS and Gal4 drivers can be used to determine the genes of the mushroom bodies that are important in the process of ethanol behavior, which can help to further understand how alcohol works in the brain to lead towards addiction that many people experience today.

Thermal management design for high power lithium-ion battery by minichannel aluminum tubes

Juan Rodriguez Ebelin Hernandez, Stephen Chang, Angel Sepulveda, Trenton Berner and Yanbao Ma, PhD
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Lithium-ion batteries are a common power source for most Electric Vehicles (EVs) since they provide a high energy capacity. The challenge at hand is to provide a stable temperature at which the battery can operate at optimum levels. Thus, providing a Thermal Management System is critical for the longevity, performance, and safety of the batteries. This research presents a novel design in which aluminum minichannel tubes are used and placed in parallel. An inlet and outlet are also in place at the bottom of the cell which circulates a liquid coolant through the pipe system, which then cools the cell itself. It was noted that cooling performance is also attributed to inlet orientation. As long as the orientation of the inlets remained on one side of the battery, the cooling performance would reach optimum levels. The number of aluminum mini channels used can vary, but as the research indicates, the more mini channels that are in place, the better the cooling performance. However, the main idea of the design is to ensure full thermal contact of the cell with the aluminum tubes as well as keeping the design compact and light. Therefore, the design being considered will not only help achieve the stable environment we wish to demonstrate, but also present a compact and cost effective product.

Using Play-by-Play Data to Model, Simulate, and Predict NBA Games

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Using play-by-play data from all 2015-16 regular season NBA games, we build generative models for substitutions of five-player lineups. This model differs from typical models in that we consider team lineups instead of players since we believe this encapsulates the synergy between the players on the court and their additive performance. The substitution model consists of a continuous-time semi-Markov chain, with both holding time distribution and transition rates inferred from data. We compare our inferred model to readily available Markov models in the R programming language's CRAN repository. Combining the substitution model with a model for how a particular group of players contributes offensively and defensively as a function of seconds played (a plus/minus rate model), we use the Gibbs Monte Carlo method to sample from our stochastic substitution model and simulate plausible game trajectories to predict outcomes of games. We create and compare different linear regression techniques for constructing the plus/minus rate model. We quantify the predictive power of our model, comparing out-of-sample predictions with actual results for both regular season and playoff games. By running simulations with and without an injured player, we show how the substitution model helps answer "what if" questions and measure impacts of injuries on the winners of games and series.

Total Protein Concentration Shows Decreased Levels of Creatinine in Insulin Resistant OLETF Rat

Esteban Sandoval Max Thorwald, Ruben Rodriguez, Rudy Ortiz, PhD
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Creatinine is a chemical waste that comes from muscle metabolism. 2% of creatine is metabolized into creatinine waste and travels down the bloodstream to kidneys to be excreted into the urine everyday. Abnormal creatinine to protein/albumin concentration in the urine indicates signs of kidney disease or impaired functions. It is hypothesized to have lower ratio of creatinine to protein when an organism is insulin resistant because of the heavy blood filtration of the kidneys. To test this hypothesis, four groups of rats were studied (n=6-8/group) 1) 1) Long-Evans Tokushima Otsuka (LETO; control) normal diet (ND), 2) Insulin Resistant Otsuka Long-Evans Tokushima Fatty) OLETF ND, 3) OLETF ARB, and 4) OLETF – ARB. Each had 30 minutes of ischemia on the right kidney and reperfusion of 6 hours. During reperfusion, urine was collected every hour for three hours then total protein concentration was measured. It is expected that the insulin resistant OLETF group will have the lowest creatinine to protein concentration because of the stress the kidneys have from heavy filtration of blood from the high levels of glucose. Measuring the ratio of creatinine to total protein concentration can prevent kidney malfunction and damage.

Screening of antimicrobial properties of gecko skin on common pathogenic antibiotic-resistant bacteria

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Various species of tropical geckos slough large portions of their skin as a defense mechanism against predators and are able to persist with large dermal breaks without contracting infections, suggesting the presence of antimicrobial properties on the epithelium. With the prevalence and rise in antibiotic-resistant bacteria, it is necessary to investigate potential new compounds for antimicrobial treatments. We hypothesized that the presence of antimicrobial properties exists on the epithelium of two gecko species, *Phelsuma madagascariensis grandis* and *Gehyra vorax*, that are able to prevent the growth of antibiotic-resistant bacteria. Homogenized skin was screened for antimicrobial activity against two known pathogenic bacteria that have developed antibiotic resistance: methicillin-resistant *Staphylococcus aureus* and carbapenem-resistant Enterobacteriaceae. Experiments were conducted to determine the effectiveness of the skin samples against the different species of bacteria. The data generated will provide a basis to fractionate the homogenized lizard epithelium, determine the identity of any compounds displaying antimicrobial properties, and ultimately, their utility for use as treatments for infections in patients.

Maximizing Access to Research Careers Undergraduate Student Training in Academic Research (MARC U*STAR)

The following student scholars are part of the Maximizing Access to Research Careers - Undergraduate Student Training in Academic Research (MARC U*STAR) Program at UC Merced. The MARC U*STAR Program is funded by the National Institutes of Health (NIH). The program seeks to increase the number of highly-trained biomedical and behavioral scientists in leadership positions to significantly affect the nation's health-related research needs. MARC U-STAR provides support for undergraduate students who are underrepresented in the biomedical and behavioral sciences to improve their preparation for high-caliber graduate training at the Ph.D. level.

For more information, please visit http://uroc.ucmerced.edu/marc

Glucocorticoid Receptor-Mediated Lipolysis Increases Following Chronic Adrenocorticotropin Infusion in Northern Elephant Seal Pups

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Northern elephant seal (NES) pups experience prolonged fasting, relying on the oxidation of fatty acids to satisfy energetic needs. Fasting is characterized by an increase in cortisol, non-esterified fatty acids (NEFA), and heat shock protein 90 (HSP90), which is necessary for glucocorticoid-mediated lipolysis. The functional relevance of increased cortisol via the GR is not well defined. We hypothesized that ACTH infusion increases lipolysis in NES via HSP90-mediated mechanism. The contributions of cortisol and its receptor (GR) were assessed by exogenous infusion of ACTH in the presence or absence of a GR blocker in the following groups (n=6): (1) control, (2) ACTH (40 units), (3) GR blocker (GRb; 400mg mifepristone), and (4) ACTH+GRb (Combo). Plasma and adipose biopsy samples were collected at days 0 (T0; immediately prior to infusion) and 6 (T6). Mean plasma cortisol concentrations decreased 41±5% in ACTH and 21±3% in Combo, but remained constant in the control and GRb groups suggestive of adrenal exhaustion. Mean plasma aldosterone increased 135%± 4 in ACTH suggesting that the adrenal gland is differentially responsive. Mean NEFA and HSP90 expression levels increased 38%±4% and 119%±1% , respectively, in the ACTH suggesting that the GR-mediated increase in lipolysis is regulated by HSP90. Mean HSP90 expression increased 31%±3% in GRb and 192%±4% in Combo compared to control suggesting that blockade of the GR has no residual effect on the binding of HSP90 to the GRE. The data suggest that the fasting-associated increase in cortisol contributes to the increase in lipolysis through a HSP90-GR-mediated pathway.

