# Table of Contents

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Abstracts (in alphabetical order by presenter) ..........38

Acknowledgments .............................................177

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**Key**

Presenter(s) in **bold**

Mentors *italicized*
RAPS Schedule

Friday, August 2, 2019
Bertrand H. Snell B10L, 110, 112, 118, 129, 169, 175, 177, 212, 213 & ERC Atrium & Student Center Dining Room

7:30-8:15 am  Registration – Presenters, Chairs, Judges
Bertrand H. Snell Atrium

8:15-8:25 am  Opening Remarks
Dr. Anthony Collins, President
Bertrand H. Snell Atrium

8:30-9:30 am  Oral Presentations – Session I
Bertrand H. Snell Classrooms

9:45-10:45 am  Oral Presentations – Session II
Bertrand H. Snell Classrooms

11:00 am -12:30 pm  Poster Session
ERC Atrium

12:30-1:15 pm  Lunch
Student Center Dining Room

1:15-1:30 pm  Award Ceremony
Robyn Hannigan, Provost
Student Center Dining Room
## Oral Presentation Session 1
### 8:30 – 9:30 AM
### Snell 110

### Section 1 – Aeronautical & Mechanical Engineering (Undergraduate)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30-8:42 AM</td>
<td>Aaron Kummer &amp; Will Martin; Dr. Kenneth Visser</td>
<td>Producing Stamped Aluminum Blades for the Second Generation of Clarkson’s Wind Turbine</td>
</tr>
<tr>
<td>8:42-8:54 AM</td>
<td>Marcos Seef; Dr. Kevin Fite</td>
<td>Understanding Control Theory Through the Inverted Pendulum</td>
</tr>
<tr>
<td>8:54-9:06 AM</td>
<td>Xavier Delgado &amp; Steven Hopkins; Dr. Craig Merrett</td>
<td>Examination of Isotropy Assumption in Isogrid Structures through Analysis and Experiments on 12 Isogrid Variations</td>
</tr>
<tr>
<td>9:06-9:18 AM</td>
<td>Gavin Buehler; Dr. Kenneth Visser</td>
<td>Comparing and Designing Airfoils to Determine the Best Geometry of a Blade for the Clarkson Ducted Wind Turbine</td>
</tr>
<tr>
<td>9:18-9:30 AM</td>
<td>Logan Melican; Dr. Brian Helenbrook</td>
<td>3D Prismatic Meshes for Use in Computational Fluid Dynamics with Parallel Computing</td>
</tr>
</tbody>
</table>

**Session Chair:** Dr. Craig Merrett  
**Judge:** Dr. Douglas Bohl
# Oral Presentation Session 1
## 8:30 – 9:30 AM
### Snell 112

## Section 2 – Biomedical Science & Engineering 1 (Undergraduate)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30-8:42 AM</td>
<td>Nicole Powell; Dr. Yungcheng Du</td>
<td>Uncertainty Analysis in Modeling Cardiac Electrophysiology</td>
</tr>
<tr>
<td>8:42-8:54 AM</td>
<td>Hannah Christiansen, Dr. Ali Boolani</td>
<td>Alterations in Gait in Relation to Feelings of Energy</td>
</tr>
<tr>
<td>8:54-9:06 AM</td>
<td>Royce Nsiah; Dr. Ali Boolani</td>
<td>The Relationship between Non-Clinical Depression and Gait</td>
</tr>
<tr>
<td>9:06-9:18 AM</td>
<td>Sarah Inzerillo; Dr. Sean Banerjee &amp; Dr. Natasha Banerjee</td>
<td>Improving Methods of Cognitive Fatigue Measurement Through RGB-D Video Analysis</td>
</tr>
<tr>
<td>9:18-9:30 AM</td>
<td>Leon Lufkin; Dr. Sumona Mondal &amp; Dr. Shantanu Sur</td>
<td>Feature Selection of Rheumatoid Arthritis Comorbidities for Disease Prediction</td>
</tr>
</tbody>
</table>

**Session Chair:** Dr. Sumona Mondal  
**Judge:** Dr. Kevin Fite
Oral Presentation Session 1  
8:30 – 9:30 AM  
Snell 118

