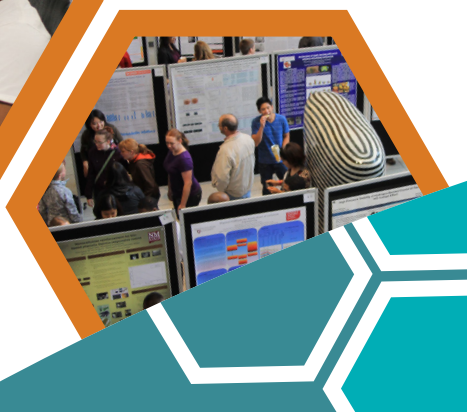
Summer 2015 at Washington State University

UNDERGRADUATE RESEARCH POSTER SYMPOSIUM



10 a.m. to 1 p.m., Friday July 31
Smith CUE Atrium, 2nd Floor
Washington State University

Office of
Undergraduate Education
Washington State University

Welcome to the WSU Summer 2015 Undergraduate Research Poster Symposium!

This summer Washington State University has been honored to host students from around the world involved in research in various programs across campus. We had 5 Research Experience for Undergraduates (REU) programs funded by the National Science Foundation (NSF), 2 program(s) funded by the United States Department of Agriculture (USDA), and others supported by private grants and funding. Student participants in these programs represent a wide range of majors, and join us from schools ranging from small colleges that only offer undergraduate degrees to large Tier 1 research universities. More than 70 students from over 40 institutions are participating in this event; one fourth of them are from WSU.

The wide range of research done by these students fits the model of undergraduate research: the students take ownership of their projects, which are mentored, unique, and appropriate to the discipline in which they work. Their work is being disseminated at today's symposium. It is quite possible that peer-reviewed journal articles and presentations to national audiences will follow for some.

Below is a list of program directors and associated programs supporting students conducting research this summer. Many are sharing their work at the 2015 poster symposium.

Amit Dhingra, Plant Genomics and Biotechnology REU
Larry Holder, Electrical Engineering and Computer Science REU
Partha Pande and **Behrooz Shirazi**, Electrical Engineering and Computer Science REU
Shelley Pressley and **Jennifer LeBeau**, Atmospheric Chemistry REU
Gretchen Rollwagen-Bollens, Landscape Ecology and Ecosystem Dynamics REU
Diane Cook and Maureen Schmitter-Edgecombe, Gerontechnology
Samantha Gizerian, College of Veterinary Medicine
Y.M. Gupta, Materials Under Extreme Conditions
Jodi Johnson-Maynard and Shelley Pressley, Regional Approaches to Climate Change
Shelley Pressley, Northwest Advanced Renewables Alliance
Lynn Turner, Pharmacy Summer Undergraduate Research Fellowship

Other faculty also work with and mentor undergraduate students in areas including chemical engineering, chemistry, and others.

The students' work, of course, would not be possible without faculty advisors participating in the programs, supervising students, and integrating them into their research groups, plus all the staff, graduate students, and other researchers on campus who have fully embraced working with these students. I would also like to note that, in addition to the financial support of the NSF and USDA, the students and programs have had financial support from various departments (and their colleges), and the Office of Undergraduate Research. I hope you enjoy the poster symposium. This abstract book will be online at our website, UndergraduateResearch.wsu.edu.

Shelley Pressley, Ph.D.
Director, Undergraduate Research
Office of Undergraduate Education

Presenters by Group and Location

Group 1: College of Veterinary Medicine (Summer Undergraduate Research Experience)			
Sec.	**Poster Title**	**Author**	**Advisor**
1.1	Motor coordination deficits and altered gene expression in Kdm6a knockout mice	Ezana Assefa	Jun Xu
1.2	Myosin head attachment time varies with sarcomere length in skinned skeletal fibers	Shelby Leighton	Bert Tanner
1.3	Optimization of the F-triggering Assay to Characterize NiV F- Mutants	Katherine D. Narvaez-Mena	Hector Aguilar-Carreno
1.4	Identifying Genomic Polymorphisms that Influence Host Mortality using the Drosophila Genetic Reference Panel	Miguel A. Rodriguez	Alan G. Goodman

Group 2: Plant Genomics and Biotechnology (REU in Horticulture)			
Sec.	**Poster Title**	**Author**	**Advisor**
2.1	Chloroplast Genomics for Understanding Genetic Diversity in Lomatium cous	Sequoia Dance	Amit Dhingra
2.2	Huckleberry TRAP analysis: Preserving culturally and medicinally important food	Danielle Guzman	Amit Dhingra
2.3	Creating cleaved amplified polymorphic sequence markers to identify herbicide resistance in weed species across the PNW	Jeanette A. Rodriguez	Ian C. Burke
2.4	Understanding the Genetic Diversity in Lomatium species	Samuel Torpey	Amit Dhingra
2.5	Morphological effects of the soil pathogen, Rhizoctonia solani, on the development of wheat plants	Aric Washines	Scot Hulbert

Group 3: Smart Environments (REU in Electrical Engineering and Computer Science)			
Sec.	**Poster Title**	**Author**	**Advisor**
3.1	Graph Pattern Mining Revisited for Personalized Knowledge Discovery	Rebecca Baumher	Yinghui Wu
3.2	Laser Power Beaming in Smart Homes	Jessie Bryant	Matthew E. Taylor
3.3	K-core Approach to Graphical Community Detection	Daniel Cardona	Ananth Kalyanaraman
3.4	Human-Robot Interaction for Flying Robot Control	Maddie Chili	Matthew E. Taylor
3.5	Intelligence and Compression	Alex Gain	Larry Holder
3.6	Learning Macro-Operators for Large Multi-Label Output Spaces	Nicholaus Jackson	Jana Doppa
3.7	A Signal Segmentation Tool to Facilitate Research involving Wireless Sensors	Ellen Louie	Hassan Ghasemzadeh

3.8	Managing Bad Data in Smart Electric Meter Measurements Using Data Mining Techniques	Glory Obielodan	Anurag K. Srivastava
3.9	Real-Time Collection of Sensor Data for Android-Based Wearables	Deontae Pharr	Hassan Ghasemzadeh
3.10	RTPMU Monitor: A multi-threaded real-time data validator for phasor measurement in smart electric grids	Sebastian S. Rodriguez	Anurag K. Srivastava

Group 4: Gerontechnology-Focused Summer Undergraduate Research Experience (GSUR)			
Sec.	**Poster Title**	**Author**	**Advisor**
4.1	Title Research Projects Documentation and Experimental Data Collection	William Quinn Bentjen	Aaron Crandall
4.2	Examining omission errors made by individuals with mild cognitive impairment and dementia when completing activities of daily living	Mary Boege	Maureen Schmitter-Edgecombe
4.3	Physical Therapist Interviews to Collect Feedback Regarding Wearable Technology	Jordana Dahmen	Diane Cook
4.4	Real-Time Web-Based Measurement of Parkinson's Tremors	Biswaranjan Das	Aaron Crandall
4.5	Web-based On-board Real-time Rendering Data System (WORRDS)	Declan Edgecombe	Aaron Crandall
4.6	Cognition & Healthy Lifestyle Factors in Healthy Older Adults	Francesca Lopez	Maureen Schmitter-Edgecombe
4.7	Repeated Real-Time Measurement of Cognition Using a Digital N-Back Task: A Pilot Study	Charles Moreno	Maureen Schmitter-Edgecombe
4.8	Imitating the behavior of a Kinect sensor in a Grideye sensor	Armin Rahimi	Aaron Crandall
4.9	Increasing Aging Services Technologies Awareness through a Video-based Intervention for Caregivers	Molly Shipman	Maureen Schmitter-Edgecombe
4.10	Activity Prompt Preferences in Smart Environments Among Older Adults With and Without Cognitive Complaints	Emily Van Etten	Maureen Schmitter-Edgecombe

Group 5: Chemical Engineering Research			
Sec.	**Poster Title**	**Author**	**Advisor**
5.1	No Adsorption on Fe-SSZ-13: Mechanistic Insight Using DFT Calculations	Emily Anderst	Jean-Sabin McEwen
5.2	Bovine Cartilage Digestion and Data Analysis	Tyler Cheung, Ashley Davie	Bernard Van Wie, Nehal Abu-Lail
5.3	Quantification of Cellulose Fibril Diameter and Particle Size of Lignin Precipitates in Various Pulp Substrates	Kirstin Egerton	Nehal Abu-Lail

5.4	Pseudomonas putida KT2442 Uptake in a Soil Column	Jordan Harvey, Jennifer Kersh	Somayeh Ramezanian, Nehal Abu-Lail
5.5	CO Hydrogenation Relevant Adsorbate Effects on Oxygen Vacancy Formations of TiO2(110)	Adam Saleh	Jean-Sabin McEwen
5.6	Effect of Solvent on Iron (II) Oxalate Dihydrate Formation and Resulting Iron-Based Catalyst	Jenny Voss	Norbert Kruse

Group 6: Atmospheric Chemistry and Climate Change (REU in Laboratory for Atmospheric Research / Civil and Environmental Engineering)			
Sec.	**Poster Title**	**Author**	**Advisor**
6.1	Quantifying Influence of Irrigation and Meteorology on Water Use Efficiency with the Eddy Covariance Technique in a Vineyard in Washington	Randy Bartoshevich	Shelley Pressley, Heping Liu, Brian Lamb
6.2	Aldehyde and Seek: Tracking R-CHO Production through the Ozonolysis of VOCs in Household Air Fresheners	A. Grant Glazer	B. Thomas Jobson
6.3	An evaluation of Amazon OH concentrations estimated from isoprene concentration, flux and products	William Holdhusen	Alex Guenther
6.4	Measuring Infiltration Rates in Homes as a Basis for Understanding Indoor Air Quality	Gabrielle Jerz	Brian Lamb, B. Thomas Jobson, Shelley Pressley
6.5	Vehicular emission ratio to determine efficiency of titanium dioxide as pollution eater	Aranxa M. Martínez Cortés	B. Thomas Jobson
6.6	Evaluation of ClearSky2 $PM_{2.5}$ Concentration	Charles C. Morris	Joseph K. Vaughan
6.7	Measuring Volatile Organic Compounds emitted from common household deodorizers as a basis for understanding indoor air quality	Inez Pabian	B. Thomas Jobson
6.8	Surface Energy Budget over an Arid Scrubland Site in Idaho	Ana Maria Zurawski	Heping Liu

Group 7: New-Generation Power-Efficient Computer Systems Design (REU in Electrical Engineering and Computer Science)			
Sec.	**Poster Title**	**Author**	**Advisor**
7.1	Analog Time-Reversal Division Multiple Access Electromagnetic Simulation	Nick Eide	Benjamin Belzer
7.2	Task Allocation	Lauren Hiland	Partha Pande
7.3	Analog Circuit Design for Time-Reversal Division Multiple Access Frequency Control	Kevin Johnson	Benjamin Belzer
7.4	Profiling and Benchmarking Graph Applications on multicore platforms for designing Network on Chips	Chan Jong	Partha Pande, Janardhan Rao Doppa, Behrooz Shirazi

7.5	A Fully-Integrated Switch-Capacitor DC-DC Converter in a 180nm CMOS	Evan Daniel Pfister	Deuk Heo
7.6	An Integrated DC-DC Buck Converter in 180nm CMOS	Lee Plunkett	Deuk Heo
7.7	Implementing Power Optimization Methodologies to Improve Energy Efficiency of Multi-Core Processors	Mohamed Azard Rilvan	Behrooz Shirazi, Partha Pande
7.8	Learning to Run Efficiently: A DVFS VFI-partitioned Multicore Platform	Ailin Yu	Partha Pande, Behrooz Shirazi

Group 8: Northwest Advanced Renewables Alliance – NARA (Summer Undergraduate Research Experience)			
Sec.	**Poster Title**	**Author**	**Advisor**
8.1	Comminution of Unmerchantable Forest Residuals to Determine Power and Energy Consumption as a Function of Moisture Content and Size Reduction Range	John Barth	Jinwu Wang, Michael Wolcott
8.2	Synthesis of Lignosulfonate Hydrogels cross-linked with PEGDGE	Maika Bui	Jinwen Zhang, Junna Xin
8.3	Making The Chemistry of the NARA Project Visible	Adriana Guzman	Karla Eitel
8.4	Activated Carbon by Chemical Activation of Lignin with Potassium Hydroxide	Shakema Haynes	Ian Dallmeyer
8.5	Preventing Nitrogen Depletion in Forests Undergoing Forest Residual Removal	Aleksandr Kirpach	Rob Harrison
8.6	Demethylation of Lignin and Lignin Model Compounds to Value Added Compounds	Kasey Markland	Xiao Zhang
8.7	Catalytic Oxidation of Lignin for Value Added Chemicals	Oshauna Morgan	Xiao Zhang
8.8	Educating Youth on Air Pollution Caused by Transportation	Jennifer Murphy	Karla Eitel
8.9	Forest Ecology and Biofuel Production Potential for Tribally-Managed Forests in the Northern Rockies	Emily Schwartz	Karla Eitel
8.10	Air Quality Impact of the NARA Biorefinery	Bailey Tebou	Brian Lamb
8.11	Characterization and Modification of Asphalt With Epoxy Resins Synthesized From Pyrolysis Oil, a Derivative of Lignocellulosic Biomass	Kyle Thompson	Jinwen Zhang, Junna Xin
8.12	CO_2 Consumption and Biofuel Transportation Adventure Race	Sarah Wilkins	Karla Eitel
8.13	Screening Value-Added Market Opportunities for Lignin	Mark Wohlpart	Paul Smith

Group 9: MARC, Honors, Chemistry, Shock Physics (Other WSU Projects)			
Sec.	**Poster Title**	**Author**	**Advisor**
9.1	Eating Undercooked Chicken Will Make You Sick	Joanna Fragoso	Michael E. Konkel
9.2	Nature, Nurture, and Behavior: Kdm6a Knockout Mice Reared in an Enriched Environment	Halle Weimar	Jun Xu
9.3	Depositing Metallic Monolayers in Graphene via Forced Redox Reactions: A Proof-of-Concept Study	Desiree Cureton-Burden	K.W. Hipps
9.4	Scanning Tunneling Microscopy Study of Temperature Dependent Rates and Activation Energy for Metal free Octaethylporphyrin at the Phenyloctane/Graphite Interface	Kevin Marchbanks-Owens	K.W. Hipps
9.5	Effects of Corrosion on the Dynamic Mechanical Behavior of Pure Magnesium	Spencer Smith	Jow-Lian Ding
	Measurement of Impact Tilt and Bowing in a 4" Bore Light Gas Gun	Ken Yang	Y. M. Gupta

Group 1: College of Veterinary Medicine (Summer Undergraduate Research Experience)

1.1	**Motor coordination deficits and altered gene expression in Kdm6a knockout mice**	1.1

Undergraduate Researcher: Ezana Assefa

Faculty Advisor: Jun Xu

Other Collaborators: Terri Driessen, Halle Weimar, Kevin Lewallen

Home Institution: Nova Southeastern University, Behavioral Neuroscience, Senior

Abstract:

Epigenetic changes are reversible chemical modifications of the chromatin that modulate gene expression. They are pivotal to brain development and function, and have been implicated in neuropsychiatric disorders. Kabuki syndrome, a neurodevelopmental disorder, is marked by fine motor deficits, intellectual developmental delay and dysmorphism. It is caused by mutations in one of two genes, Mll1 and Kdm6a, a histone methyltransferase and demethylase, respectively. Kdm6a codes for a histone demethylase that targets lysine 27 on the N-terminal tail of histone H3 (H3K27). Consequently, Kdm6a mutations result in over-methylated H3K27 that cause chromatin condensation and gene repression.

We have previously generated neuron-specific Kdm6a knockout mice (Kdm6aDel), which exhibit the motor coordination deficits reminiscent of Kabuki syndrome. In the current study, we set out to investigate where in the brain Kdm6a acts to promote motor coordination and what motor-related genes Kdm6a modulates.