Angiotensin Receptor Blockade Decreases PEPCK Expression Following a High Glucose Challenge in a Model of Metabolic Syndrome"

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The over production of glucose is a key factor in the development of hyperglycemia in diabetes. Angiotensin II (Ang II), increases de novo glucose production by the liver. Blockade of angiotensin II receptor type 1 (AT1) decreases the expression of phosphoenolpyruvate carboxykinase (PEPCK), the rate limiting enzyme in gluconeogenesis, in non-insulin dependent diabetes. However, whether AT1 activation contributes de novo glucose production by the liver in a metabolic syndrome (MetS) setting is not known. To test the hypothesis that activation of AT1 increases the expression of enzymes involved in de novo glucose production by the liver in MetS, hepatic PEPCK protein expression was examined after a 12 hour fast (T0) and 180 and 360 minutes following a glucose challenge (2g/kg) in the following groups of rats (n = 8/group): 1) untreated, lean Long-Evans Tokushima Otsuka (LETO; 2) untreated, obese Otsuka Long-Evans Tokushima fatty (OLETF); and 3) OLETF + angiotensin receptor blocker (ARB; 10 mg/kgd in diet for 8 wk; OLETF ARB). We expect an increase in PEPCK expression in OLETF at T0 and that it will remain elevated following the glucose challenge as compared to LETO. We also expect that AT1blockade will reverse this effect. In conclusion, the activation of AT1 in a MetS setting, contributes to glucose intolerance via an upregulation of gluconeogenesis which may ultimately lead to type II diabetes.

UROC Scholars at the University of California, Davis for their annual Ice Cream Social for perspective graduate students hosted by The Office of Graduate Diversity.

Summer Cardio-Renal Undergraduate Research Experience (SeCURE)

UCM-UAB SeCURE

A UC Merced & University of Alabama, Birmingham Partnership

The following student scholars are part of the Summer Cardio-Renal Undergraduate Research Experience (SeCURE) Program at UC Merced. SeCURE is a 10-week, paid summer program that offers exciting hands-on research experience to for students with a desire to pursue careers in the biomedical sciences. The program is particularly targeted to students having no local campus access to biomedical research laboratories.

For more information, please visit http://uroc.ucmerced.edu/secure

Chronic Co-treatment with Low Dose LPS and Tempol Preserves Afferent Arteriole Autoregulatory Behavior.

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Activation of toll–like receptor 4 (TLR4) with lipopolysaccharide (LPS) increases reactive oxygen species (ROS) causing oxidative stress. Tempol, a superoxide dismutase mimetic, scavenges endogenous ROS, thereby reducing oxidative stress. Afferent arteriole autoregulatory behavior is impaired following 7 days of LPS treatment. Accordingly, we hypothesized that chronic co-treatment with LPS and Tempol preserves autoregulatory behavior. Three treatment groups were used (n=4/group): LPS (0.1mg/kg/day), LPS +Tempol (2mmol/L), and saline (0.9% NaCl)+Tempol. Rats received osmotic minipumps (day 0) for infusion of LPS or saline, placed inside metabolic cages, and Tempol was added to the drinking water on day 1. Systolic blood pressures (SBP, tail cuff) were measured (days 0, 3, and 7) and collected urine was analyzed for electrolytes, and protein. Kidneys were harvested on day 7 for juxtamedullary nephron experiments. SBPs were similar across all three groups, averaging 140±4, 124±9, 127±7 mmHg, respectively on day 7. Urine output averaged 8±0, 8±1, 6±1mL/24Hrs., respectively. Urinary protein excretion averaged 9.2±0.3, 9.2±0.2, and 9.3±0.6mg/24Hrs., respectively, consistent with normal glomerular function. Autoregulatory behavior was assessed by increasing renal perfusion pressure from 65 to 170 mmHg (15 mmHg increments). Baseline diameters (100 mmHg) averaged 15.2±1.2, 14.0±1.0, and 15.0±1.5 microns, for saline (n=6), LPS (n=6) and LPS+Tempol (n=3), respectively. At 170 mmHg, arteriole diameter decreased by 25±1% ($P<0.05$) and 21±3% ($P<0.05$) in the saline and LPS + Tempol co-treated groups, respectively, signifying normal autoregulatory behavior whereas it did not change in the LPS group. Therefore, chronic co-treatment with LPS+Tempol preserves renal autoregulatory behavior, by scavenging endogenous ROS.

Evidence for altered circadian heart rhythms in response to elevated dietary Na+ in rats.

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Circadian rhythms in physiologic function are mediated by a group of transcription factors that oscillate over a 24-hour period, termed the molecular clock. Disruption of clock mechanisms promotes cardiovascular disease (CVD). High salt (HS) intake promotes endothelin-1 (ET-1) production by the vasculature and is a risk factor for CVD; however, it is unknown if HS affects circadian clock components in the heart. Therefore, we hypothesized that HS intake disrupts components of the molecular clock in the heart, via activation of ET-1 receptors. Control and endothelin type B receptor (ETB) deficient (ETB def) rats were placed on either HS or normal salt (NS) for two weeks and euthanized every 4 hours over a 24-hour period. RNA expression was assessed for clock genes (Bmal1, Cry1, Per1, Per2, DBP, CLOCK) by RT-PCR. Cosinor analysis was performed to determine mesor (daily average), amplitude (trough-to-peak), and phase (timing of peak) of gene expression oscillations. Our results indicate that HS intake suppresses both the mesor and amplitude of Per1, Per2, CLOCK, Cry1, DBP, and Cry2 expression. These effects occurred similarly in control and ETB def rats. HS intake increased heart ventricle weight (HVW) to a similar level in both genotypes. Our data indicate that HS intake disrupts the molecular clock and promotes hypertrophy in the heart independent of ETB receptor activation. We speculate that alteration in circadian components may contribute to CVD risk associated with high dietary Na+.

Bmal1 Knockout Mice Lack Diurnal Rhythms In Food And Water Intake That Mirrors Loss Of Circadian Blood Pressure Rhythm And Urinary Sodium Excretion

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Many forms of life have circadian rhythms to perform specific biological functions. Bmal1 is a transcription factor and central element of the molecular clock but its role in fluid and electrolyte regulation is unclear. We hypothesized that loss of Bmal1 would disrupt fluid and electrolyte balance in response to normal and high salt diets. To test this, we utilized Bmal1 knockout (Bmal1KO) and wildtype mice under both diets in metabolic cages and collected urine during active (lights-off) and inactive (lights-on) phases. Our results show that Bmal1KO have reduced water and food intakes on both diets compared to WT in the active-phase. Bmal1KO exhibit a loss of diurnal intake of water and food, which corresponds to a loss of diurnal blood pressure (BP) rhythm on both diets. On normal and high salt diet, WT had a diurnal pattern in sodium excretion that is higher in the active-phase and lower in the inactive-phase. Whereas, Bmal1KO had similar sodium excretion in the active and inactive-phases on both normal and high salt diets. BP followed a diurnal pattern in WT, but not Bmal1KO on both diets. We conclude that Bmal1 facilitates maintenance of a normal diurnal pattern in BP control, food and water intake and sodium excretion.