Section 3 – Chemistry 1 (Undergraduate)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30-8:42 AM</td>
<td>Mikenzie Barankovich; Dr. Devon Shipp</td>
<td>Dynamic Covalent Exchange and Self-Healing in Polyanhydrides</td>
</tr>
<tr>
<td>8:42-8:54 AM</td>
<td>Jenette DiLaura; Dr. Devon Shipp</td>
<td>Methacrylate-Based Bone Cement</td>
</tr>
<tr>
<td>8:54-9:06 AM</td>
<td>Anne Rolsma; Dr. Devon Shipp</td>
<td>Dynamic Mechanical Analysis of Polyanhydrides: A Stress Relaxation Study</td>
</tr>
<tr>
<td>9:06-9:18 AM</td>
<td>Brenna Kokosenski; Dr. Silvana Andreescu</td>
<td>Non-Enzymatic Point of Care (POC) Colorimetric Paper-Based Sensor for Uric Acid Detection</td>
</tr>
<tr>
<td>9:18-9:30 AM</td>
<td>Maximillian Card; Dr. Silvana Andreescu</td>
<td>Enzymatic Colorimetric Paper-Based Sensor for the Detection of Ethanol</td>
</tr>
</tbody>
</table>

Session Chair: Dr. Devon Shipp  
Judge: Dr. Ryan Brown
**Oral Presentation Session 1**  
**8:30 – 9:30 AM**  
**Snell 129**

**Section 4 – Education (Undergraduate)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30-8:42 AM</td>
<td>Emily Kehoe; Dr. Joshua Thomas</td>
<td>The Development of a Lab to Find the Mass of Jupiter</td>
</tr>
<tr>
<td>8:42-8:54 AM</td>
<td>Carlie Fowler; Dr. Michael Ramsdell</td>
<td>Educational Design and Implementation of a Roller Coaster Card Game</td>
</tr>
<tr>
<td>8:54-9:06 AM</td>
<td>Evelyn Laferriere; Dr. Stephen Bird</td>
<td>How Post-Secondary Schools Can Effectively Implement Sustainability Education into Their Curriculum</td>
</tr>
<tr>
<td>9:06-9:18 AM</td>
<td>Toby Harmon; Dr. Stephen Bird</td>
<td>Promoting Opportunity Awareness in Non-Urban Communities</td>
</tr>
<tr>
<td>9:18-9:30 AM</td>
<td>Taea Jackson; Dr. Stephen Bird &amp; Erik Backus</td>
<td>Understanding Community-Educational Partnerships in Sustainability Planning</td>
</tr>
</tbody>
</table>

**Session Chair: Dr. Stephen Bird**  
**Judge: Dr. Kathleen Kavanagh**
Oral Presentation Session 1  
8:30 – 9:30 AM  
Snell 169

Section 5 – Biometrics & Forensics (Undergraduate)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30-8:42 AM</td>
<td>Mariama Nije; Dr. Jeanna Matthews</td>
<td>Comparing Probabilistic Genotyping (PG) Software For Accuracy and Bias</td>
</tr>
<tr>
<td>8:42-8:54 AM</td>
<td>Cooper Fraser; Dr. Daqing Hou</td>
<td>Data Collection for Continuous User Authentication Through Behavioral Biometrics for Facebook</td>
</tr>
<tr>
<td>8:54-9:06 AM</td>
<td>Connor Gotham; Dr. Daqing Hou</td>
<td>Data Collection from User Behavior for Continuous Authentication Within Gmail</td>
</tr>
<tr>
<td>9:06-9:18 AM</td>
<td>Taylor Collins; Dr. Prashant Athavale</td>
<td>Matching Shoeprints of a Suspect with Shoeprints Obtained from a Crime Scene Through Rigid Registration</td>
</tr>
</tbody>
</table>