We first examined c-Fos expression, a marker for neuronal activity, in brain regions involved in motor coordination between Kdm6aDel and wild type mice following a motor task. Next, we performed reverse transcriptase – quantitative polymerase chain reaction (RT-qPCR) in whole brain and in discrete motor-relevant brain regions, testing genes identified in a prior RNA-sequencing analysis. We are currently in the midst of data analysis following the completion of these experiments.

c-Fos analysis suggested altered neuronal activity in Kdm6aDel mice at specific brain sites including ones linked to motor coordination (e.g. motor cortex and cerebellum). These changes in brain activity might be in turn due to down-regulated expression of genes in the mutant mice, such as Grin3b, an NMDA receptor subunit, as known in RNA-seq and RT-qPCR analysis. These results shed new light upon the etiology of Kabuki syndrome, pointing to novel potential therapeutic targets. They also help us better understand how epigenetic chromatin remodeling impact on brain function and behavior.

1.2	**Myosin head attachment time varies with sarcomere length in skinned skeletal fibers**	1.2

Undergraduate Researcher: Shelby Leighton

Faculty Advisor: Bert Tanner

Other Collaborators: Axel Fenwick

Home Institution: Washington State University, Chemistry, Junior

Abstract:

Cardiac and skeletal muscle contraction results from the calcium regulated binding of the motor protein myosin to the actin filament, which leads to generating a force producing cross-bridge. Previous research has shown calcium sensitivity in skinned skeletal fibers to be impacted by sarcomere length. We hypothesize that sarcomere length might also affect myosin cross-bridge attachment time (ton) in skinned skeletal fibers. This was tested by two groups of soleus muscle fibers, at short (2.0μm) and long (2.5μm) sarcomere lengths, as dictated by the skeletal length-tension relationship. The calcium sensitivity was measured by titrating fibers from 8.0 (relaxed) to 4.8 (activated) pCa (pCa=-log10- [Ca2+}, similar to pH) and fitting the force-pCa data to a Hill equation. The attachment time of a myosin head on an actin filament was measured by stochastic length perturbation analysis. Confirming previous research, the force-pCa data shows lower calcium sensitivity at short vs. long sarcomere length. We also found different ton values between long and short sarcomere lengths, which were 82±11ms for 2.0 μm and 96±7ms for 2.5 μm. This drop in ton values for shorter sarcomere lengths is thought to be due to lattice spacing within the muscle fiber, which in turn strains the myosin head to early detachment. It is thought that this increased spacing might persist in shorter sarcomere lengths due to the filaments bowing outwards from the compression of being shortened.

1.3	**Optimization of the F-triggering Assay to Characterize NiV F- Mutants**	1.3

Undergraduate Researcher: Katherine D. Narvaez-Mena

Faculty Advisor: Hector Aguilar-Carreno

Other Collaborators: Juana Lizbeth Zamora-Reyes, Erik Contreras

Home Institution: Mary Baldwin College, Biomedical Sciences, Senior

Abstract:

NiV virus uses glycoproteins located on its surface to undergo viral-cell membrane fusion, which is required for viral entry. The synchronized action of attachment glycoprotein (G) and the fusion glycoprotein (F) allow membrane fusion after the host cell's ubiquitous receptor (EphrinB2/B3) attaches to G. This binding triggers F to undergo a conformational cascade where it forms a pre-hairpin intermediate (PHI) that launches a fusion peptide into the host cell membrane; the PHI is composed of HR1 and HR2 regions that coalesce to form the six-helix bundle (6HB), driving membrane fusion.

Our goal is to characterize F by studying alanine point mutants in F, and their role in fusion, using the F-triggering assay. Glycoprotein G and F plasmids and GFP were transfected into PK13 cells for 18 hours. Transfected PK13 cells were then incubated with PK13 cells without or with expressed EphrinB2 (PK13 B2) at 4°C to allow receptor binding. After receptor binding, the HR2-cy5 peptide, a HR2-peptide conjugated to the Cy5 red flourophore that binds to F in the PHI conformation, was incubated with the transfected PK13 cells and target cells to detect F triggering by flow cytometry. For optimization of the assay, a series of tests were conducted in order to improve transfection efficiencies. CHOB2 and PK13B2 were analyzed to determine which had higher expression levels of EphrinB2. We also tested whether serum-free media or opti-mem reduced serum media induced higher levels of transfection. Troubleshooting this protocol allowed us to optimize transfection in the PK13 cell line, and determine that PK13B2's had higher expression of EphrinB2. Opti-mem medium also improved transfection rates. Our future focus will be to analyze hyperfusogenic and hypofusogenic mutants in the the HR3 region of F to determine if and how this region modulates F pre-fusion and PHI transition.

1.4	**Identifying Genomic Polymorphisms that Influence Host Mortality using the Drosophila Genetic Reference Panel**	1.4

Undergraduate Researcher: Miguel A. Rodriguez

Faculty Advisor: Alan G. Goodman

Home Institution: Brown university, Economics, Junior

Abstract:

Insects, much like humans, hinge on innate immune mechanisms to combat pathogenic infection. Further, the Drosophila genome contains many homologous genes with humans that function in the immune sensing of infections. Therefore, we set out to utilize a suite of 100 inbred Drosophila melanogaster lines from the Drosophila Genetic Reference Panel (DGRP) to screen for polymorphisms that affect the animals' susceptibility to infection with Kunjin virus and insect iridescent virus 6 (IIV-6). Kunjin virus, a subtype of West Nile Virus, is a flavivirus that belongs to a group of vector-borne RNA viruses. It enters both vertebrate and invertebrate cells via clathrin-mediated endocytosis. Once it has entered the cells, this small-enveloped virus containing a single stranded, positive sense RNA genome hijacks cellular pathways to promote its replication. Contrastingly, IIV-6 is a dsDNA virus that targets RNAi machinery in Drosophila. Data has shown that Drosophila infected with IIV-6 respond with an RNAi antiviral defense mechanism as an innate immune response. Although the cellular pathways appropriated to expedite the infection of mammalian cells have been extensively studied, little is known about cell-intrinsic antiviral genes that may restrict the Kunjin virus, IIV-6 virus, or many other insect-borne viruses. By conducting this study, we'll identify specific genomic polymorphisms unique to each fly line in order to analyze how they contribute to host mortality. We will then identify homologous human genes and interrogate the role they play during viral infection.

Group 2: Plant Genomics and Biotechnology (REU in Horticulture)

2.1	**Chloroplast Genomics for Understanding Genetic Diversity in Lomatium cous**	2.1

Undergraduate Researcher: Sequoia Dance

Faculty Advisor: Amit Dhingra

Other Collaborators: Bruce Williamson, Richard Sharpe

Home Institution: Washington State University, Human Development, Senior

Abstract:

Native American communities continue to rely on native plants for food, medicinal and spiritual purposes. Lomatium cous, known as “Cous Cous”, is an important perennial plant for the Plateau people who are indigenous peoples with traditional homelands in northern Idaho, western Montana, eastern Washington, eastern Oregon and northeastern California. Lomatium cous can have two dormancy periods during its life cycle. The second dormancy period occurs only under unfavorable environmental conditions. Lomatium cous roots are ready for harvest three to four years after planting. These two factors result in over harvest of the plant, causing lesser roots to accumulate for the subsequent year. There is limited information regarding the genetic diversity of Lomatium cous till date. Polymorphic chloroplast sequences are routinely utilized for phylogenetic and genetic diversity analysis that enables comprehensive characterization of a genus in a taxonomic context. Approaches that have been previously utilized in the lab to characterize two novel plant species, Bienertia sinuspersici and Suaeda aralocaspica, along with the ASAP (Amplification, Sequencing and Annotation of Plastid genomes – Dhingra and Folta, 2005) approach will be used for the identification of inter- and intra-species variation of Lomatium cous. Samples will be collected from various geographical locations. Chloroplast genome sequences from these samples will be amplified using PCR and sequenced for analysis of the genetic variation and association with different collection locations. This approach will allow for the association of genetic information with specific ecotypes that have already been characterized for medicinal and ethnobotanical properties of importance to Native American communities. Completion of this study will help establish a framework to evaluate the genetic diversity of additional Native American plant species and provide tools that are necessary for the conservation and restoration of traditional homeland ranges.

2.2	**Huckleberry TRAP analysis: Preserving culturally and medicinally important food**	2.2

Undergraduate Researcher: Danielle Guzman

Faculty Advisor: Amit Dhingra

Other Collaborators: Seanna Hewitt, Benjamin Kilian, Richard Sharpe, Samuel Torpey

Home Institution: University of Idaho, Environmental Horticulture and Nutrition

Abstract:

Many Vaccinium species, common name huckleberry, are found in the Western United States and have been a culturally important food source for several Native American tribes for centuries. In addition, Vaccinium species are also used for their medicinal properties. Huckleberries are slow growing and can take up to 15 years to reach full maturity. Because of the plant's slow developmental rate, viable methods for commercial propagation have yet to be established. Population structure and genetic diversity analysis of Vaccinium species will be instrumental to understand genetic diversity, facilitate cultivation efforts, and be a foundation for conservation and restoration efforts. Target Region Amplified Polymorphism markers (TRAP) analysis is an efficient and cost effective method used to interpret both structure and diversity of a given population. The utility of this PCR based technique has been validated on several plant species. By utilizing TRAP analysis to study huckleberry populations across a variety of habitats information will be gained regarding genetic diversity and population structure. This information will contribute to the knowledge regarding Vaccinium species and will facilitate conservation and restoration efforts that seek to preserve this culturally, nutritionally and medicinally important genus.

2.3	**Creating cleaved amplified polymorphic sequence markers to identify herbicide resistance in weed species across the PNW**	2.3

Undergraduate Researcher: Jeanette A. Rodriguez

Faculty Advisor: Ian C. Burke

Other Collaborators: Rachel Lindell, Caleb Squires

Home Institution: Heritage University, Medical Lab Science, Junior

Abstract:

In the Pacific Northwest (PNW) herbicide resistance in diverse weed species has become a major problem. With repeated herbicide applications, weeds have become resistance to many groups of herbicides such as acetyl-CoA carboxylase (ACCase) inhibitors, acetolactate synthase (ALS) inhibitors, and Photosystem II inhibitors. There are several ways to detect herbicide resistance including screening, sequencing, and cleaved amplified polymorphic sequence (CAPS) markers. Most methods are expensive and time consuming. However, the development of CAPS markers for multiple weed species is cost effective and fast. A CAPS base method will also allow growers to improve the management of their weeds with informative data about the resistant weed populations present in their field. In order to create CAPS markers, DNA was extracted from a diverse set of susceptible and resistant weeds submitted by growers. Primers where designed based on known mutations for individual species followed by Polymerase Chain Reaction (PCR) to amplify DNA fragments. Sanger Sequencing was performed on amplified DNA to identify the SNPs within the DNA. Next, restriction digests are performed and gel electrophoresis is used to identify band fragments. Resistance or susceptibility is determined based on the length of the fragments. Once the mutations are identified, the goal is to create CAPS markers to recognize a point mutation across different dicots or several monocots. Currently, there are three enzyme digest using CAPS markers that are being optimized in the hopes of diagnosing herbicide resistance among the different weed species of the PNW.

2.4	**Understanding the Genetic Diversity in Lomatium species**	2.4

Undergraduate Researcher: Samuel Torpey

Faculty Advisor: Amit Dhingra

Other Collaborators: Seanna Hewitt

Home Institution: University of Idaho, Ecology and Conservation Biology

Abstract:

Native flora of the Western United States provided food for people before modern agricultural practices were put into place. However, in the last century Native edible flora has declined in its use and habitat range. The family Apiaceae, which include celery, carrots and parsley, is home to the perennial herb genus Lomatium. Apiaceae has been studied phylogenetically, however intrageneric analysis of Lomatium species is lacking. It is not only important to understand phylogenetic relationships in this genus from a taxonomic stand point, it is also important for conservation and restoration efforts. Ethnobotanical importance of species in the Lomatium genus, such as Lomatium cous, require additional study to benefit future generations as well as the native ecosystem. An interdisciplinary approach using propagation, genetics, and metabolomics can be useful in addressing multiple concerns such as ecology, conservation, ethnobotany, and economics. Lomatium species collected from the Palouse and surrounding areas will be analyzed for genetic diversity. Target region amplified polymorphism (TRAP) analysis is an efficient and cost effective method of elucidating both structure and diversity of a given population. This method was recently utilized on a population of 152 pears, Pyrus communis, representing the progeny of crosses between three different cultivars. The analysis allowed for effective discernment of segregation of individuals in the population based on valuable agronomic rootstock properties. By utilizing these methods to study the genetic diversity of Lomatium species, we will gain an understanding of diversity and relationships among populations within the genus which may facilitate conservation and restoration efforts of this culturally and nutritionally important clade.

2.5	**Morphological effects of the soil pathogen, Rhizoctonia solani, on the development of wheat plants**	2.5

Undergraduate Researcher: Aric Washines

Faculty Advisor: Scot Hulbert

Other Collaborators: Aaron Mahoney

Home Institution: Heritage University, Environmental Studies, Senior

Abstract:

Soil borne pathogens such as Rhizoctonia solani are a causal agent of root disease and bare patch of wheat in the Pacific Northwest, USA. This soil fungus is a necrotrophic pathogen that damages the roots of wheat plants in fields under no-till or minimum tillage management. Wheat roots that are damaged by the pathogen will cause the plant to be stunted. These stunted plants will have reduced access to water and nutrients leading to a reduction in overall yield for the growers. Currently, no commercial varieties of wheat are resistant to the pathogen, however some genotypes of wheat are more tolerant than others. Using the AG-8 strain of R. solani, root damage on two wheat genotypes (Louise A and SPCB 3104) was tested. It has been demonstrated that SPCB 3104 genotype has a greater tolerance to the soil pathogen, compared to the commercial variety, Louise. These genotypes were grown in soils with and without, R. solani. Measurements from the leaves and roots were collected and recorded using manual measurements and scanned root images. Using WinRHIZO software, root length, diameter, surface area, and volume was determined. Additionally, the objective was to identify potential differences in other wheat genotypes grown in soils without the pathogen. The hypothesis was that tolerance observed in the two lines could be attributed to differences in root morphology, and that these traits may have some overlap to other wheat genotypes. These morphological differences could provide alternative root traits for increased tolerance to the pathogen, as well as, other beneficial traits, for breeding purposes.

Group 3: Smart Environments
(REU in Electrical Engineering and Computer Science)

3.1	**Graph Pattern Mining Revisited for Personalized Knowledge Discovery**	3.1

Undergraduate Researcher: Rebecca Baumher

Faculty Advisor: Yinghui Wu

Other Collaborators: Qi Song

Home Institution: University of Pennsylvania, Computer Science, Senior

Abstract:

Rich information are represented as knowledge graphs. People, places, and things are nodes in the knowledge graphs, and edges tell us how these entities are related. In this project, we utilize the YAGO dataset which has over 10 million nodes and 120 million facts, extracted from Wikipedia among other sources. This project aims to study effective models and mining algorithms to discover interesting fact in knowledge graphs. (1) We evaluate conventional graph pattern mining (GRAMI) and association rule discovery (AMIE) algorithms over real-world knowledge graphs. We found that these methods are limited in discover significant knowledge. (2) We study a new type of graph patterns, namely, localized graph patterns, to capture interesting patterns specified by personalized interests. The localized graph patterns extend conventional patterns with specified search conditions over the entity attributes and relationships. (3) We develop nontrivial extension of the conventional data mining techniques to support the discovery of localized graph patterns. Our experimental study verifies that localized graph pattern can capture more interesting patterns. This work leads to a future development of personalized knowledge and social graph knowledge mining tool.

3.2	**Laser Power Beaming in Smart Homes**	3.2

Undergraduate Researcher: Jessie Bryant

Faculty Advisor: Matthew E. Taylor

Other Collaborators: Kayl Coulston, James Irwin, Yang Hu, Lorin Vandegrift

Home Institution: Washington State University, Mechanical Engineering, Junior

Abstract:

Laser power beaming is the method of charging devices by transmitting energy via the high density light of a laser. This project focuses on using this technology to power sensors in smart homes in order to eliminate the need for wired connections and the replacement of batteries. Instead, the sensors can be charged remotely. The system involves two major parts: the base and the receiver. The base houses the camera, computer system, low-power visible laser, high-power near infrared laser, and beam directing mirrors powered by small motors. The receiver's main component is the silicon based vertical-multijunction photovolatic cells designed for high light concentrations and high voltage outputs. These cells are centered between two LED lights for positioning and are part of a circuit connected to a capacitor for storing the acquired energy. To charge, the camera first locates the visible laser and LEDs, signals the motors, and lines the laser up with the midpoint of the LEDs, targeting the receiving cells. Once in place, the visible laser is dismissed while the near infrared laser powers on and begins transmitting energy. By our calculations, this system has the capability to charge sensors within smart homes. With minor alterations, it could be used for many other purposes as well, whether stationary objects or moving targets are involved. Over 10 million iRobot Roombas have been purchased worldwide, and in the future, this home charging system could be integrated into a similar autonomous multipurpose robot.