World Heritage Research Experience Scholars Program

The World Heritage Research Experience (WHERE) Scholars Program at the University of California, Merced is a new innovative, one-year undergraduate research program for students across all academic disciplines. The program focuses on natural and cultural heritage, the legacy of the human past, and how it is reflected today in places, landscapes, and intangible aspects of our cultures. Scholars conduct faculty-mentored research in conservation, preservation, management, and outreach related to cultural and natural heritage.

WHERE Scholars will be able to engage in:

1. Design and develop research projects in the humanities and social sciences
2. Make digital maps and GIS Databases of heritage places
3. Create 3D visualizations and reconstructions of ancient cities and monuments
4. Design virtual exhibits and museums to support heritage tourism

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1940 Based Historical Demographic Model of Merced, CA.

Sydney Ruport Karl E. Ryavec, PhD
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The National Archives released the official 1940 United States Census on April 2, 2012. Due to the "72-Year Rule," the government does not release personally identifiable information about an individual or agency until 72 years after it was collected. Now that the information is open to the public, it is possible to compare information such as household ownership, street names, address numbers, and parcel usage. This presentation will report on findings from the 1940 U.S. Census of Merced, CA. There data are compared with a 2003 Geographic Information System (GIS) of contemporary parcels (i.e. real estate parcels) and other resources, such as a 1946 air photo; Google Earth images; and previous city directories. Several hundred households have been used to create this historical demographic model of the city of Merced.

3D Digital Reconstruction of Catalhoyuk

Tristan Yang Nicola Lercari, PhD
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Catalhoyuk is an ancient archaeology site due to its physical scale and the prehistoric context that it offers. Since its inscription into the UNESCO World Heritage List in 2012, Catalhoyuk still faces many long-term preservation challenges. Catalhoyuk is constantly being threatened by the fragile composition of its mudbrick and the harsh continental climates. By collecting vast amounts of data and using new cutting edge digital technologies, the Catalhoyuk Conservation team aims to create a digital application to show the progression of the decay of the site and its earthen architecture. After collecting the data using terrestrial laser scanning and small unmanned aerial vehicles (small UAVs), we generated digital 3D models using a 3D data software known as FaroScene and produced comparisons and classifications of the 3D point clouds using the software Cloudcompare. Preliminary data collected in Building 5 show that there have been significant loss of building material from the year 2012 to 2015. These results will present a new and improved way to preserve and present archaeological heritage places. Our work allows the Catalhoyuk Conservation team to monitor this UNESCO site in its current state as well as better inform the public about the Catalhoyuk's future.

UROC Scholars at the SURI Welcome BBQ.

Accelerated STEM Pathways through Internships, Research, Engagement, and Support

Accelerated STEM Pathways through Internships, Research, Engagement, and Support

The "Accelerated STEM Pathways through Internships, Research, Engagement, and Support" (ASPIRES) program is a collaboration between Cañada College's Engineering Department, San Francisco State University School of Engineering, and UC Merced. The project is supported by a grant from the US Department of Education through the Minority Science and Engineering Improvement Program (MSEIP), Grant No. P120A150014.

The overarching goals of the ASPIRES program are:

1. to increase the retention and success in STEM courses among community college students from traditionally underrepresented minority (URM) groups in STEM;
2. to increase awareness of and interest in STEM careers among K-12 and community college URM students; and
3. to increase the number of URM students receiving AS degrees and transferring to four-year institutions to pursue STEM degrees.

Insights on the Porous Structure of Aluminum Foams: a Computational Mechanics Study

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Metallic foams are interesting lightweight materials with characteristic random porous structures resulting from dedicated processing techniques. This distinctive structure leads to particular properties such as low relative density, impact energy absorption, sound absorption, and flame and heat resistance; therefore, such materials have potential for multiple applications in several fields. However, the effect of different pore shapes has not been deeply reported before and as a result there is not a robust method to predict behavior of mechanical properties of aluminum foams. The goal of this research project is to model the mechanics of aluminum foams using the Finite Element Method, with special emphasis on controlling the shape and orientation of the pores in order to obtain desired mechanical properties. The first part of the research consists of the use of MATLAB software to design samples with circular and elliptical pore shapes at random positions. A second part of the study is to use COMSOL Multiphysics 5.2 software to perform a finite element analysis to mimic the aluminum foam behavior under the influence of compressive loads and determine the maximum stress and strain of the models. This study contributes to the development of an efficient and accurate computational method to predict structure-property relations between shape, size, and orientation of the pores that will allow engineers to improve metallic foam designs.

Application of Low Cost Unmanned Aerial Systems in the Detection of Methane

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The extensive natural gas pipelines established in the U.S. make up a large part of our energy infrastructure, and, as such, monitoring these lines for leaks are essential to our everyday life and, more importantly, our safety. The approximately 300,000 miles of transmission pipelines that span the country are difficult to survey for damage. Current methods include manual ground operations through the use of methane detectors, either handheld or mounted on a car, which have been successful in exposing methane leakage. However, pipelines may not always be easily accessible to land vehicles or even safe for on-foot inspections due to the nature of the terrain. The use of manually driven aircraft is also limited in their surveying ability because of their size and they are restricted by their minimum altitude of flight. This paper will discuss the use of small Unmanned Aerial Systems (sUAS) as a more efficient and safer alternative to methane detection. sUAS have access to a wider range of topography since they can climb from the ground to high altitudes with ease, eliminating hazards for pipeline surveying employees. The implementation of NASA's Open Path Laser spectrometer (OPLS) sensor mounted onto the sUAS will be used to detect methane concentrations in parts per billion, which further increases the efficiency of the sUAS.

ASPIRE Scholars visiting UC Merced for UROC transfer bootcamp.

Applications in Modern Materials (AiMM)

The Applications in Modern Materials (AiMM) program is a comprehensive and collaborative research experience for undergraduates mentored by physics, chemistry, and engineering faculty at the University of California, Merced. Participants are involved in a wide array of research projects with applications in soft matter, biomaterials, nanomaterials, and/or materials for energy conversion and storage. These undergraduate researchers are involved in a wide array of activities including the synthesis, characterization, and/or modeling of modern materials. Every AiMM project is designed to include the student in cutting- edge research, with the expectation that their work can meaningfully contribute to publications or presentations. Complementing the interdisciplinary nature of the research areas, the program uses a three- pronged design of mentoring, networking, and professional development to support student researchers throughout (and beyond) the program. The participants are closely mentored by faculty and participate in additional networking and professional development activities to connect them with peers, postgraduates, and faculty within AiMM, as well as those associated with other currently funded University of California research programs, in addition to scientific professionals at Lawrence Livermore National Lab and within STEM-related industry.