Session Chair: Dr. Daqing Hou  
Judge: Dr. Stephanie Schuckers
## Section 6 – Electrochemistry (Undergraduate)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30-8:42 AM</td>
<td>Stephanie Barajas; Dr. Mario Wriedt</td>
<td>MOF Synthesis and Modification For Smart Windows</td>
</tr>
<tr>
<td>8:42-8:54 AM</td>
<td>Gavin Flavell; Dr. Mario Wriedt</td>
<td>Synthesis of New Zirconium Based Zwitterionic Metal-Organic Frameworks by Sequential Linker Reinstallation</td>
</tr>
<tr>
<td>8:54-9:06 AM</td>
<td>Leah Livernois; Dr. Silvana Andreescu &amp; seini Narouei</td>
<td>Electrochemical Sensors for the On-Site Detection of Toxic Metal Ions in Environmental Water Systems</td>
</tr>
<tr>
<td>9:06-9:18 AM</td>
<td>Erich Stoltzfus &amp; Hannah Holbert; Dr. Marilyn Freeman</td>
<td>Characterization of MMT Clays for Low-Cost High-Performance Ceramic Composite Separators for Lithium-Ion Batteries</td>
</tr>
<tr>
<td>9:18-9:30 AM</td>
<td>Hope Woodruff; Dr. Mario Wriedt</td>
<td>Color Palette Expansion of Electrochromic Metal-Organic Frameworks</td>
</tr>
</tbody>
</table>

Session Chair: Farideh Hosseini Narouei  
Judge: Dr. Taeyoung Kim
# Oral Presentation Session 1
## 8:30 – 9:30 AM
### Snell 177

## Section 7 – Water & Waste Treatments 1 (Undergraduate)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presentation</th>
</tr>
</thead>
</table>
| 8:30-8:42 AM | **Maria Isabel Alexander Rodriguez; Dr. Michelle Crimi**
               Pre-treatment of Precursors to Per-and Polyfluoroalkyl Substances (PFAS) Through Chemical Oxidation by Activated Persulfate |
| 8:42-8:54 AM | **Madison Bredehoeft; Dr. Shane Rogers**
               Economics of Anaerobic Co-Digestion of Cultivated Sugar Kelp on Nitrogen Bioextraction and Biogas Production at Water Resource Recovery Facilities |
| 8:54-9:06 AM | **Sasha Gallimore-Repole; Dr. Shane Rogers & Dr. Stefan Grimberg**
               Viable Small Farm Anaerobic Digester Technology: Model Development |
| 9:06-9:18 AM | **Patrick Neu; Dr. Stefan Grimberg, Dr. Shane Rogers & Dr. Michael Twiss**
               Nitrogen Removal after Methanogenesis in Anaerobic Digestion |
| 9:18-9:30 AM | **Angelika Sonne; Dr. Shane Rogers**
               Efficacy of Anaerobic Co-Digestion with Macroalgae |

**Session Chair: Dr. Shane Rogers**

**Judge: Sujan Fernando**
### Oral Presentation Session 1
8:30 – 9:30 AM
Snell 212

**Section 8 – Evolutionary & Developmental Biology**
(Undergraduate)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenter(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30-8:42 AM</td>
<td>Alan Sherrod; Dr. Ginger Hunter</td>
<td>The Role of Myosin XV on Drosophila Bristle Pattens</td>
</tr>
<tr>
<td>8:42-8:54 AM</td>
<td>Aria Belle &amp; Rhiannon Clements; Dr. Susan Bailey</td>
<td>Comparative Evolution of Pseudomonas Fluorescens in a Heterogeneous Environment</td>
</tr>
<tr>
<td>8:54-9:06 AM</td>
<td>Lea Maney; Dr. Kenneth Wallace</td>
<td>Utilizing Cell Transplantation to Visualize Mutant ascl1a Secretory Cells during Post-Embryonic Development</td>
</tr>
<tr>
<td>9:06-9:18 AM</td>
<td>Herbert Fountain; Dr. Susan Bailey</td>
<td>Viral and Microbial Biocontrol against Agricultural Pathogens</td>
</tr>
</tbody>
</table>