3.3	**K-core Approach to Graphical Community Detection**	3.3

Undergraduate Researcher: Daniel Cardona

Faculty Advisor: Ananth Kalyanaraman

Home Institution: Cornell University, Biometry & Biological Statistics, Senior

Abstract:

Clustering in networks has numerous applications throughout several disciplines. An approach for identifying clusters involves computing a partitioning of the input network, known as community detection. This typically involves an objective function called modularity. Nevertheless, there are faster classical partitioning graphical operations, namely k-core decomposition, that do not abide to an objective function. In this work, we investigate the relationship between the two graph operators through comparative evaluation of their identified modules, or communities, within a network. With better understanding of such a relationship, we could propose a clustering method using k-core decomposition and, thus, create a faster competing approach to community detection via modularity.

3.4	**Human-Robot Interaction for Flying Robot Control**	3.4

Undergraduate Researcher: Maddie Chili

Faculty Advisor: Matthew E. Taylor

Other Collaborators: Tanay Nigam, Bei Peng, Mitchell Scott

Home Institution: Elon University, Computer Science and Communication Design, Junior

Abstract:

Human-Robot Interaction (HRI) is a relatively young field, however it is growing rapidly. This field is expanding beyond academic communities as more people are exposed to robots in their everyday lives such as robotic toys and household appliances. Robots are being studied and developed for real-world applications such as educational or health care purposes. To further this technological development, we designed an experiment to determine the effect instructions can have on an individual's performance and interaction with an AR Drone 2.0. We hypothesize that the instructions will significantly change how they pilot the AR Drone 2.0. First, participants went through a brief training session on how to fly the unmanned aircraft system (UAS). Then, we split the participants into two groups based on different instructions and alternated between the two instruction sets for every other participant. We told one group the UAS was an inexpensive toy and the other that it was an expensive piece of research equipment. We told both groups to fly the UAS as quickly as possible without hitting any of the obstacles. Then participants flew the UAS through a specified obstacle course. The obstacle course featured flying to the right of a pole, then flying through and to the right of a hula-hoop and finally flying around the left side of the first pole before landing in a green square. We examined the time and accuracy of flying the UAS. After the course, participants answered a short survey that included questions about individuals' age, gender, experience with a UAS, experience with video games, and thoughts during the experiment such as nervousness and belief of the value of the UAS. Experiments are ongoing at the time of this abstract submission, thus we cannot draw any conclusions yet.

3.5	**Intelligence and Compression**	3.5

Undergraduate Researcher: Alex Gain

Faculty Advisor: Larry Holder

Home Institution: Tulane University, Mathematics and Computer Science, Senior

Abstract:

Our research aims to explore the relationship between compression and intelligence. There are three projects currently being worked on: 1. The Hutter prize — a text-based compression challenge, 2. a graph compression challenge, and 3. using spiking neuron models to design an intelligent agent with compression as a reward signal. For the Hutter prize, a program was written which identifies the structure of the text and compresses it based on the structure. The resulting compression outperformed standard compression algorithms. For the graph compression challenge, a program was written which identifies common data structures and patterns in the graph and represents them in a way that leads to compression. We will create a website where users can compete and upload compressed graphs. If successful, we hope to see intelligent methods for compressing graphs developed by users. For the project involving designing an intelligent agent, we have implemented an agent which consists of a small number of neurons and learns to select an action which leads to more compression out of two options available. This is the simplest starting point and we will work to build on this to design a more complex agent that will hopefully display complex and intelligent behavior in dynamic situations. From this, using compression as a reward, we would be able to observe a direct link between compression and intelligent behavior.

3.6	**Learning Macro-Operators for Large Multi-Label Output Spaces**	3.6

Undergraduate Researcher: Nicholaus Jackson
Faculty Advisor: Jana Doppa
Other Collaborators: Jin Tao
Home Institution: New York University, Computer Science, Senior

Abstract:

This research deals with the problem of multi-label classification when there are large numbers of labels. In a multi-label prediction problem, the goal is to predict all the relevant labels for a given input object. For example, in image tagging, we want to predict the labels of all the objects that are present in a given image. Multi-label problems arise in a number of domains including text, images, videos, biology, ecology, and smart environments. There are two main challenges in learning predictors for multi-label problems: 1) Jointly predicting the labels by exploiting the relationships between labels to improve accuracy compared to predicting labels independently; and 2) Automatically adapting the learning approach to the task loss function that is most appropriate for the real-world application at hand. Recent work (Doppa et al., 2014) showed that there are several advantages of looking at multi-label prediction as a search problem in addition to addressing the two main challenges. However, the search-based approach has severe scalability issues when there are large number of labels. To address scalability, we leverage and adapt existing dimensionality reduction techniques to learn macro search operators to improve the efficiency of a pre-specified search space. Our preliminary results on multiple benchmark domains show that we are able to learn a small set of macro search operators with little or no loss in accuracy.

3.7	**A Signal Segmentation Tool to Facilitate Research involving Wireless Sensors**	3.7

Undergraduate Researcher: Ellen Louie
Faculty Advisor: Hassan Ghasemzadeh
Home Institution: George Washington University, Computer Science, Senior

Abstract:

Sensor data from wearable sensors such as smartwatches and smartphones are used in many different research fields, including health and medicine. However, once the data is collected from the devices, researchers need to develop software algorithms such as machine learning techniques based on labeled captured data. To carry out further research and be able to develop algorithms, it is necessary for researchers to be able to divide up the often-large datasets and label the data. The data file segmentation tool is built with Java and Python using Jython to connect the two. This tool allows researchers to select a comma-separated values (CSV) file and the sensor signals they would like to plot, and then creates a line graph. From there, they can select annotation points such as the beginning and end of the specific events on the signal (e.g., start and end of a physical activity), and store those portions of the signal in a new set of CSV files. The goal of this data segmentation tool is to facilitate research in wireless sensors and data collection by relieving the burden on the researcher of having to visually identify the annotation points on the signal, which is labor intensive and prone to human errors.

3.8	**Managing Bad Data in Smart Electric Meter Measurements Using Data Mining Techniques**	3.8

Undergraduate Researcher: Glory Obielodan

Faculty Advisor: Anurag K. Srivastava

Other Collaborators: Guo Yu

Home Institution: Utah State University, Computer Engineering, Sophomore

Abstract:

It is not uncommon to find error incidences in smart electric meter data collection. The flawed data can lead to poor decision making, resulting in unintended consequences. These errors can easily go unnoticed in large data. It is therefore necessary to detect bad data before the data is processed and possibly replace them with the best estimate. The goal of this project is to utilize data mining techniques to sift through a given set of data, find bad data in the data stream, and replace them with the proper values based on historical trends. The first technique developed was a Python computer program based on statistical algorithms. The algorithms used the average of the data and its standard deviation. Using these statistics, an acceptable data range was established. The developed computer program has thus far been successfully tested using a small synthetic data of two hundred and seventy numerical values with known errors generated by electric distribution system analysis tool GridLab-D. In the future, further testing will be done to assure the program's effectiveness.

3.9	**Real-Time Collection of Sensor Data for Android-Based Wearables**	3.9

Undergraduate Researcher: Deontae Pharr

Faculty Advisor: Hassan Ghasemzadeh

Other Collaborators: Niloofar Hezarjaribi

Home Institution: Kennesaw State University, Computer Science, Senior

Abstract:

The goal of this project is to develop a data collection tool that captures data from wireless wearable devices in real-time. The system can be used for development of remote monitoring intervention for patients with a chronic illness. The devices we are working with includes the Samsung Galaxy Gear 1 smart watch and Samsung Galaxy S4 phone, which are both powered by the Android platform that contains very precise and accurate sensors built into the hardware such as accelerometers and gyroscopes. Specifically focusing on the accelerometer and gyroscope sensors, the data that is derived from the smart watch will be transmitted to its paired handheld device via Bluetooth. Utilizing the Bluetooth functionality offers a system of real-time communication between these two wirelessly connected devices. Once the data is collected, we can analyze the data using machine learning algorithms to detect medication adherence using unique patterns of hands movements.

3.10	**RTPMU Monitor: A multi-threaded real-time data validator for phasor measurement in smart electric grids**	3.10

Undergraduate Researcher: Sebastian S. Rodriguez

Faculty Advisor: Anurag K. Srivastava

Other Collaborators: HyoJong Lee

Home Institution: Northwestern University, Computer Engineering, Senior

Abstract:

Real-time monitoring of phasor measurement unit (PMU) data is critical for situational awareness and real-time decision-making in the electric power grid. Considering the amount of PMU data that passes through a server every second, it is important to keep track of inter-PMU data trends. Since PMUs may log data at variable rates through multiple routing switches, a considerable amount of noise is always present. A way to validate erroneous data points must be accurate in real-time to ensure the veracity of depending applications. In this work, RTPMU Monitor, a multi-threaded application has been developed in .NET 4.5 using the PI Software Development Kit (PI SDK) developed by OSISoft. RTPMU Monitor queries PMU data points from a PI system and detects outliers in real-time using standard data mining procedures. Users can define different methods and parameters to correct extraneous data and opt to replace questionable points with a more approximate measurement. The validation process is shared concurrently between threads, allowing for multiple PI server tags to be validated at the same time, all while visualizing data in real-time. Validating the PMU data allows critical trends to be more trustworthy in detecting the operating system condition, which in returns allows engineers to track system faults, transients, stress, loads, among other system parameters.

Group 4: Gerontechnology-Focused Summer Undergraduate Research Experience (GSUR)

4.1	**Title Research Projects Documentation and Experimental Data Collection**	4.1

Undergraduate Researcher: William Quinn Bentjen

Faculty Advisor: Aaron Crandall

Other Collaborators: Declan Edgecombe, Bishu Das, Armin Rahimi

Home Institution: Pullman High School

Abstract:

I am working on documentation and data collection assistance for smart environment research projects, as well as assisting in the installation of one of the smart homes. A lot of my work on the smart environments is mapping the environment and sensor placement inside the environment. One of the reasons documentation of the area is important is because of the layout of the environment may change resulting in different patterns for the sensors, an example of this is if a table is in a path most people will change their walking path to go around the table instead of going around it changing the data that could have been acquired if the table wasn't in the path. It also allows for visualization to be achieved easier by making a drawing of the room to scale. After all the rooms' walls and dimensions were written down they were turned into a scaling vector graphic image (SVG or .svg which are like normal images but when a SVG is enlarged it will not get pixelated like a rasterized image for example a .jpg or .png file) of the room with some furniture and other objects like tables, desks, couches, etc. Once the mapping is done it will be used with Declan's "W.O.R.R.D.S."(temporary name for some code Declan has been working on to make updated version of PyViz) page so all the sensors will light up on the map I also have been helping test a activity learning app for iPhones that is meant to slowly learn your habits and will eventually try to predict what you are doing, which it has done with me on several occasions.

4.2	**Examining omission errors made by individuals with mild cognitive impairment and dementia when completing activities of daily living**	4.2

Undergraduate Researcher: Mary Boege

Faculty Advisor: Maureen Schmitter-Edgecombe

Other Collaborators: Jenna Beaver

Home Institution: Washington State University, Biology, Postbaccalaureate

Abstract:

Older individuals with dementia and with mild cognitive impairment (MCI), a pre-dementia stage, have difficulty completing complex everyday tasks of daily living (e.g. cooking and managing finances). The social and financial cost of individuals with these impairments is high. Researchers are developing technologies to allow impaired individuals to retain their autonomy and successfully remain in their home. The goal of this project was to determine the types of task steps that are left out by dementia and MCI participants when completing tasks of daily living. The following study compared 130 older adult participants (aged 53-94) who were classified as having MCI (n=52), dementia (n=13), or having no cognitive impairment (n=65). To control for age and education, each cognitively impaired individual was matched with a healthy participant of the same age and education level. Participants completed eight everyday tasks of daily living in a campus apartment, including writing out a birthday card, sweeping and dusting, cooking, and operating a DVD. Omissions of activity steps during task completion (i.e. steps not completed) were coded and analyzed by categories as: preparatory (e.g. retrieved broom), action-oriented (e.g. writes a birthday wish), and concluding (e.g. returns DVD to the pile). Across all three categories, the dementia group committed significantly more omission errors than their healthy control counterparts. In contrast, the MCI group committed significantly more errors than controls only in the action-oriented category. Our study suggests that action-oriented omissions errors are most common in MCI, with preparatory and concluding omission errors becoming more prominent in dementia. Information about omission error types can be used in the future to create specific reminders for impaired individuals in their home.

4.3	**Physical Therapist Interviews to Collect Feedback Regarding Wearable Technology**	4.3

Undergraduate Researcher: Jordana Dahmen

Faculty Advisor: Diane Cook

Other Collaborators: Gina Sprint, Douglas Weeks

Home Institution: Washington State University, Biology, Junior

Abstract:

Wearable technology has the potential to augment current subject evaluation with objective measurements of gait in inpatient rehabilitation settings. An ongoing study at St. Luke's Rehabilitation Institute has been investigating such wearable sensor-derived measurements by having patients perform a sequence of ambulatory tasks that resemble every day activities. Gait characteristics are computed from the collected acceleration and angular velocity data from three wearable inertial sensors. From this data researchers are able to quantitatively describe ambulation performance and present the information with visualizations such as plots and graphs. The results of this research are relevant to the engineering community; however, the usefulness of this data for the clinical community has not been verified. To investigate the clinical utility, Physical Therapists (PT) from St. Luke's were recruited to undergo an interview process to gather their feedback (N=4 currently). PTs were presented with several gait metrics and visual displays of gait characteristics. They were then asked a series of questions related to the data and its perceived usefulness. The PT responses yield both qualitative and quantitative evidence regarding applicability and adoptability for wearable sensors in rehabilitation. Expected analysis includes comparisons between responses from different PT classifications, such as PT vs. PT-aid, prior experience with wearable technology vs no prior experience with wearable technology, etc. Preliminary results indicate there are trends and correlations along with averages that can be calculated from the questions that utilized a rating system (from a scale of 1-5). For example so far there has been a difference in responses between PTs who have prior experience with wearable technology vs no prior experience. On the 1-5 scale of usefulness PTs with no prior experience rated the Whole Body Movement metrics a 2.33 on average while PTs with prior experience rated its usefulness a 3.83.

4.4	**Real-Time Web-Based Measurement of Parkinson's Tremors**	4.4

Undergraduate Researcher: Biswaranjan Das

Faculty Advisor: Aaron Crandall

Home Institution: Washington State University, Computer Science, Senior

Abstract:

Parkinson's disease is a progressive nervous system disorder affecting over 7 million people worldwide. One of the primary symptom is tremors in the range of 3-7Hz, often in the extremities. Proper pharmaceutical treatment requires frequent tracking of tremor severity. Currently these tremors are often measured by visual inspection, which is subjective and unreliable. Objective methods currently in-use or being developed involve wearable sensors. These sensors can often be intrusive and their weight can mask tremor symptoms. This project delivers a prototype of a real-time, web-based platform that can be deployed in every day homes and be used to measure Parkinson's Tremors by clinicians remotely on any modern browser. We use Intel's RealSense F200 cameras to track hand-movements. RealSense F200 is a full VGA depth resolution, 1080p RGB Camera capable of tracking 22 hand points with a resolution of <1mm at a range of 0.2-0.85 meters. We also use Shimmer (V3) to validate the camera data. Shimmer (V3) is a wearable sensor which provides accelerometer and gyroscope data at a very high-resolution. This project sends data obtained from the camera and the wearable sensor to the cloud where a lightweight webserver analyzes and validates these data sets and sends it forward to client machines. Future studies will move from clinical settings to a more home setting without requiring additional wearable sensors. This work enables clinicians to remotely view the data and the results in almost real-time.