Silk-based time-release model of small-molecule drugs

Jessica Anderson Li Zhang, PhD, and Patricia LiWang, PhD
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Despite developments in producing potent pharmaceuticals that prevent HIV infection, patients' poor adherence to taking daily medication challenges the drugs' efficacy in the field. A silk-based, time-release delivery of tenofovir (TFV), an FDA-approved HIV inhibitor, would reduce the need to take daily medications. Silk fibroin has already demonstrated ability to time-release proteins, supporting the possibility that a silk-fibroin film would time-release TFV at an effective concentration for at least three days. To simulate TFV, we are encapsulating a small-molecule dye in the silk fibroin films. In eight different trials, two concentrations of Allura Red AC were incorporated into 3 and 6% silk-fibroin films, which were water-vapor annealed to become insoluble and exposed separately to both phosphate buffered saline (PBS) and simulated vaginal fluid (SVF). The concentrations of the dyes released daily were determined by measuring aliquots of the SVF and PBS solutions using standard spectrophotometric methods. Results of the experiment may support the development of silk-based drug delivery systems for small-molecule pharmaceuticals—potentially lowering the rate of HIV infections worldwide.

Topographical Pattern Transfer to Polyacrylamide Gels for Cardiac Cell Alignment

Bita Bhziz Lian Wong, Rachel Hatan, Jose Zamora,Kara McCloskey PhD
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During a heart attack, cardiomyocytes (CM) are deprived from oxygen, leading to death without regeneration. Tissue engineering holds promise towards developing solutions to produce more efficient diagnostic and drug discovery platforms, patient-specific organ transfer, and models for basic science research. Embryonic stem cells and induced pluripotent stem (iPS) cells have the ability to differentiate into all cell types, making them a valuable cell source for applications in tissue engineering. Moreover, because iPS cells are patient specific, their derivatives also eliminate the need for immunosuppressive therapies. In order to direct the cell fate of human iPS to CM cell lineage, mechanical forces have been shown to play an important role such as electrical stimulation, mechanical strain, topography-guidance, and substrate stiffness. Our goal is to culture iPS-derived CM on wrinkled microchips using a cost-effective shrink nanofabrication method to create the wrinkle topography for guiding cell alignment on physiological stiffness. The results show that the pattern can be transferred to polyacrylamide (PA) hydrogel, but the CM preferentially adhered to the flat glass rather than the wrinkled PA. Future work plans to optimize the cell seeding density, extracellular matrix proteins and the linker's concentration in order to increase the adhesion of CM on PA.

The creation and evaluation of an entangled state between two quantum harmonic oscillators.

Kevin Collins, Lin Tian PhD
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Much of current research, especially in the field of quantum information, has been devoted to identifying methods that generate entangled states. This is due, in part, because entanglement is necessary for quantum computing, quantum cryptography, and quantum teleportation. Our work identifies operations that can be used to generate and tune an entangled state of a bipartite system composed of a nanomechanical resonator mode and a superconducting electrical resonator mode. We show that the application of a squeeze operation to a Gaussian thermal state will transform the separable state into an entangled state. We then show that a beam splitter operation can be used to tune the entangled state. We assess the entanglement using logarithmic negativity.

Optimization of functional molecules

Efrain Cuellar, and Ryan Baxter, PhD
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Pharmaceutical drug design, development, and manufacturing highly depends on the efficiency of chemical reactions that use cheap starting material, yet provide a quick turnover product time by its final product development. In addition, safety measures are taken into action nowadays when developing pharmaceutical precursor or any chemical by trying to use renewable material feedstock, avoiding hazardous by-product waste, and designing chemical routes with the least amount of energy usage. As a result, many synthetic chemist are interested in identifying novel chemical strategies to optimize yield by reducing number of synthetic steps and applying bench stable inexpensive starting material for the production of pharmaceutical precursors while reducing generation of hazardous waste. Our group has developed a silver-catalyzed CH functionalized route to the simplest, abundant, and cheapest type of hydrocarbons, the alkanes. A critical step though for synthesizing high value functionalized organic compounds from simple pre-existing functionalized hydrocarbons, is developing robust synthetic routes by optimizing best conditions using cheap and abundant reagents and catalyst such as aldehydes, biomolecules, and carboxylic acid radical source in room temperature.To this end we sought to optimize current synthetic method to optimize the best condition of a series of organic reactions. Using aldehyde, persulfate, silver catalyst, and quinone with changes of parameters (concentration, temperature, working solvent, and reaction time), we can determine the most efficient route producing a diverse flavor of functional molecules.

Computing Hyperpolarizabilties of Coupled Chromophores

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Nonlinear optical materials have many applications in optoelectronics, optical data processing, and telecommunications. The current modulators use lithium niobate, an expensive, unsustainable, toxic inorganic material. An alternative technology we are researching is organic electro-optic (OEO) chromophores. OEO chromophores are safer, cheaper and have faster electron transfer that could lead to ultra-fast data processing. Further research into the electronic structure of single chromophores is necessary before bulk behavior is understood and implementation can occur. Understanding the orientation and packing of the chromophores is crucial due to its relationship with the non-linear optical properties. One way to characterize non-linear optical properties is determining second order polarizability, also called hyperpolarizability. Using the computational chemistry method known as density functional theory, we have computed the hyperpolarizability of OEO dimer chromophores oriented in various directions to further understand their electronic properties. Coupled Perturbed Hartree-Fock method and two-state model DFT methods were utilized to calculate hyperpolarization and compared.

Catalytic Intramolecular Hydroarylation of Alkynes for the Synthesis of Indenes

Daniel Panasenko Amir Keshavarz, Benjamin J. Stokes, PhD
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Functionalized indenes serve as a backbone of several pharmaceutical products. Using a Thorpe–Ingold-assisted strategy, we sought to prepare indene carbocycles using intramolecular hydroarylation of alkynes (formally, a 5-endo-dig cyclization). Starting from 2-methyl-2-phenylpropanoic acid, reduction and partial reoxidation to the aldehyde was followed by a Corey-Fuchs reaction to afford the terminal alkyne, which was then coupled to various aryl halides using a Sonogashira reaction to afford alkyne hydroarylation substrates. Acid-catalyzed hydroarylation of said substrates gave modest product yields compared to the analogous hydroarylation of alkenes. The nature of the acid catalyst and its influence on the reaction is discussed.

Room Temperature N-Arylation of Amino Acids Precursor for C-H Alkylation Reactions of Heterocycles and Quinones

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Direct methods for radical C-H alkylation have been developed in recent decades, but they still contain many limitations. The Minisci reaction requires heating at low pH and produces mixtures of mono- and bis-alkylated products, the borono-Minisci reaction works for aromatic radicals, but is not efficient for alkyl radicals. Knowing these drawbacks and the critical role of aromatic heterocycles in the field of medicinal chemistry, our research involves synthesizing unnatural amino acids and then develops a new method to utilize them as stable radical precursors for the C-H functionalization reaction of aromatic hetrocycles and quinones.