**Session Chair:** Dr. Susan Bailey  
**Judge:** Dr. Andrew David
## Oral Presentation Session 1

**8:30 – 9:30 AM**

**Snell 213**

### Section 9 – Electrical & Computer Engineering (Undergraduate)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30-8:42 AM</td>
<td><strong>Frank Swiatowicz; Dr. Yu Liu</strong></td>
<td>Benchmarking for Performance Evaluation and Optimization of Multiple Physics Simulations</td>
</tr>
<tr>
<td>8:42-8:54 AM</td>
<td><strong>Jacob Csencsics; Dr. Daqing Hou &amp; Dr. Jeremie Fish</strong></td>
<td>Using GPUs to Parallelize Causation Entropy</td>
</tr>
<tr>
<td>8:54-9:06 AM</td>
<td><strong>Caleb Dillingham; Dr. Jeremie Fish</strong></td>
<td>Generating Probability Distributions for Network Synchronization Regarding Basin Stability</td>
</tr>
<tr>
<td>9:06-9:18 AM</td>
<td><strong>Jhonatan Carbajal Palacios; Dr. Ming-Cheng Cheng &amp; Dr. Yu Liu</strong></td>
<td>Thermal Simulation of a CPU Based on HotSpot – an Open-Source Thermal Simulation Tool</td>
</tr>
<tr>
<td>9:18-9:30 AM</td>
<td><strong>Andrew Schmier; Dr. Faraz Hussain</strong></td>
<td>Benchmarking Concurrent Algorithms in Go and C++</td>
</tr>
</tbody>
</table>

**Session Chair: Dr. Yu Liu**

**Judge: Dr. David Crouse**
Oral Presentation Session 1  
8:30 – 9:30 AM  
Snell B10L

Section 10 – Sensors & Signals (Undergraduate)

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30-8:42 AM</td>
<td>Niccolo Meniconi; Dr. Mahesh Banavar</td>
<td>Neural Network-Based Dereverberation and Benchmarking</td>
</tr>
<tr>
<td>8:42-8:54 AM</td>
<td>Cono Sammarco; Dr. Chee-Keong Tan</td>
<td>Gold Gratings Design Analysis for GaN-Based Optical Biosensor</td>
</tr>
<tr>
<td>8:54-9:06 AM</td>
<td>Lewis Collum; Dr. Mahesh Banavar</td>
<td>Real-Time Distributed IMU Using JSON Streams with Application in Indoor Localization and Sensor Networks</td>
</tr>
</tbody>
</table>

Session Chair: Dr. Mahesh Banavar  
Judge: Dr. William Jemison
## Oral Presentation Session 2
### 9:45 – 10:45 AM
### Snell 110

### Section 1 – Riverine Environments (Undergraduate)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presentation</th>
</tr>
</thead>
</table>
| 9:45-9:57  AM | **Caitlyn McAfee; Dr. Shane Rogers**
Development of Sustainable Eradication Practices for Invasive European Water Chestnuts in the Hudson River Basin |
| 9:57-10:09 AM | **Olivia Brown; Dr. Tom Langen**
Use of Constructed Nesting Habitat by New York Freshwater Turtles: Nest Spatial Patterns and Microenvironmental Conditions |
| 10:09-10:21 AM | **Maya Hoon; Dr. Michael Twiss**
Terrestrial Gastropods Accumulating Mercury in a St. Lawrence River Wetland |
| 10:21-10:33 AM | **Clarreese Greene; Dr. Ian Knack & Dr. Tyler Smith**
Using Hydraulic Modeling to Generate Stage-Discharge Rating Curves with Comparable Accuracy to a Traditional Measured Rating Curve |
| 10:33-10:45 AM | **Thomas Leonard; Dr. Michael Twiss**
Mercury Content in Terrestrial Arthropods along a Moisture Gradient in an Upper St. Lawrence River Wetland Ecosystem |

**Session Chair: Evie Brahstedt**  
**Judge: Dr. Andrew David**
<table>
<thead>
<tr>
<th>Time</th>
<th>Presenters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:45-9:57 AM</td>
<td>Nathaniel Beaupre &amp; Neil Schaffer; Dr. Kevin Fite</td>
<td>A Multi-Bar Kinematic Linkage for Partial Finger Prostheses</td>
</tr>
<tr>
<td>9:57-10:09 AM</td>
<td>Rachael Meacham &amp; Elena Sanchez; Dr. Kevin Fite</td>
<td>Development of a Myoelectric Thumb Prosthesis</td>
</tr>
<tr>
<td>10:09-10:21 AM</td>
<td>Morgan Reynolds; Dr. Shantanu Sur</td>
<td>Cervical Cancer Cell Response to Supramolecular Mimic of Extracellular Matrix</td>
</tr>
<tr>
<td>10:21-10:33 AM</td>
<td>Michael Sanborn; Dr. Damien Samways &amp; Dr. Shantanu Sur</td>
<td>The Mechanistic &amp; Physiologic Effects of Plasma Membrane-Peptide Amphiphile Interactions</td>
</tr>
</tbody>
</table>