4.5	**Web-based On-board Real-time Rendering Data System (WORRDS)**	4.5

Undergraduate Researcher: Declan Edgecombe

Faculty Advisor: Aaron Crandall

Other Collaborators: Vishnu Das, Quinn Bentjen

Home Institution: Washington State University, Electrical Engineering, Senior

Abstract:

The Gerontological community heavily relies on data. The data collection process allows one to create multiple different displays to a user. While this may be more widely used in many other disciplines including design and system maintenance, it is an extremely helpful tool for the participants of studies. These spaces are “smart homes”, and having a live image of what is happening in the home allows researchers to visualize what is going on in the home, while drawing conclusion at the same time, giving them a sense of how the system works.

Currently, the Center for Advanced Studies in Adaptive Systems (CASAS) is using a tool that only runs directly off a computer’s desktop, which is connected to the smart home system. Although this tool functions nicely, it is platform dependent and came be improved significantly. Through HTML5, CSS, JavaScript, JQuery, Flask, RabbitMQ, and SVG images, the new tool streams data from the sensors speedily through a web server and onto a website accessible from anywhere by anyone on the Internet. This results in a tool that can be easily set up in additional smart homes to see figure out what is happening in these houses and judge how well the system works.

4.6	**Cognition & Healthy Lifestyle Factors in Healthy Older Adults**	4.6

Undergraduate Researcher: Francesca Lopez

Faculty Advisor: Maureen Schmitter-Edgecombe

Other Collaborators: Kayela Robertson, Christa Simon

Home Institution: San Diego State University, Psychology, Postbaccalaureate

Abstract:

With the older adult population increasing, it is important to investigate factors that support cognition in older adulthood. Cognitive processes, including task monitoring, selective attention, task shifting, and reasoning, typically decline with age. The current study examined the relationship between healthy lifestyle factors and cognition in healthy older adults. Forty-five healthy older adults ($M = 67.1$, $SD = 7.82$) were administered cognitive tests and completed subjective self-report measures that assessed physical activity (CHAMPS) and sleep quality (PSQI). To gather objective data, a subset of participants ($N = 11$) was randomly assigned actigraph-accelerometers (Withings Pulse O2) for seven days that recorded physical activity and sleep data. Hierarchical regression analyses revealed that age (entered in block 1) accounted for a significant amount of the variance on the cognitive tests of working memory, ($F = 21.38$, $p < .001$), and task-switching, ($F = 11.55$, $p = .002$). Although the addition of the physical activity and sleep measures did not lead to a statistically significant increase in variance explained for any of the cognitive measures, self-reported physical activity uniquely predicted selective attention performance ($t = -2.03$, $p = .050$), while self-reported sleep quality uniquely predicted task-switching performance ($t = 2.26$, $p = .031$). The objective and self-report subjective measures of physical activity and sleep quality did not significantly correlate with one another. The results of the current study indicate that physical activity and sleep quality may play a role in supporting cognition in healthy older adults. Consistent with prior work, the results also revealed a discrepancy between subjective and objective measures of physical activity and sleep. It will be important to further examine lifestyle factors as they pertain to cognition using both objective and subjective measures.

4.7	**Repeated Real-Time Measurement of Cognition Using a Digital N-Back Task: A Pilot Study**	4.7

Undergraduate Researcher: Charles Moreno

Faculty Advisor: Maureen Schmitter-Edgecombe

Other Collaborators: Robert Fellows, Shirin Shahsavand

Home Institution: San Diego State University, Psychology, Senior

Abstract:

Ecological momentary assessment (EMA) is a form of data collection involving repeated report of affect, behavior, and cognitions. This method of data collection can be useful for gathering detailed real-time information to identify patterns and fluctuations in cognition over time. Despite the advantages, utilizing EMA for neuropsychological assessment is particularly challenging because practice effects may obfuscate the accuracy of serial testing sessions. If a stable level of 'baseline' performance can be reached, then fluctuations in performance on the neuropsychological task throughout the day could be used to provide real-time information about cognition. The purpose of the present pilot study was to identify the number of test administrations required before practice effects are negligible, and then to determine whether fluctuations in performance throughout the day could be related to environmental and physiological factors such as fatigue, stress, exercise, and other possible factors. Baseline performance was established for reaction time, number of completed trials, and accuracy derived from 50 trials of the neuropsychological task (i.e., an n-back task) administered to younger adults (N = 5) using a computerized tablet. Descriptive statistics revealed that reaction time decreased and number of trials completed within a 45-second interval increased over test administrations. The findings revealed that a baseline performance for reaction time and number of completed trials could be reached for all participants. We are now using this n-back task with an EMA application (app) on a tablet to examine the natural variability in cognitive performances that may occur throughout the day or be related to certain other environmental or physiological factors (e.g., fatigue, stress). It is expected that this data will reveal fluctuations in cognitive abilities that can be matched to daily tasks (e.g., exercise) suggesting that repeated administration of a brief neuropsychological task could be used to provide real-time information about cognition.

4.8	**Imitating the behavior of a Kinect sensor in a Grideye sensor**	4.8

Undergraduate Researcher: Armin Rahimi

Faculty Advisor: Aaron Crandall

Home Institution: Washington State University, Computer Science, Senior

Abstract:

In order to be able to integrate technology into the field of gerontechnology, engineers need access to data. Sometimes, however, the sensors used to gather the data are either expensive or very large. The aim of this research project is to see if it is possible to substitute the Microsoft Kinect with a simple grideye sensor, and use some machine learning algorithms to imitate the behavior of a Kinect in the grideye sensor.

The grideye sensor that was used in this project outputted 64 temperature values that can be mapped onto an eight by eight grid. Using this grid the relative position of a person standing in front of the sensor can be determined. However, to ensure that the readings from the sensor are correct, they need to be compared and contrasted with the readings from the Kinect. The field of view of the Kinect was divided into 64 cells as well. Using the center of mass of a person in front of the sensor, their position was mapped onto one of the cells in the field of view of the Kinect sensor. Comparing the positon the Kinect sees to the thermal values of the grideye sensor, it can be easily determined that the grideye sensor is correct in its temperature readings and the positioning.

The grideye sensor however is much more limited than the Kinect in terms of the amount of information it outputs. Thus a machine learning algorithm was used that successfully enabled the grideye sensor to behave like the Kinect sensor, and give all the information a normal Kinect sensor would.

4.9	**Increasing Aging Services Technologies Awareness through a Video-based Intervention for Caregivers**	4.9

Undergraduate Researcher: Molly Shipman

Faculty Advisor: Maureen Schmitter-Edgecombe

Other Collaborators: Joyce Tam

Home Institution: Washington State University, Neuroscience, Senior

Abstract:

Research has shown that aging services technologies (ASTs) can reduce caregiver burden. However, ASTs have been underutilized due to a lack of awareness. This study evaluated the effectiveness of a video-based intervention for caregivers. Thirty-eight caregivers completed a series of questionnaires and an AST knowledge-based tool task before (T1) and after (T2) they viewed videos that discussed memory aids, medication management tools, and daily living aids. The questionnaires assessed AST-related knowledge, attitudes, stigma as well as the overall helpfulness of the intervention. A majority of the participants were female (N=27). Most caregivers indicated that their care-receivers had a hard time doing daily task due to medical conditions (N=31). The highest ranked challenges by caregivers that their care-receiver faced were remembering and managing medications, trouble exercising and completing housework and high fall risk. The biggest group of caregivers lived with their care-receiver (N=15). Compared to pre-intervention (T1), Wilcoxon Signed Ranks tests showed that caregivers were significantly more accurate post-intervention (T2) at correctly identify AST tools (T1 Mdn = 6, T2 Mdn = 10; $p < .001$). Caregivers also self-reported a higher level of perceived AST-related knowledge (T1 Mdn = 3.2, T2 Mdn = 4.4; $p < .001$) and endorsed a lower level of AST-related stigma (T1 Mdn = 3.60, T2 Mdn = 4.00; $p = .041$) after viewing the videos. There were no pre-post differences found in AST attitude (T1 Mdn = 4.83, T2 Mdn = 4.83; $p < .05$), however, attitude scores were highly positive and near ceiling to start. Overall, most participants felt that the intervention was helpful (N=31). The preliminary findings from this study suggested that the video-based intervention was beneficial to caregivers and may have clinical and educational implications.

4.10	**Activity Prompt Preferences in Smart Environments Among Older Adults With and Without Cognitive Complaints**	4.10

Undergraduate Researcher: Emily Van Etten

Faculty Advisor: Maureen Schmitter-Edgecombe

Other Collaborators: Alyssa Weakley, Diane Cook

Home Institution: San Diego State University, Psychology, Senior

Abstract:

The U.S. older adult population is projected to double by 2050, with rates of individuals with cognitive impairments also increasing. Research has shown that prompting devices can help older adults maintain independence with some activities of daily living (ADL). However, preference regarding how a prompt is delivered is currently unknown. Because older adults are more likely to utilize technologies they find beneficial, the purpose of this study was to compare preferences for different prompting modes among older adults with and without cognitive difficulties. Older adults (n = 170), were told to make a specific error (e.g., leaving faucet on) for each of three different daily activities (e.g., watering plants) that they completed in a campus smart apartment. To rectify the errors, participants were given three different prompt modes: indirect, direct, and multimodal. Indirect verbal prompts directed the participants back on task but did not tell them exactly what to do, direct verbal prompts told the participant exactly what to do, and multimodal prompts verbally directly told and visually showed a video of what needed to be done. Participants were asked which prompt they preferred the best and also given a battery of tests and questionnaires to assess cognitive abilities. Participants were median split according to level of self-reported cognitive complaints on a questionnaire and matched on age and education. It was found that participants reporting more cognitive difficulties preferred the multimodal prompts, while participants reporting less cognitive difficulties had a preference for direct prompts ($p = .033$). Further analysis revealed significant correlations between memory measures and type of prompt preferred ($ps<.05$), while other domains of cognition (e.g., executive functioning, language) did not significantly correlate with type of prompt preferred ($ps>.05$). These findings suggest that as observed and reported memory abilities decline, individuals desire greater prompting support.

Group 5: Chemical Engineering Research

5.1	**No Adsorption on Fe-SSZ-13: Mechanistic Insight Using DFT Calculations**	5.1

Undergraduate Researcher: Emily Anderst

Faculty Advisor: Jean-Sabin McEwen

Other Collaborators: Renqin Zhang, Feng Gao, János Szanyi

Home Institution: Washington State University, Chemical Engineering, Junior

Abstract:

Emission of hazardous NOx gases from lean-burn diesel engines is a continual concern for the automotive and transportation sectors of developed nations. To address this concern, the catalysis community has been exploring removal of NOx through selective catalytic reduction by ammonia over Fe and Cu exchanged zeolite catalysts. To design systems that better facilitate this process, mechanistic insight into zeolite behavior is crucial. One study, conducted by Boubnov et al., involving Fe-ZSM-5, proposed Fe2+-O+H-N=O as an intermediate complex, this alludes towards fundamentally different mechanistic behavior for NO adsorption between Fe and Cu-containing catalysts. To investigate this, our study explored NO adsorption on an –OH stabilized Fe-SSZ-13 zeolite catalyst. Density Functional Theory calculations were conducted to elucidate the most likely reaction complexes produced upon adsorption at the active sites of the six- or eight-membered ring (6MR or 8MR) which makeup the zeolite framework. We examined both Fe2+ (as [Fe2+(OH)-]+ and Fe3+ (as [Fe3+(OH)-]2+) as the active sites.

Based on our results, initially, the most energetically favorable site is found within the 6MR, however, with the addition of adsorbates, we found sites within the 8MR to be more favorable. This behavior is consistent with our previous work involving Cu-SSZ-13. Our results show that, for Fe2+, the most stable configuration occurs within the 8MR, where NO is co-adsorbed with OH on Fe. Likewise, for Fe3+, we found that the lowest energy configuration was achieved when NO adsorbed directly onto Fe within the 8MR without interaction with the OH ligand. Our findings cast doubts on the proposed intermediate species (Fe2+-O+H-N=O) and, consequently, the conclusion that Fe and Cu exchanged catalysts exhibit different behavior upon NO adsorption. To further validate our results and provide experimentally relevant references, computational X-ray emission spectroscopy, X-ray Adsorption Near Edge Structure spectra and Infrared Spectroscopy will be produced.

5.2	**Bovine Cartilage Digestion and Data Analysis**	5.2

Undergraduate Researcher: Tyler Cheung, Ashley Davie
Faculty Advisor: Bernard Van Wie, Nehal Abu-Lail
Other Collaborators: Arshan Nazempour, Chrystal Quisenberry
Home Institution: Washington State University, Chemical Engineering and Bioengineering, Senior

Abstract:

Cartilage is the vascular tissue surrounding moving joints. Because of its nature, cartilage tissues do not heal upon injury. As such, researchers have been attempting hard to culture cartilage in vitro in bioreactors. Our lab aims at engineering cartilage in a unique centrifugal bioreactor using simultaneous chemical and mechanical stimuli. Chondrocytes present the main cell type in a cartilage tissue. To engineer cartilage, chondrocytes are seeded in the reactor with appropriate growth factors and mechanical conditions. We aim at harvesting large number of chondrocytes for further experiments. To do that, bovine knee joints are obtained fresh as donations from local butchers. The bovine knee joins are aseptically treated to get the cartilage. After harvesting the cartilage, a collagenase solution is used to break down the peptide bonds in collagen and to separate the extracellular matrix from the cells. Separated cells are then incubated for approximately sixteen hours. After that, cells are strained and washed to help eliminate any possible contamination. Once this is complete, cells are prepared for freezing and future experiments. Contamination is always checked by culturing a swab of the digestion solution on a plate with Tryptic soy agar. Contaminated cells are thrown away. In addition to the experiments, we analyze data from engineered cartilage tissues that were under the atomic force microscopy (AFM).

AFM was used to map the density and locations of N-cadherins and β-integrins on the surface of chondrocytes. To profile for these proteins, six force-volume maps are screened for specific antigen-antibody binding forces using a home-built software. Finally, the force-volume maps are analyzed for quantification of the mechanical properties of the cartilage tissues. In conclusion, our research helps identify the relationship between the structure of cartilage and its functionality as a mechanical sensor.

5.3	**Quantification of Cellulose Fibril Diameter and Particle Size of Lignin Precipitates in Various Pulp Substrates**	5.3

Undergraduate Researcher: Kirstin Egerton

Faculty Advisor: Nehal Abu-Lail

Other Collaborators: Baran Arslan, Xiao Zhang

Home Institution: Washington State University, Chemical Engineering, Senior

Abstract:

An analysis was performed on atomic force microscope images of cellulosic biomass in order to obtain a quantitative analysis on the fibril and particle sizes present in lignocellulosic substrates when subjected to different pretreatments. Fibril and particle diameters were measured from an array of images using the AFM software offline image analysis. Histograms of the distributions of the diameters found for lignin particles and cellulosic fibers were then constructed to investigate the substrates heterogeneity. Lignin free substrates showed uniform fibril size with a diameter of approximately 25 nm. It can be concluded that treatment methods had no significant effect on fibril diameter size. Kraft lignin precipitates have ≈18% larger particle sizes compared to lignosulfonates and orgonosolv lignin. This might be due to the higher hydrophobicity of kraft lignin which results in increased aggregation of the lignin. In conclusion, our results indicate that the control substrates that we work with are largely homogenous in their surface composition. This is important to studies aiming at elucidating the roles of cellulose, lignin and xylan on biomass interactions with enzymes.

5.4	**Pseudomonas putida KT2442 Uptake in a Soil Column**	5.4

Undergraduate Researcher: Jennifer Kersh, Jordan Harvey

Faculty Advisor: Somayeh Ramezanian, Nehal Abu-Lail

Other Collaborators: Mohammed Alibrahim

Home Institution: Washington State University, Chemical Engineering, Senior

Abstract:

Past research has shown that biofilms of nonpathogenic bacteria can be used to improve the mechanical properties of soils. In order to form biofilms, bacteria must first adhere to the soil. Our research focused on the adhesion of the bacteria P. putida to sand at varying pH levels. To quantify this adhesion, a solution of phosphate buffered saline (PBS) and bacteria was run through a column of sand. The growth of the bacteria was monitored in a previous experiment, allowing us to use the bacteria when they were in the late exponential phase of growth. The PBS was adjusted to a desired pH level and the solution's optical density (OD) was adjusted to 0.1 and then the bacterial solution was run through the sand column. The amount of bacteria remaining in the solution after being run through the column was measured by taking the OD of roughly 2 mL samples of the effluent every 32 seconds. The pore volume and the relative bacterial concentrations were then calculated from this data and plotted to form breakthrough curves. A breakthrough curve that shows a higher relative bacterial concentration in the effluent indicates that the bacteria did not adhere as strongly to the column. Our data shows that bacteria suspended in PBS of pH 4 had the highest adhesion to the sand, whereas bacteria suspended in PBS of pH 10 had the weakest adhesion to the sand column. From these results, we conclude that P. putida adheres strongly to sand at lower pH levels, implying stronger biofilms will form in soils of lower pH's.