The Synthesis of Calamitic Mesogenic Organic Small Molecules and Their Influence on the Properties of CdSe/ZnS Core–Shell Quantum Dot Nanocomposites

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Mesogenic organic ligands can stabilize quantum dots (QDs) in the isotropic and nematic phases. A calamitic, or rod-shaped, ligand was designed to bind CdSe/ZnS core-shell QDs through an alkylamine tether and prevent their aggregation in a liquid crystal material. The mesogenic ligand was prepared following a convergent multi-step synthesis using classical organic reactions. The purity of isolated intermediates and products was verified using NMR spectroscopy and GC-MS. NMR spectroscopy was also used to quantify the ligand exchange ratios on the QDs. While studying the phase transition behavior of the ligated QD using fluorescence microscopy, the formation of 3-D capsules was observed. We have begun to prepare new ligands with varied alkylamine tether length in order to probe their binding efficiency to core-shell QDs, as well as their influence on capsule formation. In the future, steric and electronic modifications to the 4,4'-diphenyl core of the ligand will be made.

Investigation of Protein Metamorphosis

Yvonne Yee Alicia Vazquez, Andy LiWang, PhD
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Most organisms have developed an internal timekeeper known as a circadian clock to adjust for the predictable changes of light and temperature caused by the day/night cycle. The clock generates a ~24-hour rhythm and controls many biological activities like sleep schedules and metabolic functions. The circadian clock found in cyanobacteria serves as a good model for research due to its simplicity and capability for reconstruction in vitro. Cyanobacteria contain three core oscillator proteins: KaiA, KaiB, and KaiC. During the day, KaiA binds to KaiC, promoting KaiC autophosphorylation. KaiB has the rare ability to switch between two topographical folds, allowing two distinct functions: active and inactive. At night, KaiC reaches the proper phosphorylation state for active KaiB to bind. Once bound, it sequesters KaiA from the C-terminus of KaiC to form a ternary KaiABC complex, thereby promoting KaiC autodephosphorylation. KaiB primarily exists as an inactive tetramer, occasionally sampling the active monomer state. To investigate the mechanism behind KaiB fold switching, KaiB genes are modified using polymerase chain reaction. The genes are then ligated into a plasmid for transformation into E. coli cells. After gene expression, mutant KaiB proteins are extracted and purified. Multiple mutant variants of KaiB are created for analysis via Nuclear Magnetic Resonance to help better understand possible intermediate structures of the dimer-monomer equilibrium of KaiB.

Linewidth Broadening of InAs/GaAs Quantum Dot Molecules

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Quantum dots, predominately studied for their electrical, magnetic and optical properties, are recently attracting interest for the coupling of their quantum states to mechanical motion. One type of state that merits investigating is the interdot exciton state of coupled quantum dot pairs. These are of considerable interest due to their possible application in quantum technologies, such as quantum computing or quantum metrology. When experimentally observed, the interdot exciton exhibits a larger linewidth in comparison to the intradot exciton, which is contradictory to Heisenberg's Uncertainty Principle. Common belief is that the linewidth broadening is due to the applied electric field affecting the interdot stronger than the intradot electron-hole pair, as a result of its larger electric dipole moment. In addition, we consider the possibility of a mechanical deformation affecting the quantum dot system. Here we treat the dot pair as a coupled mechanical oscillator: we use a theoretical mass-spring model to investigate whether the linewidth broadening is purely due to mechanical fluctuations, electrical fluctuations, or a mixture of both. Experimentally, we analyze interdot exciton transitions as functions of their temperature, electric field, and excitation conditions in terms of their line profiles. The different types of line profiles allow us to determine the line broadening mechanisms.

Applied Research in Modeling and Data-Enabled Science

ARCHIMEDES

Applied Research in Modeling and Data-Enabled Science

In April 2014, UC Merced received funding from the National Science Foundation to host a Research Experience for Undergraduates (REU) program in applied mathematics for three summers. The REU program is called "Applied Research in Modeling and Data-Enabled Science", or ARCHIMEDES, and it focuses on data-enabled science and mathematical modeling. The objectives of the program are: to introduce students to scientific computing to strengthen programming skills, to use mathematical models to solve real-world problems, to apply computational tools to research-level problems, and to analyze results using data and translate into a scientific context.

The ARCHIMEDES program supports eight undergraduate students for nine weeks each summer as they learn and develop the mathematical and computational tools necessary for data-driven applications, and as they gain professional-level research experiences in preparation for careers in STEM fields. In the first week, students participate in a computational "bootcamp" designed to develop fundamental computational skills, preparatory to doing research during the rest of their summer program. The students then work intensely for the remaining eight weeks, in teams of four and with a faculty mentor, on projects with strong computational and modeling components. Students actively participate in weekly workshops and presentations to practice their communication skills. They will produce a technical report and a poster, and present at the Undergraduate Research Summer Symposium. The goal of the ARCHIMEDES program is to provide a rigorous and meaningful research experience in modeling and data-enabled sciences for undergraduate students in a team environment and improve the communication skills of future mathematical researchers.

Modeling Biological Invasion with the Reaction-Diffusion Equation

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Shilpa Khatri,PhD Karin Leiderman,PhD
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Every year, invasive species cause irreversible damage to economies and ecosystems worldwide. Preventing the spread of such species is an important step toward reducing impact on native flora and fauna, along with preserving local economies. A noteworthy example is Japanese knotweed, Fallopia japonica, a perennial native to Eastern Asia. It was introduced to the United States in the 1870s as an ornamental plant and has since displaced native vegetation and clogged rivers. Since fragments from the main plant can generate new sprouts, transport of such fragments by river networks may play a key role in its spread. To better understand the impact of a river on the spread of Japanese knotweed, we applied the Crank-Nicolson time splitting method to a reaction-diffusion model and compared our results with field data to assess its accuracy.

Sparse Signal Recovery Methods for Variant Detection in Next-Generation Sequencing Data

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Recent research suggests an overwhelming proportion of humans have structural variants (SVs): rearrangements of the genome such as inversions, insertions, deletions and duplications. The common methods of SV detection involve sequencing fragments from an unknown genome, mapping them to a reference genome, and analyzing the resulting configuration of fragments for evidence of rearrangements. While SVs occur relatively infrequently in the human genome, they are hard to identify due to the indirect nature of SV detection, resulting in high false-positive identification rates. Our approach aims to improve SV detection in two ways. First, we solve a constrained optimization equation consisting of a negative Poisson log-likelihood objective function with an attached penalty term that promotes sparsity. Second, we focus on detecting SVs in the analysis of multiple related individuals simultaneously. Therefore we are able to implement familial constraints, which limit a child's genome to express SVs if, and only if, one or more of its parents have first expressed a SV. This problem formulation is designed to improve SV detection despite a large amount of error attributed to both current DNA sequencing methods and noisy mapping processes from the test genome to the reference genome. Through careful modeling and leveraging related individuals to narrow the boundaries of study, we anticipate higher accuracy of SV predictions.