Session Chair: Dr. Shantanu Sur  
Judge: Dr. Ali Boolani
### Oral Presentation Session 2
**9:45 – 10:45 AM**
**Snell 118**

**Section 3 – Chemistry 2 (Undergraduate)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenter(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:45-9:57 AM</td>
<td><strong>Alejandro Garcia; Dr. Mario Wriedt</strong></td>
<td>Using Trimeric M3(μ3-O) Clusters as Building Blocks in Mechanochemical Synthesis of Robust Zwitterionic Metal–Organic Frameworks</td>
</tr>
<tr>
<td>9:57-10:09 AM</td>
<td><strong>Tony Koppers &amp; Zachary Goad; Dr. Mario Wriedt</strong></td>
<td>Encapsulation of Single Molecule Magnets in Metal Organic Frameworks for the Creation of High-Density Information Storage</td>
</tr>
<tr>
<td>10:09-10:21 AM</td>
<td><strong>Sam Pyser; Dr. Mario Wriedt</strong></td>
<td>The Microencapsulation Of a UV Filter Substance in Metal-Organic Frameworks</td>
</tr>
<tr>
<td>10:21-10:33 AM</td>
<td><strong>Brendan Barrow; Dr. Dhara Trivedi</strong></td>
<td>Understanding the Chemical Contribution to the Enhancement Mechanism in SERS</td>
</tr>
<tr>
<td>10:33-10:45 AM</td>
<td><strong>Conrad Gende; Dr. Dhara Trivedi</strong></td>
<td>Understanding Computational Methods for Molecular Modeling</td>
</tr>
</tbody>
</table>

**Session Chair:** Dr. Mario Wriedt  
**Judge:** Dr. Ali Othman
### Oral Presentation Session 2
9:45 – 10:45 AM
Snell 129

Section 4 – Image Analysis (Undergraduate)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenter(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:45-9:57 AM</td>
<td>Ashwin Ajit &amp; Samuel Gwinn; Dr. Sean Banerjee &amp; Dr. Natasha Banerjee</td>
<td>Image Based Object Weight Prediction</td>
</tr>
<tr>
<td>9:57-10:09 AM</td>
<td>Jacob Gately &amp; Matthew Kolessar Wright; Dr. Souymabrata Dey, Dr. Natasha Banerjee &amp; Dr. Sean Banerjee</td>
<td>Multi-Material Classification for Using Thermal Data to Understand Swipe Interactions with Natural Surfaces</td>
</tr>
<tr>
<td>10:09-10:21 AM</td>
<td>Peter-John King &amp; Christian Gummerson; Dr. Sean Banerjee, Natasha Banerjee, Dr. Ajit Achuthan</td>
<td>An Automated System to Determine the Focus of a Microscope for Use in Material Deformation Analysis</td>
</tr>
<tr>
<td>10:21-10:33 AM</td>
<td>Taylor Ormasen; Dr. Joshua Thomas</td>
<td>All Sky Camera: Next Phase in Automating the Reynolds Observatory</td>
</tr>
<tr>
<td>10:33-10:45 AM</td>
<td>Carlie Fowler; Dr. Joshua Thomas</td>
<td>Mapping Extended Red Emission with Clarkson’s Reynolds Observatory: Creating the First ERE Map of NGC7129</td>
</tr>
</tbody>
</table>

Session Chair: Dr. Joshua Thomas
Judge: Dr. Chee-Keong Tan
**Oral Presentation Session 2**  
*9:45 – 10:45 AM*  
*Snell 169*