5.5	**CO Hydrogenation Relevant Adsorbate Effects on Oxygen Vacancy Formations of TiO2(110)**	5.5

Undergraduate Researcher: Adam Saleh

Faculty Advisor: Jean-Sabin McEwen

Other Collaborators: Gregory Brandon Collinge

Home Institution: Washington State University, Chemical Engineering, Senior

Abstract:

CO hydrogenation to higher alcohols by Fischer-Tropsch synthesis over CoCu-based catalysts is currently being researched as an alternative to the energy-intensive and petroleum-reliant industrial process of olefin hydroformylation [1-3]. These higher alcohols are used as chemical feedstock for plastics and other highly desirable products, and producing them from domestically derived and potentially renewable CO and H2 would represent a significant step toward carbon-neutral energy independence for the United States. Experimental evidence suggests that oxides play a critical role in the selectivity and activity of CoCu-based catalysts [1], and as such, oxides are the focus of this study. Specifically, we wish to quantify how adsorbates relevant to CO hydrogenation over CoCu-based catalysts effect the reduction and re-oxidation potential of rutile TiO2 (a convenient oxide model) during reaction.

To accomplish this goal we have used Density Functional Theory (DFT) calculations to determine how single atoms of Co and Cu, as well as CO, influence oxygen vacancy formation on oxygen and hydroxyl terminated TiO2(110) surfaces. Hydroxyl terminated surfaces are included to capture realistic reaction conditions in which hydrogen deposition by solvent or reactant gases are potentially relevant. While pure DFT treatment of oxides is known to inaccurately describe oxide electronic properties, energetic trends have been shown to be unaffected [4], and this work will therefore only use the pure DFT treatment. Our preliminary results indicate that the lowest coordinated oxygens of either surface are the most susceptible to the formation of vacancies, which is in accordance with Pabisiak et al [5]. Kim et al. [6] have found that the addition of adsorbents to TiO2 tends to increase these vacancy formation energies and this will be investigated for the case of Co, Cu, and CO in future work.

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5.6	**Effect of Solvent on Iron (II) Oxalate Dihydrate Formation and Resulting Iron-Based Catalyst**	5.6

Undergraduate Researcher: Jenny Voss

Faculty Advisor: Norbert Kruse

Home Institution: Washington State University, Chemical Engineering, Senior

Abstract:

Iron based catalysts are extensively explored due to the availability and cheap cost of iron metal. The preparation of iron based catalysts remains crucial because of the complicated chemical phase composition under catalytic reaction conditions. We therefore have explored iron (II) oxalate dihydrate as a precursor to non-supported iron catalysts and report here on its preparation and characterization along with its thermal decomposition and activation into the desired catalysts. In particular, the effect of solvent used during iron oxalate precipitation has been investigated. Accordingly, iron (II) oxalate was precipitated using iron (II) dichloride tetrahydrate and oxalic acid dihydrate in water, ethanol and isopropanol. To favor nucleation of precipitating iron (II) oxalate over its growth into larger particles, a quick precipitation procedure was used. The rationale behind this procedure was to create high specific surface area materials for the catalytic CO hydrogenation to fuel additives. We present infrared spectroscopic evidence for iron (II) oxalate formation and demonstrate the occurrence of iron (II) oxidation state by X-ray photoemission. In a subsequent step, we have activated the iron (II) oxalate precursor by thermally decomposing it using temperature programmed methods (TPDec). The resulting Fe/FeOx catalyst, with an oxalate precursor developed in ethanol, was found to exhibit a specific surface area of 5.09 m2/g which is considered favorable for catalytic reaction studies in the future.

Group 6: Atmospheric Chemistry and Climate Change (REU in Laboratory for Atmospheric Research / Civil and Environmental Engineering)

6.1	**Quantifying Influence of Irrigation and Meteorology on Water Use Efficiency with the Eddy Covariance Technique in a Vineyard in Washington**	6.1

Undergraduate Researcher: Randy Bartoshevich

Faculty Advisor: Shelley Pressley, Heping Liu, Brian Lamb

Other Collaborators: Jackie Chi, Patrick O'Keefe, Pete Jacoby, Hossein Sadeghi

Home Institution: Washington State University Tri-Cities, Environmental Science, Junior

Abstract:

Washington State has taken its place as the second largest grape producer in the nation, with the warming of the climate and the future growth of population it is possible that water will become a much scarcer resource. This presents a problem for the farmers and their ability to make decisions on how to use their water, versus the quality of grapes produced. To help Washington grape farmers make informed decisions in regards to irrigation strategies, research is in progress to better understand Water Use Efficiency (WUE) at Ciel du Cheval vineyard on the Alcora Estate in Benton City, WA. WUE is defined as the ratio of Net Ecosystem Exchange (NEE) or the exchange of carbon dioxide (CO2) between the biosphere and the atmosphere, and Evapotranspiration (ET) or the water use. Eddy covariance (EC) flux measurements are being collected to measure NEE and ET, with other parameters. The EC tower is equipped with instruments capable of measuring meteorological quantities (e.g., air temperature, relative humidity, rainfall, wind direction and wind speed, etc.) as well as vertical fluxes, or vertical transport of sensible heat, latent heat, and CO2. Results from this study will include continuous flux measurements of NEE and ET and the resulting WUE calculation. The goal is to quantify the relationship between WUE and environmental conditions such as soil moisture, and air temperature, along with the farmer's use of water cooling systems, and wind turbine systems. These measurements will allow for more precise information to be available to the farmers to aid in the decision making processes for water management, irrigation strategies, and grape production.

6.2	**Aldehyde and Seek: Tracking R-CHO Production through the Ozonolysis of VOCs in Household Air Fresheners**	6.2

Undergraduate Researcher: A. Grant Glazer

Faculty Advisor: B. Thomas Jobson

Other Collaborators: Yibo Huangfu, Inez Pabian

Home Institution: Stanford University, Atmosphere and Energy Engineering, Junior

Abstract:

In the fight against climate change, engineers and policymakers are turning to energy-efficient homes as a means of lowering greenhouse gas emissions. These new homes rely on improved insulation to reduce the amount of energy used for utilities. Corollary to this is a reduction in air exchange throughout the home, often leading to an accumulation of hazardous air pollutants. Washington State University's Laboratory for Atmospheric Research is undertaking a four-year EPA-funded research investigation analyzing indoor air quality as it pertains to climate change and human health. As part of this study, the chemical composition of commercial air fresheners was investigated. Products such as candles and aerosol sprays are known to emit volatile organic compounds (VOCs). This project first characterized the gases released by household air fresheners before analyzing their secondary products produced from ozonolysis reactions. During preliminary trials, off-gases from several air fresheners, including a candle, a wall plug-in, and wax melts, were diluted into 14 SLPM of blended nitrogen and zero air in a 150 L environmental chamber. VOC content was analyzed using a gas chromatograph – mass spectrometer (GC-MS). The chromatograms from the preliminary trials reveal the presence of hydrocarbon-based solvents, ozone-reactive monoterpenes such as limonene and alpha-pinene, and several known carcinogens, including toluene. In later trials, ozone was added to the N2/zero air blend in controlled mixing ratios ranging from 50ppbv to 140ppbv. Inferences made based on known ozonolysis reactions and the relative concentrations of monoterpenes between trials indicated the presence of potentially hazardous secondary products, including ketones and aldehydes. Further analysis determined the mass emission rate of compounds of interest for each air freshener product. This information will be used later to analyze the presence of these chemicals in the homes used in the EPA study.

6.3	**An evaluation of Amazon OH concentrations estimated from isoprene concentration, flux and products**	6.3

Undergraduate Researcher: William Holdhusen

Faculty Advisor: Alex Guenther

Other Collaborators: Dasa Gu, Pradyumn Singh

Home Institution: Reed College, Math-Physics, Senior

Abstract:

Isoprene is a volatile organic compound emitted by trees that has a large influence on atmospheric chemistry. One of the main reactants with isoprene is the hydroxyl radical (OH). Due to its high reactivity and short atmospheric lifetime, it is very difficult to measure hydroxyl directly, so instead, most studies have used indirect approaches to infer concentrations.

Concentrations of isoprene and its reaction products methyl vinyl ketone (MVK) and methacrolein (MACR) measured by a proton transfer reaction mass spectrometer (PTMRS) aboard an aircraft as a part of the GOAmazon project will be used to calculate hydroxyl concentrations in two separate methods, one using the concentration ratios of isoprene and products, the other using isoprene flux and concentration. Previous studies have shown that these methods produce very different OH concentrations (differing by a factor of 3-10). To evaluate these differences, OH concentrations will be calculated for two separate sites and for both rainy and dry seasons. Also, a sensitivity study will be conducted with a 1D chemistry and transport model, MXL, to investigate the relationship between OH, isoprene, isoprene products, and isoprene flux.

6.4	**Measuring Infiltration Rates in Homes as a Basis for Understanding Indoor Air Quality**	6.4

Undergraduate Researcher: Gabrielle Jerz

Faculty Advisor: Brian Lamb, B. Thomas Jobson, Shelley Pressley

Other Collaborators: Maddy Fuchs

Home Institution: City Colleges of Chicago, Chemistry, Sophomore

Abstract:

Infiltration rates of houses are important to understand because ventilation can be a dominate factor in determining indoor air pollutant level. There are chemicals that are emitted from surfaces or point sources inside the home which are harmful to humans; these chemicals come from various objects including furniture, cleaning supplies, building materials, gas stoves, and air fresheners. The use of proper ventilation to cycle cleaner outdoor air into the house can be crucial for maintaining healthy living conditions in the home. At the same time, there can also be outdoor pollutants which infiltrate the house and contribute to poor indoor air quality. In either case, it is important to determine infiltration rates as a function of outdoor weather conditions, the house structure properties and indoor heating and cooling systems.

In this work, the objective is to measure ventilation rates using periodic releases of a tracer gas and measuring how quickly the tracer concentration decays. CO2 will be used as the tracer gas because it is inert and harmless at low levels. An Arduino timer is connected to a release valve which controls the release of 10.00 SLPM of CO2 into the uptake vent within the test home. CO2 will be released until there is at least a 200 to 300 ppm increase above ambient indoor levels. Computers with CO2 sensors and temperature/pressure sensors attached will be used to record data from different locations within the home which will continuously record data up to a week. The results from these periodic ventilation measurements will be analyzed with respect to outdoor wind and temperature conditions and house structure properties. The data will also be used to evaluate an established indoor air quality model.

6.5	**Vehicular emission ratio to determine efficiency of titanium dioxide as pollution eater**	6.5

Undergraduate Researcher: Aranxa M. Martínez Cortés

Faculty Advisor: B. Thomas Jobson

Other Collaborators: Claudia A. Toro

Home Institution: University of Puerto Rico-Río Piedras, Environmental Science, Senior

Abstract:

Mobile sources are the main constituents of urban air pollution, having a direct impact on public health and the environment. However, strategies like new fuel and engine technologies are designed to mitigate these vehicular emissions. A different method is suggested for the performed experiment, using the phocatalyst titanium dioxide (TiO2) to coat the surface of two different road materials: asphalt and concrete. TiO2 is known to be effective to degrade NOx and volatile organic carbons. These compounds can be damaging to health and are the precursors for photochemical ozone pollution. Photoactive urban surfaces could be a cost effective air pollution mitigation strategy for the world's mega cities. In this experiment, an environmental chamber constructed of transparent PFA Teflon film was setup on the roof of a building in the Washington State University, Pullman. Six samples of either asphalt or concrete, already coated with the photocatalyst were placed in the chamber and air was sampled to measure loss of NOx relative to CO upon exposure to solar radiation. Relative humidity, temperature, and air flow through the chamber were also measured.. CO was used as a tracer for pollution, but also because it does not get adsorbed in the TiO2 surface of the samples. With these measurements, a ratio between CO and NOx for vehicular emissions was established to determine if the coating on the samples is effective at removing harmful oxides of nitrogen from the ambient air. Different experiments have been performed using similar methodology, but none have done it under real outdoor conditions. Results from this experiment will help to elucidate if the proposed removal mechanism of harmful NOx species from the atmosphere will be effective in real outdoor conditions.

6.6	**Evaluation of ClearSky2 $PM_{2.5}$ Concentration**	6.6

Undergraduate Researcher: Charles C. Morris

Faculty Advisor: Joseph K. Vaughan

Home Institution: Valparaiso University, Meteorology and Mathematics, Senior

Abstract:

ClearSky2 (CS2), a system simulating PM2.5 concentrations from agricultural field burning smoke, is evaluated using observations of PM2.5, among others, from the RARE 2013 campaign. CS2 is an air quality simulation system that predicts PM2.5 concentrations from agriculture burn scenarios for use in the management of agriculture burning and protection of air quality and human health. Burn parameters, such as acres to burn and fuel load in tons per acre, are converted by CS2 into point source Sparse Matrix Optimized Kernel for Emissions (SMOKE) input files. SMOKE calculates estimates of emissions varying over time and space, including plume rise. CS2 is equipped for multiple scenarios and the PM2.5 emissions are extracted from each scenario and treated as a unique tracer. CS2 uses Community Model for Air Quality (CMAQ) to simulate dispersion of PM2.5 tracers, resulting in hourly gridded concentration maps. In 2013, an agricultural burning emissions study called RARE observed PM2.5 and other VOC concentrations from field burns near Nez Perce, ID and Walla Walla, WA. RARE measured these concentrations with airborne and ground-based instruments. The CS2 results for PM2.5 concentrations are compared to those observed in the RARE field study. The fires around Nez Perce and Walla Walla are treated as point sources in CS2. Though CS2 utilizes the 4-km Weather Research and Forecasting model (WRF) meteorology, here we also try using the 1.33-km WRF. CS2 results are tested against observations from RARE. The 1.33-km WRF meteorology may capture smaller scale winds and provide increased accuracy. The HYSPLIT trajectory model is utilized for further analysis as it tracks a single parcel of air or smoke from a point source and presents its atmospheric track through the atmosphere. Testing ClearSky's accuracy can add confidence for CS2 use and also guide further development.

6.7	**Measuring Volatile Organic Compounds emitted from common household deodorizers as a basis for understanding indoor air quality**	6.7

Undergraduate Researcher: Inez Pabian

Faculty Advisor: B. Thomas Jobson

Other Collaborators: Yibo Huangfu, A. Grant Glazer

Home Institution: Northern Arizona University, Biochemistry, Senior

Abstract:

The Washington State University Laboratory for Atmospheric Research is initiating the exploratory phase of a three-year EPA-funded study to analyze indoor air quality as it pertains to health and climate change. A number of indoor air quality measurements will be used to determine a wide range of indoor pollutant sources associated with the off-gassing of everyday household products and materials. A common source of pollution in homes originates from household deodorizers, specifically air-freshener sprays1. The objective of this project was to assess volatile organic compounds (VOC's) released from various fragrant aerosol sprays to determine the reactivity of these chemical compounds with ozone. Gas chromatography/mass spectrometry (GC/MS) was used to characterize and compare VOC's emitted from a variety of Glade scented sprays and an all-natural Pure Citrus non-aerosol spray. In addition, selected household deodorizers were reacted with ozone inside an environmental chamber to simulate indoor air conditions. Secondary products of ozonolysis reactions with monoterpenes were examined to further determine the potential effects that deodorizers have on indoor air quality. Preliminary results from the chemical survey of scented sprays indicate a number of VOC's that will readily react with ozone such as α-pinene, Δ3-carene, and limonene, to form secondary pollutants. Furthermore, carcinogenic and mutagenic compounds that include toluene, benzene, and xylene isomers were found in most samples. Findings from this study will be applied to future data collected from indoor air samples obtained from several homes as a basis for understanding indoor air quality in the Northwestern United States.