Merced Nanomaterial Center for Energy and Sensing

MACES Summer Undergraduate Research Fellowship Program: MACES (Merced Nanomaterial Center for Energy and Sensing) was established with support from NASA in the fall of 2015. Our educational mission is to establish a vertically integrated STEM program that will produce a highly skilled and diverse workforce for NASA missions and beyond. One of the key components of the program is a 9-week long summer undergraduate research program that recruits students from local community colleges and nearby CSU campuses. Students will work side by side with UC Merced graduate students and faculty. Through structured mentoring and intensive hands-on training, students in the program will gain the experimental skills that allow them to effectively and safely work in a laboratory setting. This will be complemented by a weekly seminar series that introduces students to different research topics conducted in MACES and at NASA. Upon completion, students will be able to demonstrate basic knowledge of their research area and to summarize their own research.

Spectroscopic and Optical Properties of Perovskite Quantum Dots

Edwin Betady, Som Sarang and Sayantani Ghosh, PhD
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Perovskite Quantum dots are emerging candidates to replace existing quantum dot technology due to their high Quantum yield and Photoluminescence (PL) emission tunability. We looked at low temperature dependent excitonic spectroscopic properties of these quantum dots to better understand the energy phase space as well as charge carrier dynamics of perovskite quantum dots. PL emission spectra at low temperatures revealed the emergence of higher energy peaks at 2.25 eV and 2.45 eV respectively along with the persistence of the high temperature peak at 2.6 eV. These new peaks could be a result of energy up conversion or could arise from a higher energy band within the quantum dots. We expect power dependent spectroscopic measurements to reveal the charge carrier dynamics resulting in these peaks. Furthermore, Time-Resolved PL measurements were done to quantify the lifetime of charge carriers at low temperatures and it was observed that the charge carriers corresponding to the low temperature PL peaks had a lifetime of the same order (~10ns). Inorganic perovskite quantum dots also exhibited linear polarization in its emission PL with a maximum polarization value of 0.20. It has been proposed that the polarization in perovskite quantum dots is attributed to its asymmetric dipole moment. We systematically studied this polarization effect in the presence and absence of a magnetic field in order to understand this process better. These results reveal great potential for perovskite quantum dots in displays and other opto-electronic applications.

Consistently generating a 3D carbon scaffold

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Carbon cloth is made of woven carbon fiber which has high electrical conductivity, chemical and thermal stability, and good mechanical properties. They are lightweight, flexible, and most importantly, are made of an abundant resource. To harness the carbon cloth as an electrode for energy storage and energy conversion, carbon nanotubes are grown to produce a high surface area, mechanically robust 3D-scaffolded structure. We are investigating to form mechanically-stable and extremely large conductive surface area by using the catalyst-assisted chemical vapor deposition method to grow carbon nanotubes. Using carbon cloth has an advantage over nickel foam substrates because after high temperature processing nickel foam is no longer conductive and needs to be removed by etching; additionally, it is difficult to make a free-standing 3D carbon electrode. Compared to graphene-based 3D electrodes this method doesn't require lengthy processing time and toxic chemicals to exfoliate graphene and can form a 3D structure directly. I have demonstrated that carbon nanotubes can be conformably grown on carbon cloth. Compared with untreated carbon cloth, the surface area increased by at least 50 times. I will report on the energy storage capability at this symposium.

Assembling Single-Stranded DNA Scaffold for PNA-DNA Hybrid Origami Structures

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Hybridization of oligonucleotides has been utilized extensively to create DNA-based nanostructures for biosensing and drug delivery applications. However, the use of these structures in living systems has been challenging because of their instability against immune-triggered enzymatic degradation. Here, we employed peptide nucleic acids (PNAs) to assemble PNA-DNA hybrid structures for in vivo studies. The polyamide backbones of PNAs can resist enzymatic degradation. Moreover, the uncharged nature of PNA backbones enables quicker and stronger duplex formation with DNAs. Enzymatic ligation was used to assemble single-stranded DNA templates with user-defined nucleotide length, which orchestrated PNA-DNA binding along the scaffold according to sequence specificity. Gel electrophoresis analysis indicates the formation of ligated DNA scaffolds and specific PNA-DNA hybridization. The assembly of PNA-DNA hybrid structures will be the first step to creating in vivo DNA-based nanoscale biosensors.

Testing of a clogging-based point-of-care (POC) device

William Cheung Melissa Xu, M.S., Anand Subramaniam, PhD
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It is important to have a point-of-care (POC) diagnostic device that is accurate and that can provide rapid results in situations where conventional medical resources are unavailable. We hypothesized that a device that uses clogging of immunoprecipitates in a porous medium might provide such a POC device. To test the validity of this method, we conducted wicking experiments with model inorganic precipitates in aqueous solutions – Ludox-SM 30 colloidal silica and sodium-rich montmorillonite at various concentrations. The porous media that we employed was Whatman Chromatography 1 paper. We found that the amount of liquid that wicked into the paper, measured through the rise height in linear wax printed channels, was lower for higher concentrations of particles. The dynamics of the wicking was reproducible and was consistent with the Lucas-Washburn equation. Building on these promising results, we are now developing a POC device that quantifies immunoprecipitation.

Photoluminescence Spectroscopy as a Tool to Characterize Interfaces of Perovskite Solar Cells

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Perovskite solar cells have been an active area of research for the past decade with power conversion efficiency (PCE) efficiencies reaching as high as 22%. One of the major reasons for this advancement is the interfacial engineering of perovskite solar cells. Static and Dynamic Photoluminescence (PL) spectroscopy has been proven as a very useful tool to better engineer interfacial layers for solar cells. PL quenching is an effective way to quantify and characterize diffusion properties of charge carriers at the interface. PL quenching measurements were done on various Lead Acetate Perovskite samples with additional interfacial layers and a PL quenching efficiency as high as 75% was observed. PCE values of the various samples were also measured and these value were in complete agreement with the PL quenching data obtained. Time resolved PL measurements showed a trend of decreasing lifetime with the addition of new interfacial layers, attributed to the increased efficiency of charge carrier diffusion at the interface. To further demonstrate uniform quenching from the samples, scanning PL images were plotted which further inferred excellent interfacial properties of the various layers. These results demonstrate the importance of PL spectroscopy in characterizing the efficiencies of various interfaces in Perovskite solar cells.