**Section 5 – Biochemical and Biomedical Science (Graduate)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Presentation Details</th>
</tr>
</thead>
</table>
| 9:45-10:00 AM | **Kevin Susice; Dr. Thomas Lufkin and Dr. Petra Kraus**  
Generation of CRISPR Modified Bovine Intervertebral Disc Reporter Cell Lines for Culture and Scaffold Assessment |
| 10:00-10:15 AM | **Mahfuza Akter; Dr. Susan Bailey**  
The Impacts of Spatial Structure on the Evolution of Antibiotic Resistance |
| 10:15-10:30 AM | **Madhura Bellare; Dr. Evgeny Katz & Dr. Artem Melman**  
Electrochemical Signal-Triggered Release of Biomolecules Functionalized with His-tag Units |
| 10:30-10:45 AM | **Vasantha Krishnan Kadambar; Dr. Artem Melman & Dr. Evgeny Katz**  
Electrochemically Stimulated Molecule Release Associated with Interfacial pH Changes |

**Session Chair:** Dr. Artem Melman  
**Judge:** Dr. Costel Darie
Oral Presentation Session 2  
9:45 – 10:45 AM  
Snell 175

Section 6 – Water & Waste Treatments 2 (Undergraduate)

9:45-9:57 AM

**Pieter Heyn; Dr. Thomas Holsen & Dr. Selma Thagard**  
The Application of Foam Fractionation in Plasma Water Treatment of Per- and Polyfluoroalkyl Substances (PFAS)

9:57-10:09 AM

**Ian Morrow; Dr. Selma Mededovic-Thagard**  
Investigation of the Species Impacting the Rate of Degradation in Plasma Water Treatment

10:09-10:21 AM

**Sopuruchi Uwakweh; Dr. Thomas Holsen**  
Aqueous Film-Forming Foams Containing Per- and Polyfluoroalkyl Substances and their Precursors: Characterization and Treatment Options

10:21-10:33 AM

**Aaliyah Harris; Dr. Stefan Grimberg**  
Ammonia Inhibition on Methane Production

10:33-10:45 AM

**Charles Cole; Dr. Stefan Grimberg**  
The Effects of a Cation Exchange Membrane on Ammonia Inhibition and Anaerobic Digestion Efficiency

Session Chair: Sujan Fernando  
Judge: Dr. Shane Rogers
## Oral Presentation Session 2
### 9:45 – 10:45 AM
### Snell 177

**Section 7 – Computational Biology (Graduate)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenters &amp; Titles</th>
</tr>
</thead>
</table>
| 9:45-10:00 AM  | **Daniel Fuller; Dr. Sumona Mondal & Dr. Shantnau Sur**
                  | Optimizing Parameters for Bayesian model of RA Prediction Using Information Theory |
| 10:00-10:15 AM | **Frederick Amoah-Darko; Dr. Diana White & Dr. Jonathan Martin**
                  | Continuous Model of Dynamic Instability of Microtubules considering Random Pausing |
| 10:15-10:30 AM | **Sashika Sureni Wickramsooriya; Dr. Rana Parshad & Dr. Jonathan Martin**
                  | Biological Control via Alternative Food to Predator                                |

**Session Chair: Dr. Diana White**

**Judge: Dr. Sumona Mondal**
Oral Presentation Session 2
9:45 – 10:45 AM
Snell 212

Section 8 – Computational Modelling (Graduate)

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:45-10:00 AM</td>
<td>Leila Nikdel; Dr. Susan Powers</td>
<td>Evaluation of Utilizing High Granularity Data in Building Energy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Simulation Development and Calibration</td>
</tr>
<tr>
<td>10:00-10:15 AM</td>
<td>Weichen Xie; Dr. Christino Tamon</td>
<td>On the Complexity of Quantum Transducers</td>
</tr>
<tr>
<td>10:15-10:30 AM</td>
<td>Alan Schay; Dr. Daqing Hou</td>
<td>Exploring User Motivation Reflection Similarity Using NLP Tools</td>
</tr>
<tr>
<td>10:30-10:45 AM</td>
<td>Aratrika Ray; Dr. Daqing Hou, Dr. Mahesh Banavar &amp; Dr. Stephanie Schuckers</td>
<td>Usage Scenario Oriented Continuous User Authentication on Mobile Devices</td>
</tr>
</tbody>
</table>

Session Chair: Dr. Daqing Hou
Judge: Dr. Faraz Hussein
Oral Presentation Session 2  
9:45 – 10:45 AM  
Snell 213  

Section 9 – Signals & Signal Processing (Graduate)  