6.8	**Surface Energy Budget over an Arid Scrubland Site in Idaho**	6.8

Undergraduate Researcher: Ana Maria Zurawski

Faculty Advisor: Heping Liu

Other Collaborators: Eric Russell, Zhongming Gao

Home Institution: Humboldt State University, Environmental Engineering, Junior

Abstract:

Sagebrush ecosystems provide important ecosystem services in the arid and semi-arid regions of the North American West. Due to natural and anthropogenic disturbances and climate change, these ecosystems are experiencing widespread degradation changing the ecosystem-atmosphere interactions. By considering changes in the surface energy budget, ways to quantify and predict this ecosystem's feedbacks to climate can be achieved. Eddy covariance data were collected from May through August of 2014 at a height of 60m over sagebrush-dominated ecosystems near Idaho Falls, Idaho. Our objective is to study how meteorological variables affect the partitioning of surface-based net radiation into latent, sensible, and soil heat fluxes. In arid and semi-arid regions, soil moisture availability has great impact on ecosystem evapotranspiration thus causing changes in the surface energy budget. Our study will allow for an improved understanding of how climate change will alter land surface processes over sagebrush ecosystems in a northwestern arid and semi-arid region.

Group 7: New-Generation Power-Efficient Computer Systems Design
(REU in Electrical Engineering and Computer Science)

7.1	**Analog Time-Reversal Division Multiple Access Electromagnetic Simulation**	7.1

Undergraduate Researcher: Nick Eide

Faculty Advisor: Benjamin Belzer

Other Collaborators: Robert Olson, Joe Baylon

Home Institution: Washington State University, Electrical Engineering, Junior

Abstract:

Wireless networks-on chip (WiNoCs) for multi-core systems-on-chip employ on-chip wireless links to reduce power consumption and latency compared to wired NoCs. Previously proposed WiNoCs, with single-channel omni-directional antennas, rely on token passing to access the wireless medium, causing significant timing delays. Spatially and temporally focusing the energy using Time-Reversal Division Multiple Access (TRDMA) offers a faster and more power efficient solution by creating spatial channels between each Tx/Rx pair.

Past proposed TRDMA systems utilize digital sampling, which is not practical for WiNoCs due to their extremely short-duration on-chip impulse responses. To demonstrate the feasibility of analog TRDMA employing Fourier series (FS) approximations, simulations are run with Finite Difference Time Domain (FDTD) software. A 60-gigahertz Gaussian modulated pulse is sent from one transmitting (Tx) antenna on a silicon chip with copper ground plane. The on-chip electric field at a location (Rx) several mm away is measured as a pass-band signal, from which the base-band complex envelope (CE) is obtained. FS analysis determines the number N of FS coefficients needed to accurately approximate the CE. The time-reversed conjugated CE approximation is then converted back to pass-band and transmitted from the Rx antenna. The effect of channel reciprocity should focus the energy spatially and temporally at the Tx.

Preliminary results suggest that when the time-reversed signal is transmitted, the original narrow impulse is received at the Tx. The FS approximation order needed is definitely less than 60 and appears to be suitable at 40.

If TRDMA is shown to work for a WiNoC then this could reduce the power consumed by the chip and speed up the transfer of data between processors on-chip.

7.2	**Task Allocation**	7.2

Undergraduate Researcher: Lauren Hiland

Faculty Advisor: Partha Pande

Other Collaborators: Eshan Mohandesi, Shervin Hajiamini

Home Institution: Western Oregon University, Computer Science, Senior

Abstract:

With the Dynamic voltage and frequency scaling (DVFS) we are able to increase the processor speed to improve performance or decrease its speed to save power. We want to accurately predict when to either decrease or increase the voltage and frequency on a processor in order to maximize potential power savings and minimize time penalty. The processors have both busy and idle cycles. Busy cycles are more computation intensive and thus we want to be faster during busy cycles. Idle cycles are less computation intensive, therefore we want to save power, and decrease the processors power consumption. We are using a modular discrete event driven computer system simulator platform called gem5 to run the simulations for our algorithm. On Gem5 we have run experiments with different numbers of cores, varying cache sizes, and high or low processing speed. The algorithm we are currently working on is task allocation algorithm designed to exploit DVFS in a multicore system. With this algorithm we are using voltage and frequency scaling in multicore systems to increase performance while being conscious to power constraints. Currently we are running different simulations using our task allocation algorithm and extracting the task times and communications needed to make task graphs. Once the required data has been extracted we can use our algorithm to test the information.

7.3	**Analog Circuit Design for Time-Reversal Division Multiple Access Frequency Control**	7.3

Undergraduate Researcher: Kevin Johnson

Faculty Advisor: Benjamin Belzer

Other Collaborators: Pawan Agarwal

Home Institution: University of California Santa Cruz, Electrical Engineering, Senior

Abstract:

Multi-core processing eventually runs into timing delay issues when the number of cores and the distance between them increases. Time Reversal Division Multiple Access (TRDMA) offers an efficient solution which reduces power consumption in wireless network-on-chip (WiNoc) systems. TRDMA takes advantage of the fact that wirelessly transmitted signals take multiple paths to a receiving antenna. By spatially and temporally focusing all of a signal's energy on a desired receiver, we reduce the power needed to transmit information between cores that are far apart. Previously proposed TRDMA systems utilized digital sampling, which is not practical for WiNoCs due to extremely short-duration on-chip impulse responses. To demonstrate the feasibility of analog TRDMA with Fourier series (FS) approximations, tunable high-Q bandpass filters must be designed in order to calculate the FS coefficients. Varactors (Variable Capacitors) were used to vary the capacitance and tune the bandpass filter by changing its center frequency. Tuning the filter in this way secured the greatest gain while reducing an adequate amount of power. To get this result, we used a sawtooth wave to control the voltage difference between the drain and the source of the varactor.

In ongoing work we believe that we can show that time and spatial localization can be improved with this circuit. We have simulated and created a tunable high Q inductor-less bandpass filter that significantly reduces the area used on a chip. This reduces the power used in TRDMA and promises to improve the efficiency of multi-core processing.

7.4	**Profiling and Benchmarking Graph Applications on multicore platforms for designing Network on Chips**	7.4

Undergraduate Researcher: Chan Jong

Faculty Advisor: Partha Pande, Janardhan Rao Doppa, Behrooz Shirazi

Home Institution: University of Georgia, Computer Science, Senior

Abstract:

Due to the accelerating scaling of information, the "Big Data" computing paradigm has emerged to make sense of the data. Unfortunately, the industry standard for analyzing and categorizing Big Data, Graph analytics, is computationally intensive and involve complex data movements. Owing to these demands, Graph Analytics is best performed on massive multicore architectures with high bandwidth interconnects. In this regard, efficient Network on Chip (NoC) architectures with emerging wireless technologies represent a viable solution that can be tailored to the communication characteristics of Graph analytics. In this work, we profile the inter-core communication characteristics in order to create efficient NoCs for each of the four prevalent Graph Analytic applications: Community Detection, Page Ranking, Graph Mining, and Graph Matching.

To compensate for the lack of a universal format for existing real-world datasets, we present the creation of a graph format conversion suite to streamline the usage of various graph analytic applications.

Lastly, due to the complexity of graph analytics, we propose using the snowball sampling strategy to scale down larger graph files in order to have realistic simulation durations without losing accuracy. Through these techniques, we present a more efficient, streamlined and scalable approach to compute Graph Analytic problems.

7.5	**A Fully-Integrated Switch-Capacitor DC-DC Converter in a 180nm CMOS**	7.5

Undergraduate Researcher: Evan Daniel Pfister

Faculty Advisor: Deuk Heo

Other Collaborators: Zhiyuan Zhou

Home Institution: Washington State University, Electrical Engineering, Junior

Abstract:

More efficient energy management has been the main goal for companies and industries around the world. The goal being to maximize efficiency of electronic devices without sacrificing space or even more importantly cost. To achieve higher efficiency requires a new perspective on already existing technologies leading to a new approach when apply solutions and eventually a new generation of innovative appliances. The dark horse of these new appliances is switch-capacitor converters which can provide greater efficiency than typical DC-DC converters used today and which use capacitors to store and deliver energy.

The reason for the increased attention from both academic and industrial researchers on the subject of integrated capacitors is they can achieve low series resistance and high capacitance density and most importantly, can be used to implement DC-DC converters in current CMOS processes without additional fabrication steps. Through the use of multiphase interleaving the efficiency can be measured around (80%) when using none ideal components while on the downside having low power density somewhere around (0.67 mW/mm2). While on the other hand trying to achieve higher power density reduces the overall efficiency of the circuit to somewhere around (60%) trying to find the perfect balance to power density and efficiently is key.

7.6	**An Integrated DC-DC Buck Converter in 180nm CMOS**	7.6

Undergraduate Researcher: Lee Plunkett

Faculty Advisor: Deuk Heo

Other Collaborators: Zhiyuan Zhou

Home Institution: Washington State University, Electrical Engineering, Junior

Abstract:

The goal of this research project is to design an integrated DC-DC Buck converter with pulse width modulation using Cadence software. The overall system will use the Buck converter method with CMOS's, where it takes an input voltage and goes through the system to get a lower output voltage similar to a transformer. The advantages of using a CMOS with a Buck converter is high efficiency, constant output voltage, fast response to load and line transients and minimum off-chip components.

The system is designed to take in an input voltage of 2V to a range of desired output voltages based on the feedback systems variable reference voltage that can be set by the user. The feedback system consists of a compensated error amplifier, comparator with a sawtooth, and non-overlapping gate drivers. For all load currents, fixed-frequency pulse width modulation feedback is used with type III compensation feedback, and is most efficient in high and medium load systems. The compensation network provides the ability to adjust and maintain a steady output voltage during changes in Vin or load perturbations. The system operates in constant conduction mode which improves the efficiency as power is always delivered to the load.

7.7	**Implementing Power Optimization Methodologies to Improve Energy Efficiency of Multi-Core Processors**	7.7

Undergraduate Researcher: Mohamed Azard Rilvan

Faculty Advisor: Behrooz Shirazi, Partha Pande

Other Collaborators: Shervin Hajiamini

Home Institution: Southern Connecticut State University, Computer Science, Junior

Abstract:

Chip Multi-core processors, consume a large portion of total system power. A core contains periods of internal computation and inter-communication. Periods of idle cycles provide an opportunity to save energy. Energy could be saved by adjusting the voltage and frequency at the cost of performance degradation. Dynamic voltage and frequency scaling (DVFS) is a technique that adjusts voltage and frequency based on the computation and communication characteristics of a running application on the multi-core system.

We have integrated three DVFS methodologies with Gem5, a full system simulator, to investigate the maximum energy efficiency gained by these methodologies for various computation and communication intensive applications. We use windowing, which divides the simulation into time frames, as a technique to identify the intensity of the processor bound and memory bound operations of the applications. The overall goal of these methodologies is to predict the suitable voltage and frequency of the cores in the future windows. We aim to obtain the optimal range of window sizes for which the cores save maximum energy with minimal impact on core performance.

We propose a history-based DVFS, which predicts processor's performance based on weighted average of the core's predicted computation, and the history of the expected computation in the past few windows. We also consider communication of the cores in terms of network load and store utilizations to understand the communication behavior. According to the network load and store utilization, and core utilization we assign defined threshold values to adjust voltage and frequency to minimize power consumption.

7.8	**Learning to Run Efficiently: A DVFS VFI-partitioned Multicore Platform**	7.8

Undergraduate Researcher: Ailin Yu

Faculty Advisor: Partha Pande, Behrooz Shirazi

Other Collaborators: Ryan Kim

Home Institution: Case Western Reserve University, Computer Engineering/Systems and Control Engineering, Junior

Abstract:

In recent years, multiple Voltage Frequency Island (VFI)-based designs have been seen as a viable, scalable power management technique for multicore platforms. Due to workload-driven variations in applications, operating these islands with optimal power efficiency requires dynamic scaling of voltage and frequency during chip operation, thus leading to the development of Dynamic Voltage and Frequency Scaling (DVFS) techniques. Traditional DVFS techniques rely on control-theoretic algorithms that require slow, complex hardware modules for each individual processing core. However, the usage of VFIs requires a DVFS algorithm that predicts a suitable voltage and frequency for a group of processing cores, resulting in increasingly complex hardware modules for these types of algorithms. Fortunately, Machine Learning (ML) algorithms present an alternative solution to these control algorithms. In this work, we deploy various trained ML techniques, e.g. decision trees, support vector machines (SVM), and decision tables. Using hardware with ML algorithm-specific design, we were able to efficiently handle DVFS decisions within VFIs.

By leveraging these ML techniques, our synthesized designs show that we can achieve high prediction accuracy while minimizing hardware complexity.

Group 8: Northwest Advanced Renewables Alliance – NARA (Summer Undergraduate Research Experience)

8.1	**Comminution of Unmerchantable Forest Residuals to Determine Power and Energy Consumption as a Function of Moisture Content and Size Reduction Range**	8.1

Undergraduate Researcher: John Barth

Faculty Advisor: Jinwu Wang, Michael Wolcott

Other Collaborators: Vincent McIntyre, Kelley Welsch

Home Institution: Washington State University, Economic Sciences, Senior

Abstract:

Research into biofuels is creating sources of sustainable energy. In the Pacific Northwest unmerchantable forest residuals-a byproduct of logging-is being looked into as a potential source of biojet fuel. However, the process of breaking down this byproduct is extremely energy intensive. Thus, my research objective is to create an equation to determine energy consumed based on the moisture content and size reduction range of the woody biomass and to identify the optimal conditions for the material size reduction. To reach this objective I am measuring the energy consumed by running the material through a small scale industrial hammer mill using 5 different levels of moisture content as well as multiple screen sizes at each moisture content to get varying particle size reductions. A G-series elite conditioning chamber is used to condition the wood to each moisture content, and a rotap testing sieve shaker is used to determine the average particle size after each size reduction. I have currently completed all of the different particle size transfers for the moisture content of 6%. Going forward, results will need to be found for each of the other moisture content levels. With the results taken from measuring the energy consumed, as well as the average particle size, a constant for each moisture content and particle size reduction will be created using the Rittinger's comminution equation. The constant will vary with the five different moisture content levels investigated in this project and the relationship between them will be correlated by an empirical equation. The finished equation will show that the amount of energy consumed is a function of the moisture content and the size reduction and would be able to predict the most optimal conditions for breaking down the forest residuals. This will aid in the production of future biojet fuels.

8.2	**Synthesis of Lignosulfonate Hydrogels cross-linked with PEGDGE**	8.2

Undergraduate Researcher: Maika Bui

Faculty Advisor: Jinwen Zhang, Junna Xin

Other Collaborators: XiaoXu Teng

Home Institution: University of Washington, Bioresource Science and Engineering, Sophomore

Abstract:

Hydrogels are network based polymers noted for its ability to retain large amounts of water. Industries take advantage of their hydrophilic property to enhance its products; these include drug delivery services, soil rehabilitation, biosorption, etc. Lignosulfonate is a copious lignin-derived byproduct from the pulping process of paper production. Because of the economical and sustainable advantages of using biomass material over fossil-fuels, industries are looking towards replacing synthetics with bio-based products. In this study, sodium lignosulfonate was cross-linked with poly (ethylene glycol) diglycidyl ether (PEGDGE) to synthesize lignosulfonate hydrogels. The effect of changing reaction (mass sodium lignosulfonate, mass PEGDGE, temperature) and application (time, pH) hydrogel formation conditions were investigated in respect to maximum swelling capacity. Fourier transform infrared spectroscopy (FT-IR) and thermogravimetric analysis (TGA) were used to characterize the products. It was found that the best conditions for maximizing swelling capacity of lignosulfonate hydrogels are 4g sodium lignosulfonate and 1.2g PEGDGE synthesized at 85◦C.