Enhancing a Low-Temperature Solid Oxide Fuel Cell

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The solid oxide fuel cell (SOFC) is a developing technology proposed to substitute the use of fossil fuels in automobiles. SOFCs have been used mostly for stationary purposes but its use for automobiles is being researched. Platinum electrodes and yttria-stabilized zirconia (YSZ) electrolytes have been proposed for low temperature SOFCs. However, the significant ohmic loss in the electrolyte and the agglomeration of porous electrodes due to high temperatures have become significant issues in achieving high performance and durability. The proposed solution is the reduction of the electrolyte thickness (to reduce ohmic loss) and the use of few nm thick YSZ overcoat on the Pt electrode to avoid morphological degradation. We will fabricate cells with stainless steel support (~200 ?m)/Pt anode (~150 nm)/YSZ electrolyte (~300 nm)/Pt cathode (~150 nm)/YSZ nanocoat (~3 nm) layers by the use of sputter-deposition and atomic layer deposition techniques.

Kinetics and Mechanical Integrity of Thermoresponsive PNIPAm Hydrogels

Ian Hill and Jennifer Lu, PhD
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Near infrared light (NIR) responsive hydrogels can be made by the incorporating of carbon nanomaterials into thermoresponsive poly(N-isopropylacrylamide) (PNIPAm) hydrogels. PNIPAm hydrogels can be used as a NIR-driven actuator, or a dynamic scaffold, to apply mechanical force for tissue engineering applications. Current PNIPAm gels are limited by slow gel kinetics, weak mechanical integrity, and inadequate swelling/deswelling cycle performance. It has been reported that PNIPAm gels grafted with freely-mobile PNIPAm chains can improve hydrophobic aggregation during the deswelling phase above the lower critical solution temperature (LCST) and thus drastically improve their kinetics. This summer, I compared the kinetics of polymer gels with long-chain PNIPAm graft chains, mixed chain-length PNIPAm graft chains, and gels without grafted chains, and report the gel kinetics study. I am also investigating the use of graphene oxide (GOx)- grafted gels, and comparing their abilities to photothermally actuate gels with NIR light and swelling/deswelling kinetics with gels incorporating few walled carbon nanotubes (FWCNTs). The goal of future works is to create gels with mechanical robustness, and faster gel kinetics.

Low-Power Sensor for a Point-of-Care (POC) Magnetic Levitation (MagLev) Based Medical Diagnostic Tool

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Diagnostic tests help improve patient care by diagnosing patients before symptoms are discovered and reduce the need for trial and error treatment. Unfortunately, those who do not have access to a nearby doctor or laboratory often cannot receive the best diagnostic care. In order to alleviate those restrictions, the objective of this project was to create an affordable low power POC-diagnostic tool centered on the MagLev device that can detect diseases such as HIV, syphilis and Zika virus. The device uses antibody coated polystyrene beads and levitates them between magnets. The biochemical reactions between the coated polystyrene bead, antigens in the sample, and secondary antibodies cause gold to be deposited onto the bead (positive samples). The deposition of gold causes a change in density of the bead and thus leads to a measurable change in levitation height of the bead in the MagLev device. A positive sample will see the bead drop at varying speeds proportional to the concentration of antigen in the sample, while a negative sample will not see a height change. The focus of this phase of the project was to develop and improve on the sensor to detect the levitation height of the bead. Switching from a laser diffraction sensor to the newly developed LED based sensor saw power consumption drop by over 400% and allows improved multiplexed sensing.

Stimuli-Responsive Transition Metal Dichalcogenides (TMDs) and Their Assembly into 3D Monoliths for Efficient Energy Applications

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Recent international interest in reconfiguring the global energy infrastructure away from reliance on fossil fuels and toward renewable, clean and green energy has continuously fueled the reviving research directed toward nanotechnology-powered energy devices. Crumpled nanostructures of 2D soft, active materials (SAMs) such as molybdenum disulfide (MoS2) or reduced graphene oxide (rGO) offer increased surface area for catalytic reaction, allowing for more efficient reactions. Electrohydrodynamic (EHD) spray coating is the preferred method of deposition. EHD spraying allows for a crumpled structure to form, wastes less material than spin coating, and provides more precision than drop casting. Optimizing the synthesis and deposition of crumpled nanostructures should increase the efficiency and output of any devices relying on chemical reactions, especially solar cells and fuel cells. We expect to create a single junction solar cell with a power conversion efficiency (PCE) greater than 20%. Cells with greater PCE can be used to create more powerful batteries and solar arrays, providing significant energy generation and reducing fossil fuel dependency.

Hydrothermal Synthesis of Zinc Oxide Nanowires on Potassium Hydroxide Roughed Carbon Cloth for the Generation of 3D Hierarchical Carbon Structures

Carlos Ortuno and Jennifer Lu, PhD
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3D porous carbon structures have been regarded as one of the promising candidates for energy storage. Creating 3D porous structures with extremely large surface area consistently and reproducibly remains challenging. We are proposing the use of zinc oxide nanowires on carbon cloth as a template to generate a 3D carbon hierarchical structure. In this summer, we have been working on two projects: potassium hydroxide (KOH) roughening carbon cloth and depositing a seedlayer of zinc oxide on carbon cloth for hydrothermal growth. In this presentation, we will report the status of each project. We have demonstrated the potential of using aerosol spray to deposit KOH on carbon cloth. We also are investigating the use of electropolymerization with zinc to uniformly coat the surface of the carbon cloth. This will serve as a seedlayer for the hydrothermal growth of zinc oxide nanowire. We will demonstrate some preliminary results of zinc oxide nanowire growth.

Biocompatible method for covalent surface-tethering of long DNA using Hyrdrazone chemistry

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Techniques that probe DNA at the single-molecule level have illuminated the details of a number of complex biomolecular processes, and many of these techniques require long DNA to be tethered to a solid surface. Existing methods for tethering DNA are typically not sequence-specific, and often can generate unwanted side-reactions. For example, amide-coupling chemistry can lead to nonspecific reactions with amines in the DNA bases, and copper-catalyzed click chemistry can generate oxygen radicals, which are damaging to biomolecules. In this project we are developing a more specific and biocompatible method to covalently tether long DNA to a surface. The method relies on short 'anchor' DNA strands on the surface to capture long DNA from solution, and covalently cross-links the two strands using hydrazone chemistry. This approach is biocompatible and combines the stability of a covalent bond with the sequence specificity of base pairing. The next step will be to use this strategy to perform single-molecule force measurements on DNA.

Effects of Viscosity Index Improvers on Optically-Detected Fluid Cleanliness

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Viscosity Index Improvers (VII) are included in lubricant formulations to improve viscosity of oils over a higher range of temperatures. VII are generally comprised of polymers that can vary greatly based on their specific chemistry and molecular structure. Some light-based automatic particle counters record VII as contaminants. In order to meet stringent cleanliness goals, the effects of the VII on particle counts must be minimized. Filtration improves the particle counts, but it is unclear what impact the filtration has on the performance of the VII in oil. To investigate this, a new procedure for blending VII into oil was developed and the particle counts of various blends were studied using a filtering station. For each case, we characterized the effect of the viscosity index improvers on fluid cleanliness and the effect of filter passes on particle counts. The results provide information about the relationships between additive chemistry, optically detected oil cleanliness, and VII effectiveness.

Dr. Jing Li. a scientist from NASA-Ames, delivering a talk during one of the MACES professional seminar series.

Data-Enabled Science and Computational Analysis Research, Training, and Education for Students (DESCARTES)

The Data-Enabled Science and Computational Analysis Research, Training, and Education for Students (DESCARTES) Program is an NSF-funded four-year research, training, and education program for undergraduate applied math majors. DESCARTES Scholars are trained in state-of-the-art computational and data science. Using these skills, DESCARTES Scholars engage in research that reaches across a broad variety of disciplines.

A Level-Set Approach to Solving Poisson Equations in Irregular Domains with Robin Boundary Conditions

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Mechanical Engineering, University of California, Santa Barbara[2]

Several diffusion-dominated problems in science and engineering require the solution of Poisson-type equations in irregular domains. These types of problems include free-boundary (Stefan-type) problems that describe interesting physical phenomena such as the crystallization and solidification of different materials, where the evolution of the interface is not known a priori, and usually depends on the gradients of the solution. Therefore, it is important to develop numerical methods for solving Poisson-type equations that produce not only accurate solutions, but also accurate gradients of the solutions. In this work, we present a numerical approach for solving the Poisson equation in irregular domains with Robin boundary conditions. We employ the level-set method to represent irregular domains, and discretize the Poisson equation using a combination of a classical, second-order discretization for the internal nodes and first-order finite-volume discretization for the interfacial nodes. We demonstrate in several examples that our method is second-order-accurate in both the solution and the gradients of the solution.

Understanding Innovation through the Analysis of a Patent Dataset

Amy Bowler, Randall Nguyen, and Jason Davis, PhD
School of Natural Sciences, University of California, Merced.

The goal of this research was to find a way to track innovation. To do this, we analyzed 46 gigabytes of unstructured text data provided by the United States Patent and Trademark Office covering every patent filed between 1929 to 1979. Pairing this with a structured dataset covering 1979 to 2005, we generate a time-series of "innovation" snapshots measuring the relative contributions of each of the 50 states to the output of the United States. This work will eventually be used as input to sociological and economic studies and assessments of policies that facilitate innovation.

Analysis of San Francisco Employment from 2012-15 and its Implications

Ekaete Sarah O. Ibanga, and Michael T. Stobb, MD
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Tracking the trends for employment data has social and economic significance in today's society. Developing a general model for perceived trends in an existing dataset with a mostly-fixed employment population, such as that of the city of San Francisco, gives a standard by which to compare in our ever-changing economy. While many employment parameters exist, most are highly collinear and offer little information gain. Removing these parameters yields a lower dimensional system that still accurately predicts total pay. Furthermore, this low dimensional space can be used to classify employee's job titles, through either logistic regression or decision trees, leading us to a better overall understanding of the employees of San Francisco.

Statistical Analysis of the 2016 Presidential Primaries

Eshita Nandini, Michael Stobb, and Arnold Kim, PhD
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Statistical methods applied to county data collected for the United States 2016 presidential primaries. Methods such as random forests and linear regression used to see correlations between certain characteristics of a county and how voting for candidates worked out for counties. Characteristics looked at included ethnicities and percent poverty level in counties and preferences for presidential candidates. Correlations mapped out diagram voting patterns with major parties (Democratic and Republican). Considering the candidates nominated for both of these parties, primary results can help predict possible voting patterns for the upcoming Presidential Election.

Understanding Innovation through the Analysis of a Patent Dataset

Randall Q. Nguyen, Amy L. Bowler, Jason K. Davis, PhD
School of Natural Sciences, University of California, Merced.

We analyzed 46 gigabytes of unstructured text data provided by the United States Patent and Trademark Office covering every patent filed from 1929 to 1979. Pairing this with a structured dataset covering 1979 to 2005, we were able to generate a time-series of "innovation" snapshots measuring the relative contributions of each of the 50 states to the output of the United States. This work will eventually be used as input to sociological and economic studies and assessments of policies that facilitate innovation.

Analysis of the Forbes 2000 Ranking of the World's Biggest Companies

Timothy T. Trisnadi, Michael T. Stobb, and Arnold D. Kim, PhD
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The current information age is flooded with data, much of which is complicated and difficult to interpret. It has therefore become necessary to create computational tools that allow for the processing and analysis of large datasets. Here we examine the effectiveness of two such methods for classifying a business from the Forbes 2000 ranking of the world's largest companies, based on their market value statistics. The first is the classic logistic regression model, which models the probability of class labeling as a logistic function, the second is classification trees, which uses recursive binary splitting on factors to construct a decision tree for the data. We show that while both methods yield consistent results, the classification tree, and its family of similar methods, give better results for this dataset.

The following students are registered participants of the 2015 University of California, Merced Undergraduate Summer Research Symposium:

Effects of volcanic ash on pulse jet engines for small unmanned aerial systems engaged in observing volcanic activity

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Pulse-jet engines are currently in use on small unmanned aerial systems (SUAS) used for various applications. The simplistic design and high efficiency of a pulse jet engine is ideal for a SUAS in low altitude and high speed operations, such as is necessary for the deployment of SUASs to monitor volcanic activity. However, volcanic ash containing silica, sulfuric acid and various other elements expelled from volcanic activity may prove detrimental to pulse jet engine operations. Due to its chemical properties, volcanic ash can adversely react with metallic alloys that may cause oxidation and eventually corrode these components under certain conditions. In this paper, pressure and temperature analysis will be performed on a valved pulse-jet engine exposed to volcanic ash. Computational fluid dynamics (CFD) inspection and external barometric pressure/temperature sensors will monitor the inlet and outlet of the pulse jet to determine efficiency based on experimental temperature data. Thrust capacity is measured through a real-world spring system that will correlate to Hooke's Law and mass flow rate. Based on these factors we hope to understand how the efficiency and performance of a pulse-jet engine changes when exposed to volcanic ash, and if a pulse-jet engine would be a suitable engine for employing on a SUAS studying volcanic activity.

The Zeeman Effect and its Relationship to Laser Cooling: A Review

David Gray, Carrie A. Menke, PhD
School of Natural Sciences, University of California, Merced.

The Zeeman Effect is observed in a variety of quantum mechanical phenomena, and this is due to how an atom reacts when an external magnetic field is applied and how the electron is excited. A beam of light is used in this effect and this can be observed when laser cooling is applied, the idea of laser cooling being the way in which a beam of light is slowed by lowering its temperature to near absolute zero. Two different applications of laser cooling are used to determine this relationship between the Zeeman Effect and laser cooling, and these are the Zeeman slower and magneto-optical trapping. The relationship is determined when magnetic fields are applied and a laser beam is used, where the beam is split due to the excitation of electrons. The purpose of this project is two-fold: review the Zeeman effect, laser cooling, and the relationship between the two, and create a program using ImageJ and Excel to analyze and observe the Zeeman lab.

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