8.3	**Making The Chemistry of the NARA Project Visible**	8.3

Undergraduate Researcher: Adriana Guzman

Faculty Advisor: Karla Eitel

Other Collaborators: Andrew Trogstad-Isaacson

Home Institution: Washington State University Tri-Cities, Biology, Junior

Abstract:

One of the challenges that chemistry can pose to high school students is the difficulty of being able to conceptualize what is occurring to the polymers involved in reactions at the molecular level. Names can be given to processes and definitions, but if students are not able to visualize them, then they may develop a lack of interest in learning the physical chemistry. This lesson plan is designed for high school students to visualize how sugars, such as cellulose, are converted into biofuel and how lignin is extracted. One of the goals of the lesson was to show a cross section of the cell wall, pointing out the different polymers and discussing why the lignin extraction is difficult. Students will be able to more accurately see how cellulose, hemicellulose, and lignin all are arranged in the plant cell walls of woody biomass in order to better understand how the conversion occurs. Because of the large nature of the specific polymers, cellulose, hemicellulose, and lignin, traditional molecule kits are ineffective. These polymers are recreated in this lesson using mini colored marshmallows, gumdrops, and toothpicks. Students constructed models to assist them in understanding the roles and interactions of the polymers in the plant cell walls of woody biomass. The lesson was tested with middle and high school teachers and high school students where they provided critical feedback.

8.4	**Activated Carbon by Chemical Activation of Lignin with Potassium Hydroxide**	8.4

Undergraduate Researcher: Shakema Haynes

Faculty Advisor: Ian Dallmeyer

Home Institution: University of Arkansas at Pine Bluff, Industrial Technology Management and Applied Engineering, Sophomore

Abstract:

The NARA co-products team is seeking to generate value-added co-products from the lignin produced during the conversion of softwood forest residuals to jet fuel. Activated carbons (ACs) are porous materials used for a variety of applications, mostly as adsorbents. In this research, AC was produced by chemical activation with potassium hydroxide (KOH). Chemical activation with KOH was chosen in order to obtain highly activated materials for demanding adsorption applications. A series of AC materials was prepared from a common precursor by varying the maximum activation temperature and the KOH-to-lignin ratio. After washing away the activation agent and drying the materials, gas physisorption experiments were conducted to characterize the porous structure of the ACs. The objective of these experiments was to gain an understanding of the effect of temperature and KOH:lignin ratio on the surface area, pore volume, and pore size distribution of the AC materials, which have a strong influence on the effectiveness of ACs in specific adsorption application.

8.5	**Preventing Nitrogen Depletion in Forests Undergoing Forest Residual Removal**	8.5

Undergraduate Researcher: Aleksandr Kirpach

Faculty Advisor: Rob Harrison

Other Collaborators: Jason James, Austin Himes, Kim Littke

Home Institution: Tufts University, Civil Engineering, Sophomore

Abstract:

Soil nutrient information plays a key role in determining how forest residual removal can be done in a way that is both environmentally sustainable and economically viable. Nitrogen, specifically, is a valuable indicator of potential forest growth. The purpose of this study is to incorporate deep soil data into an existing stability rate. This gives more accurate information about the total nitrogen stock, revealing that it is actually larger than it was previously believed to be. This in turn provides a more accurate representation of how much above ground biomass can be removed without creating a nitrogen depletion risk. In this study, the nitrogen stock (kg/ha) was calculated for 31 sites and at 8 soil depth levels that went down as far as 3 meters (previous studies only went down to 1 meter). The total stock was calculated by the multiplication of the bulk density at each depth with the layer height and the percent composition of nitrogen of individual samples, which were analyzed by a CHN analyzer. The nitrogen removal estimates were found by calculating the total nitrogen available in all above-ground biomass. A stability ratio was then created that depicted how sustainable forest residual and biomass removal would be at certain sites based on how much total nitrogen was available. It was found that removing 10% or less of the total available nitrogen stock would be very sustainable and would not put the area at risk of nitrogen depletion. Removal of more than 10 percent, however, would begin to create some risk. As a result of this information, forest residual removal can be done in manner that is both efficient and sustainable.

8.6	**Demethylation of Lignin and Lignin Model Compounds to Value Added Compounds**	8.6

Undergraduate Researcher: Kasey Markland

Faculty Advisor: Xiao Zhang

Other Collaborators: Ma Ruoshui, Mond Guo, Carlos Hiroaki Kuwabara

Home Institution: Washington State University, Chemical Engineering, Senior

Abstract:

Lignin is an abundant component in nearly all plant biomass and the largest source of renewable material with an aromatic skeleton. Large quantities of industrial lignin are already produced annually as a waste product of the pulp and paper industry, where the vast majority is burned as a low cost fuel to provide energy for the chemical pulping process. The emerging biomass refinery industry will further introduce an enormous amount of lignin. However, selectively and effectively converting lignin into valuable products is a well-recognized challenge. Dicarboxylic acids (DCAs) have also been commonly observed as products from the oxidative cleavage of aromatic rings in lignin or its fragments, yet this pathway has not been explored until recently. DCAs such as muconic acid, muconolactone, maleic acid, succinic acid, and malonic acid are important platform chemicals for the polymer, pharmaceutical, and food industries. To date, there still lacks information mechanistically exploring the reaction pathways and key barriers towards converting biorefinery lignin selectively and efficiently for DCA production. The methoxy content on aromatic rings and the side-chain configuration of lignin subunits side-chains have been recently identified as two of the key aspects that affect the aromatic ring cleavage selectivity and efficiency. In this work, we will compare several approaches and developing novel catalytic pathways for selective demethylation of representative biorefinery lignins to support the oxidative conversion of these lignins to DCAs. Monomeric lignin model compounds are employed to discuss the impact of methoxy contents and side chain variations on the lignin demethylation reactions.

8.7	**Catalytic Oxidation of Lignin for Value Added Chemicals**	8.7

Undergraduate Researcher: Oshauna Morgan

Faculty Advisor: Xiao Zhang

Other Collaborators: Ruoshui Ma

Home Institution: Johnson C. Smith University, Biology, Senior

Abstract:

Utilizing biomass solely for biofuel production poses an economic challenge mainly due to the low value of fuel. Generating valuable co-products in addition to biofuel from the biomass-to-biofuel conversion process is the key to overcome this economic barrier. It is expected that enormous amounts of biorefinery lignin will be generated as a waste stream during the biorefining process. Thus, there are increasing interests in converting lignin to value added co-products. Promising pathways have been discovered whereby lignin can be oxidatively converted to valuable chemicals such as dicarboxylic acids and monomeric phenolic compounds. Sulfite pretreatment to overcome recalcitrance of lignocellulose (SPORL) and milled wood lignin (MWL) are two of the several new lignin sources identified by National Advanced Renewables Alliance (NARA). However, the structural characteristics of these lignin samples and their potential for value added chemical conversion have not been well understood. This project aims to characterize and compare the structures of several representative biorefinery lignin samples, including SPORL and MWL, and determine their reactivity toward oxidative conversion to dicarboxylic acids and monomeric phenolic compounds. Thioacidolysis, nitrobenzene oxidation, gel permeation chromatography (GPC), and Fourier Transform InfraRed (FT-IR) will be employed in the characterization process for the analysis of lignin structures and substructures. The National Renewable Energy Laboratory laboratory analytical procedure (NREL LAP) (2008) will be used for the determination of structural carbohydrates and lignin content of samples. Results obtained from this project will give us important information on the impacts of lignin structural variations on oxidative conversion of biorefinery lignin towards dicarboxylic acids and monomeirc phenolic compounds.

8.8	**Educating Youth on Air Pollution Caused by Transportation**	8.8

Undergraduate Researcher: Jennifer Murphy

Faculty Advisor: Karla Eitel

Other Collaborators: Leslie Dorsey, Ashlee Fliney, Danica Hendrickson, Andrew Trogstad-Isaacson

Home Institution: University of Idaho, Elementary Education, Senior

Abstract:

Air pollution caused by transportation sources have been a major concern for many years. Efforts to create cleaner sources of fuel, such as biodiesel, have curbed these concerns. However, educating youth on such issues has not been a priority in the solution. In order for change to occur, younger generations need to be educated on such issues. This lesson educates first graders about air pollution caused by transportation and introduces them to cleaner sources of fuels such as biodiesel. It also allows them to make informed decisions on ways in which they can reduce air pollution. Students engage in a course in which they hand out pollution cards at mile markers and then compare the environmental impact left from each fuel source. The lesson was tested with 6 to 7 year old students at the McCall Outdoor Science School in McCall, Idaho. Each took pre and post-tests which helped to determine prior knowledge and comprehension. The results showed students learned how transportation creates air pollutants, how alternative sources of fuel like biodiesel have less environmental impact than diesel, and ways in which they could cut down on air pollution by riding a bike, walking, or telling their families to not leave a vehicle idling.

8.9	**Forest Ecology and Biofuel Production Potential for Tribally-Managed Forests in the Northern Rockies**	8.9

Undergraduate Researcher: Emily Schwartz

Faculty Advisor: Karla Eitel

Home Institution: University of Washington, Environmental Science and Resource Management, Senior

Abstract:

Before European intervention in 1910, the tribes of the northern Rockies utilized prescribed fires to maintain healthy forests. Over the years, this practice created a network of fire-adapted and fire-resilient forests. Prescribed fire also supported tribal cultural values linked to hunting and food cultivation. Small, frequent controlled fires reduced the amount of biomass accumulation in the forest, thereby reducing the risk for catastrophic wildfires. A forest management practice that has been adopted more recently is the use of mechanical thinning: the selective removal of some dead, dying and healthy trees using machinery. Tribal forest managers are leading the way in the removal of excess woody biomass, and this provides an opportunity for biofuel research and production.

This four-lesson curriculum develops student understanding of holistic approaches to forest management and the biofuel potential of woody biomass. In lesson one, students will learn the history of the Confederated Salish Kootenai Tribes (CSKT) and their relationship to prescribed fire, both culturally and ecologically. In lesson two, students will create two simulated northern Rocky forests, one representing a tribally managed forest after thinning and the other a forest that results from aggressive fire suppression after European arrival. These will then be ignited and their burn times and overall damage compared to determine how management practice affects forest health and resilience to fire. In lesson three, students will “manage” an imaginary plot of land. Using CSKT data on the density of woody biomass in their managed forests, the students will determine how much jet fuel could be produced by mechanical thinning on each plot of land. In lesson four, students will discuss the results of lessons two and three, deciding for themselves how forest management practices affect the health and resilience of forests, and the biofuel potential thinning offers.

8.10	**Air Quality Impact of the NARA Biorefinery**	8.10

Undergraduate Researcher: Bailey Tebou

Faculty Advisor: Brian Lamb

Other Collaborators: Vikram Ravi

Home Institution: North Carolina State University, Chemical Engineering and Paper Science Engineering, Sophomore

Abstract:

Current methods of removing woody biomass residue from logging operations are wasting a potential biofuel resource and, due to slash burns of these residues, are negatively impacting the environment. The establishment of a biofuel supply chain to convert woody biomass into usable biofuel would benefit the environment and create less pollution. Through the Northwest Advanced Renewables Alliance (NARA) project, plans have been developed to use woody biomass residue as a feedstock for aviation biofuel. This will involve bio-processing of the residue at a refinery, which in turn, will have the potential for emission of a variety of air pollutants, including various air toxic compounds. To assess the possible impact of a bio-refinery on local air quality, we employ the EPA AERMOD Gaussian dispersion model to assess downwind pollutant concentrations under winter and summer weather conditions. Meteorological input data covering January, 2013 and July, 2014 were obtained from the Weather Research & Forecasting numerical weather forecast system for the Pacific Northwest. Simulated criteria and air toxic pollutant concentrations are presented in terms of receptor time series, contour maps of average and maximum downwind concentrations, and in tables of mean and maximum levels. These output products are used to assess the overall impact of a NARA bio-refinery on local air quality as part of an overall sustainability assessment of the biofuel supply chain in the Pacific Northwest.

8.11	**Characterization and Modification of Asphalt With Epoxy Resins Synthesized From Pyrolysis Oil, a Derivative of Lignocellulosic Biomass**	8.11

Undergraduate Researcher: Kyle Thompson

Faculty Advisor: Jinwen Zhang, Junna Xin

Home Institution: San Jose State University, Chemical Engineering, Senior

Abstract:

Asphalt is an important commodity that has a vital purpose in civic infrastructure, both in urban and rural communities alike. Polymer-modified asphalt has become a popular topic of interest due to the advantageous property modifications provided by its polymer components. Such alterations include increased moisture resistance, higher tensility, better resistance to long-lasting deformation, greater elasticity, and lower temperature susceptibility. In this study, asphalt was modified with an epoxy resin synthesized from pyrolysis oil (a derivative of lignocelluosic biomass). Typically, in commercial and industrial settings, epoxy resins are formed by treating bisphenol-A with chloromethyloxirane (epichlorohydrin). Lignocelluosic biomass, namely lignin, houses similar hydroxyl environments like those found in bisphenol-A, and thus can be used as a substitute. The phenolic, hydroxymethyl, and carboxylic functional groups belonging to the pyrolysis oil were epoxidized with epichlorohydrin. Fourier transform infrared (FTIR) analysis and thermal gravimetric analysis (TGA) were performed to verify the existence of epoxide rings on the resulting monomer. The monomer was then cured with the Diels-Alder adduct resulting from the reaction between dipentene and maleic anhydride (DPMA). The cured epoxy resin was then mixed with a 60/70 asphalt at different concentrations: 7.5 wt.%, 15 wt.%, and 22.5 wt.%, respectively. Rheology analysis was performed on the resulting epoxy-asphalt mixture, yielding results that indicate greater elasticity (based on the observed storage and loss moduli) and improved resistance to temperature deformation and cracking.

8.12	**CO_2 Consumption and Biofuel Transportation Adventure Race**	8.12

Undergraduate Researcher: Sarah Wilkins

Faculty Advisor: Karla Eitel

Other Collaborators: Leslie Dorsey, Andrew Trogstad-Isaacson

Home Institution: Yale University, Sophomore

Abstract:

Considering the effects of climate change, it is important to explore the viability of all renewable energy resources. Groups such as the Northwest Advanced Renewables Alliance (NARA) are investigating the potential of biomass as an energy source to determine if it can be successfully turned into biofuel on a large scale. Transportation of the slash, or woody biomass, to a facility is a critical source of CO2 emission in the conversion process. This lesson created is modeled on the Transportation Lifecycle Assessment conducted by Indroneil Ganguly and other researchers at the University of Washington and Oregon State University. The research examined the acidification and CO2 emissions of three different processes: a truck transporting slash to a grinder at a centralized location, a truck bundling slash on sight then transporting it to a grinding facility, and a mobile chipper chipping at the slash site before transport.

During the lesson, which has been pilot tested with both teachers and middle schoolers, students are tasked with transporting their own biomass (recycling) in a bin from one location to another. They simulate both off road and on road transport by hopping on one foot and walking, respectively. The students must model one of three pre-treatment methods explained above. Additionally, students measure their heart rate increase and total time of transportation to simulate the CO2 emission and the economic benefit. From this lesson, students will be able to understand that the transportation of woody biomass is complicated and that the environmental and economic factors of this process are sometimes at odds with one another. The students will also be able to understand the basic biomass transportation chain and recognize the potential of biomass as a source of renewable energy.

8.13	**Screening Value-Added Market Opportunities for Lignin**	8.13

Undergraduate Researcher: Mark Wohlpart

Faculty Advisor: Paul Smith

Home Institution: The Pennsylvania State University, Chemical Engineering, Junior

Abstract:

Increasing pressures from volatile oil prices and pro-renewable governmental policy have quickly driven the biomass industry from non-existence to one that produces over 13 billion gallons of corn ethanol annually. While first-generation biofuels are quickly approaching maturity, problems concerning how they are sourced and debates over their true benefits have arisen. 2nd generation biofuels are an incoming industry that address many of these problems. 2nd generation biomass-to-liquid (BtL) technologies convert lignocellulosic biomass into, among other things, liquid biofuels and extracted lignin. While a full-scale plant could produce well over 100,000 tons of lignin annually, most is burned as a low-value fuel source. Identifying higher-value outlets for lignin would bolster the economics of 2nd generation BtL plants, and full-scale commercialization could be expedited. A literature review was conducted to identify and outline possible lignin valorization processes. Although literature was sufficient at identifying possible applications, the majority of publications were concerned solely with technical possibility, and largely ignored economic feasibility. In order to glean this information, primary sources were contacted and interviewed during summer 2015. These interviews sought to characterize the current state of lignin value-added markets, evaluate the economics underlying identified markets, and develop a recommendation for which opportunity to pursue.

Group 9: MARC, Honors, Chemistry, Shock Physics (Other WSU Projects)

9.1	**Eating Undercooked Chicken Will Make You Sick**	9.1

Undergraduate Researcher: Joanna Fragoso

Faculty Advisor: Michael E. Konkel

Other Collaborators: Negretti NM, Gourley CR, Nissen MS, Konkel ME

Home Institution: University of Texas at San Antonio, Microbiology and Immunology, Senior

Abstract:

Campylobacter jejuni is a leading bacterial cause of human foodborne disease. Illness associated with this bacterium is frequently acquired from eating foods cross-contaminated with raw chicken or from eating undercooked chicken. In order to cause disease, this bacterium invades the cells lining the human intestinal tract. The purpose of this study was to determine if C. jejuni behaves differently when cultured in the laboratory versus when cultured with gut intestinal cells. We hypothesize that proteins synthesized by C. jejuni in response to incubation with human intestinal cells will promote bacterial invasion of these cells. We determined the ability of four different C. jejuni strains to invade human INT 407 cells over time and in the presence of chloramphenicol. Chloramphenicol is an antibiotic that selectively inhibits C. jejuni protein synthesis. Binding and internalization assays revealed that C. jejuni strains can be divided into two groups – highly invasive and poorly invasive strains. Additional work revealed that the number of C. jejuni bacteria internalized significantly increased over time. Moreover, chloramphenicol significantly inhibited the number of bacteria internalized by INT 407 cells for the highly invasive strains. Together, these data demonstrate that C. jejuni adapt to incubation with host gut cells and synthesize proteins that promote host cell invasion. In summary, these studies will enable us to determine virulence attributes and conditions that are associated with the ability of C. jejuni to cause diarrhea.

9.2	**Nature, Nurture, and Behavior: Kdm6a Knockout Mice Reared in an Enriched Environment**	9.2

Undergraduate Researcher: Halle Weimar

Faculty Advisor: Jun Xu

Other Collaborators: Terri Driessen, Ezana Assefa, Kevin Lewallen, Morgan Ramey-Dixon

Home Institution: Washington State University, Neuroscience, Junior

Abstract:

Kabuki syndrome, a disorder resulting in motor deficits and intellectual disability, is caused by mutations of the gene Kdm6a. The protein product of Kdm6a is an epigenetic modulator that demethylates lysine 27 on histone H3 (H3K27), activating transcription of neighboring genes. Consequently, Kdm6a mutations lead to changes in histone modifications and gene misregulation.

We recently developed neuron-specific Kdm6a knockout (Kdm6aDel) mice, and found motor deficits in the Kdm6aDel compared to wild type (WT) mice, consistent with motor symptoms in individuals with Kabuki syndrome. Previous studies have found that epigenetic modifications can be altered by the stimuli of an enriched environment (EE) during adolescence. Therefore, EE may compensate for the epigenetic and gene expression anomalies of these Kdm6aDel mice. Specifically, we hypothesize that the Kdm6aDel males reared in EE will exhibit improved motor coordination compared to Kdm6aDel males reared in standard housing. Further, the EE mice will have reduced anxiety and enhanced episodic memory compared to the control mice as is consistent with the findings of previous studies.

To test our hypothesis, we housed juvenile Kdm6aDel and WT males in enriched or standard housing for four weeks. EE cages were larger with novel objects (e.g. blocks, tunnels, and running wheels). Motor coordination, anxiety, and episodic memory tests were conducted at postnatal day 60. Preliminary analysis suggested that EE might not affect motor coordination, with enriched and control Kdm6aDel males exhibiting similar levels of deficits in rotarod performance. It's possible that the motor deficit arises in adulthood. Collectively, these results provide important basis for future studies of Kdm6aDel mice – for instance, how Kdm6a-mediated chromatin modifications might contribute to the effects of EE on cognitive development and function.

9.3	**Depositing Metallic Monolayers in Graphene via Forced Redox Reactions: A Proof-of-Concept Study**	9.3

Undergraduate Researcher: Desiree Cureton-Burden

Faculty Advisor: K.W. Hipps

Other Collaborators: Matthew Larson, Leo James Smith, Jeremy Eskelsen, David Y. Lee

Home Institution: Alabama A&M University, Chemistry, Senior

Abstract:

It was recently found by Zhao et al. (Science, 343, p.1228, 2014) that a free-standing single-atom-thick iron membrane can be placed inside graphene pores simply by etching a graphene-on-nickel (Gr/Ni) sample with iron (III) chloride solution. Apparently in their experiment iron was reduced from the FeCl3 solution while it was etching the Ni substrate. In this proof-of-concept study we investigate the possibility of synthesizing any metal membranes in graphene regardless of its relative redox potential to the substrate element. We choose graphene-on-copper Gr/Cu, since the overall redox potential of Cu + Fe3+

The 2-D products are characterized by a model name, X-ray Photoelectron Spectroscope (XPS) and a home-made ambient Scanning Tunneling Microscope (STM).

9.4	**Scanning Tunneling Microscopy Study of Temperature Dependent Rates and Activation Energy for Metal free Octaethylporphyrin at the Phenyloctane/Graphite Interface**	9.4

Undergraduate Researcher: Kevin Marchbanks-Owens

Faculty Advisor: K.W. Hipps

Other Collaborators: Ashish Bhattarai

Home Institution: Alabama A&M University, Senior, Chemistry

Abstract:

Porphyrins are a highly versatile and important class of organic compounds with wide ranging applications in electronic devices. By varying substituent and functional groups porphyrins can be designed to possess unique opto-electronic properties. Recently, these compounds have been used in probing fundamental processes at the solution-solid interface. In this work, Scanning Tunneling Microscopy (STM) studies of the adsorption and desorption processes of a metal free octaethylporphyrin (H2OEP) at the phenyloctane solution – graphite interface will be reported. Temperature dependent desorption studies of H2OEP will be used to determine rate constants at various temperatures and these temperature dependent rate constants provide the activation energy for desorption. Of special interest will be a comparison of desorption energies and rates for the metal free compound compared to a similar metal porphyrin, cobalt(II) octaethylporphyrin (CoOEP), whose desorption rates and activation energy are known.

9.5	**Effects of Corrosion on the Dynamic Mechanical Behavior of Pure Magnesium**	9.5

Undergraduate Researcher: Spencer Smith

Faculty Advisor: Jow-Lian Ding

Other Collaborators: Ilhan Yu, Jialong Ning

Home Institution: University of Utah, Mechanical Engineering, Senior

Abstract:

Because of its light weight, magnesium is an attractive material for mechanical designs in which weight is an important design criterion. Light weight materials are critical for automotive, aerospace, biomedical, and defense industries. Many applications in these industries also require the materials to perform under high strain rates, such as in automotive collisions or ballistic barriers. It is known that materials behave differently depending on how fast the material is loaded. Thus for proper selection and applications of the materials, understanding their mechanical behavior under dynamic loading is critical. Besides dynamic loading, some material could also be subjected to corrosive environments such as those encountered in biomedical applications.

The main objective of this research is to study the effects of corrosion on the dynamic response of pure magnesium. Samples with and without corrosion treatment are tested under loadings at different strain rates. The strain rates tested include .001/s, 1000/s, and 4000/s. The 1000/s and 4000/s strain rate tests were conducted using a Split-Hopkinson Pressure Bar testing machine and the .001/s strain rate tests were conducted using a standard compression testing machine. The results from the low strain rate tests, .001/s, are used as a baseline for comparing the dynamic behavior. To understand the deformation and fracture behavior, the evolution of microstructures as a function of deformation is also investigated. For dynamic experiments, the stopper ring method is used to stop the test at some preset strains, namely, 3% and 10%. Stopper rings were made from quenched and tempered 4130 steel and machined to the proper sizes according to the preset strains.

Measurement of Impact Tilt and Bowing in a 4” Bore Light Gas Gun

Undergraduate Researcher: Ken Yang

Faculty Advisor: Y. M. Gupta

Other Collaborators: Kurt Zimmerman, Nathan Arganbright, Drew Rickerson

Home Institution: Auburn University, Physics, Senior

Abstract:

The project I have completed this summer at WSU’s Institute for Shock Physics is measuring the impact tilt between a projectile and target to help evaluate the quality of shock wave experiments using a 4” smooth bore light gas gun. The impact tilt angles were determined by placing shorting pins at known locations on the impact side of a target, measuring the relative time of impact of the pins, and measuring the projectile velocity at impact. Initial measurements were conducted to investigate experimental reproducibility. Subsequent measurements looked at the consistency of the pins used to measure projectile time of arrival and the flatness or degree of bowing of the impact plane. In addition, the experiments were performed at different impact velocities to determine if there were any observable trends in the measured tilt. The results indicate that the quality of impacts were generally good throughout the velocity range explored, and the pin to pin consistency was within the uncertainty of the measurement. However, there is evidence of bowing of the projectile or target at high impact velocities.

In lieu of a poster, a brief technical report was completed.

Presenters by Last Name

Author	Poster Title	Sec.
Anderst, Emily	No Adsorption on Fe-SSZ-13: Mechanistic Insight Using DFT Calculations	5.1
Assefa, Ezana	Motor coordination deficits and altered gene expression in Kdm6a knockout mice	1.1
Barth, John	Comminution of Unmerchantable Forest Residuals to Determine Power and Energy Consumption as a Function of Moisture Content and Size Reduction Range	8.1
Bartoshevich, Randy	Quantifying Influence of Irrigation and Meteorology on Water Use Efficiency with the Eddy Covariance Technique in a Vineyard in Washington	6.1
Baumher, Rebecca	Graph Pattern Mining Revisited for Personalized Knowledge Discovery	3.1
Bentjen, William Quinn	Title Research Projects Documentation and Experimental Data Collection	4.1
Boege, Mary	Examining omission errors made by individuals with mild cognitive impairment and dementia when completing activities of daily living	4.2
Bryant, Jessie	Laser Power Beaming in Smart Homes	3.2
Bui, Maika	Synthesis of Lignosulfonate Hydrogels cross-linked with PEGDGE	8.2
Cardona, Daniel	K-core Approach to Graphical Community Detection	3.3
Cheung, Tyler	Bovine Cartilage Digestion and Data Analysis	5.2
Chili, Maddie	Human-Robot Interaction for Flying Robot Control	3.4
Cureton-Burden, Desiree	Depositing Metallic Monolayers in Graphene via Forced Redox Reactions: A Proof-of-Concept Study	9.3
Dahmen, Jordana	Physical Therapist Interviews to Collect Feedback Regarding Wearable Technology	4.3
Dance, Sequoia	Chloroplast Genomics for Understanding Genetic Diversity in Lomatium cous	2.1
Das, Biswaranjan	Real-Time Web-Based Measurement of Parkinson's Tremors	4.4
Davie, Ashley	Bovine Cartilage Digestion and Data Analysis	5.2
Edgecombe, Declan	Web-based On-board Real-time Rendering Data System (WORRDS)	4.5
Egerton, Kirstin	Quantification of Cellulose Fibril Diameter and Particle Size of Lignin Precipitates in Various Pulp Substrates	5.3
Eide, Nick	Analog Time-Reversal Division Multiple Access Electromagnetic Simulation	7.1
Fragoso, Joanna	Eating Undercooked Chicken Will Make You Sick	9.1
Gain, Alex	Intelligence and Compression	3.5
Glazer, A. Grant	Aldehyde and Seek: Tracking R-CHO Production through the Ozonolysis of VOCs in Household Air Fresheners	6.2

Guzman, Adriana	Making The Chemistry of the NARA Project Visible	8.3
Guzman, Danielle	Huckleberry TRAP analysis: Preserving culturally and medicinally important food	2.2
Harvey, Jordan	Pseudomonas putida KT2442 Uptake in a Soil Column	5.4
Haynes, Shakema	Activated Carbon by Chemical Activation of Lignin with Potassium Hydroxide	8.4
Hiland, Lauren	Task Allocation	7.2
Holdhusen, William	An evaluation of Amazon OH concentrations estimated from isoprene concentration, flux and products	6.3
Jackson, Nicholaus	Learning Macro-Operators for Large Multi-Label Output Spaces	3.6
Jerz, Gabrielle	Measuring Infiltration Rates in Homes as a Basis for Understanding Indoor Air Quality	6.4
Johnson, Kevin	Analog Circuit Design for Time-Reversal Division Multiple Access Frequency Control	7.3
Jong, Chan	Profiling and Benchmarking Graph Applications on multicore platforms for designing Network on Chips	7.4
Kersh, Jennifer	Pseudomonas putida KT2442 Uptake in a Soil Column	5.4
Kirpach, Aleksandr	Preventing Nitrogen Depletion in Forests Undergoing Forest Residual Removal	8.5
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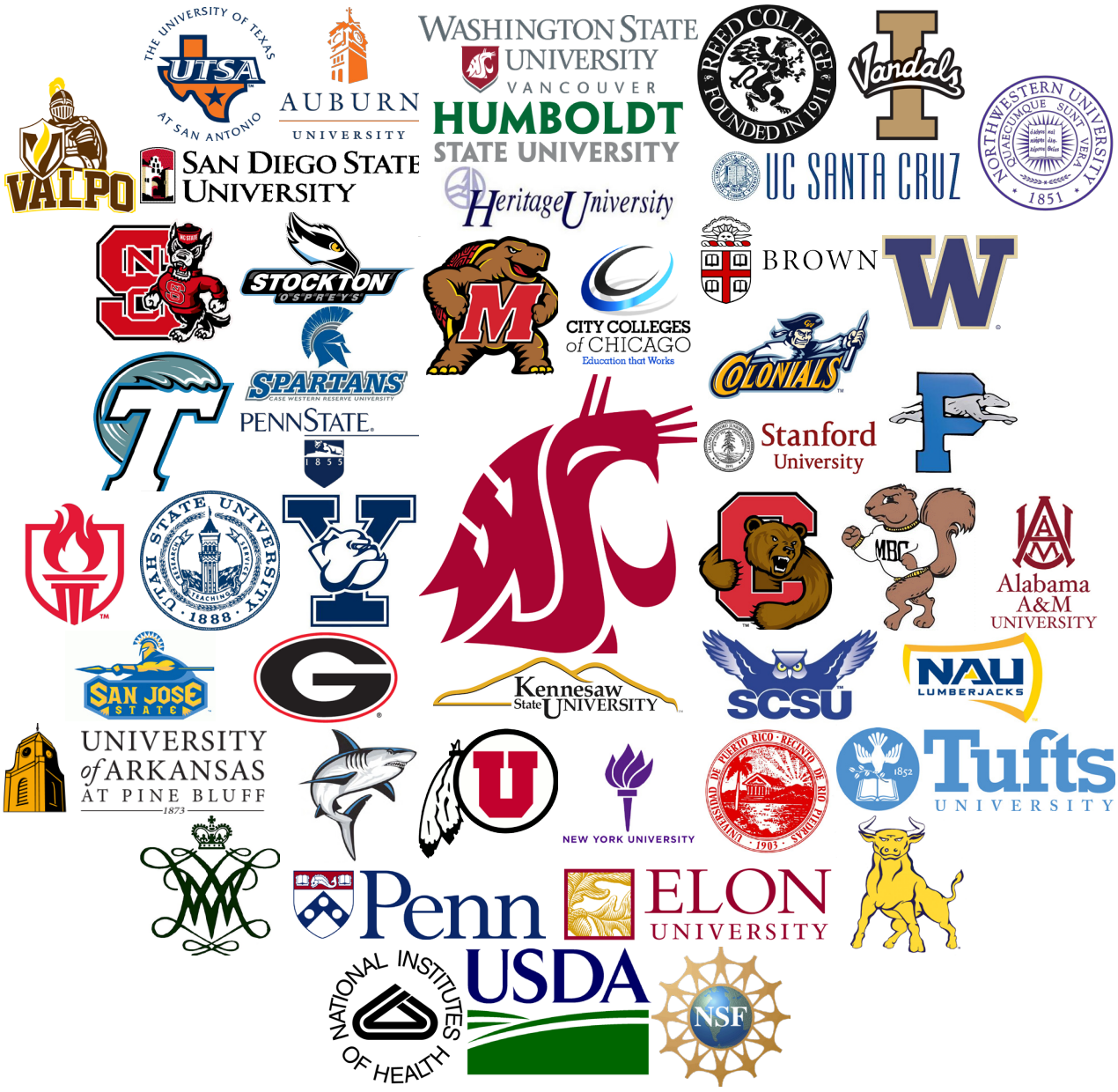

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