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:45-10:00</td>
<td>Blaine Ayotte; Dr. Mahesh Banavar, Dr. Daqing Hou &amp; Dr. Stephanie Schuckers</td>
<td>Fast and Accurate Continuous User Authentication by Fusion of Instance-Based, Free-text Keystroke Dynamics</td>
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<td>10:00-10:15</td>
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<td>10:15-10:30</td>
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<td>Time-of-Flight (ToF) Cameras for Underwater Situational Awareness</td>
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<td>Optimized Modified Time Delay of Arrival for Biomedical and Geo-Hazard Applications</td>
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Session Chair: Dr. Mahesh Banavar  
Judge: Dr. Yu Liu
## Section 10 – Sustainability & Human Behavior (Undergraduate)

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**Session Chair:** Erik Backus  
**Judge:** Dr. Steven Wojkiewicz
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<td>Oksana Vysochanska; Dr. Susan Powers *</td>
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**Judge: Dr. Elizabeth Pienkos**

* Sustainability Poster
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Judge: Pedro Fernandez-Caban

* Sustainability Poster
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**Judge: Dr. Prashant Athavale**
# Poster Presentation Session

**11:00 AM – 12:00 PM**

**ERC Atrium**

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* Sustainability Poster
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| 29 | Matt Vonden Steinen; Dr. Steven Wojtkiewicz  
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| 30 | Nancy Ni; Dr. Stephen Bird & Erik Backus *  
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| 31 | Taea Jackson; Dr. Stephen Bird & Professor Erik Backus *  
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**Judge: Dr. Michael Twiss**

* Sustainability Poster
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**Judge: Dr. Mario Wriedt**

* Sustainability Poster
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**Judge: Jacob Hunt**

* Sustainability Poster*
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**Judge: Dr. Tom Langen**

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Section 11 – Engineering Design (Undergraduate)

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Judge: Dr. Craig Merrett

*S Sustainability Poster*
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**Judge: Dr. Jeremie Fish**

* Sustainability Poster*
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**Judge: Dr. Devon Shipp**

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Section 14 – Environmental Science & Sustainability (Graduate)

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Judge: Dr. Michelle Crimi

* Sustainability Poster
As industrial robots continue to populate factories and domestic robots loom on the horizon, the limitations of computers’ abilities to interpret the physical properties of their surrounding and the objects which they and their human counterparts interact with have become evident. The objective of this research is to understand how humans interact with objects of differing weights, and to implement a machine learning algorithm to predict if an object is too heavy for a human to lift. In data collection trials, various subjects are asked to lift objects of different weights in three different experiments, and the interaction is captured in an image sequence. We are assessing the relationship between properties such as lift time and speed to object weight, and will extract features from these images to train classifiers for predicting the weight of the object.

Mentors: Dr. Sean Banerjee, Dr. Natasha Banerjee, Department of Computer Science, Clarkson University
The Impacts of Spatial Structure on the Evolution of Antibiotic Resistance

Mahfuza Akter, Susan F. Bailey

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When a population of bacteria is exposed to antibiotics it may evolve resistance through the combination of random mutation and natural selection driving fixation of antibiotic resistance mutations. In a natural environment, however, a number of different complex stressors may be simultaneously driving evolution in a population. Spatial structure in the environment is one such stressor that has the potential to drive a diverse range of evolutionary responses depending on the impact of local neighborhood interactions and small-scale variations in the environment. Local interactions between one bacterial cell and another can have direct impacts on sensitivity to antibiotics – e.g. bacteria growing in biofilm are often less sensitive to antibiotics. To explore the importance of local interactions on the evolution of antibiotic resistance, we tracked the evolution of Pseudomonas aeruginosa exposed to a consistent semi-lethal concentration of the antibiotic ciprofloxacin across four different environments that differed in their degree of spatial structure. Degree of spatial structure was varied by adjusting the concentration of agar, while the limiting nutrient, xylose, was kept constant. Here we report on key differences in growth rate and antibiotic resistance driven by the degree of spatial structure in these evolved populations and discuss potential mechanisms driving these differences.

Mentor: Dr. Susan F. Bailey, Department of Biology, Clarkson University
Pre-treatment of Precursors to Per-and Polyfluoroalkyl Substances (PFAS) Through Chemical Oxidation by Activated Persulfate

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Per- and polyfluoroalkyl substances (PFAS) have been extensively used for industrial and military purposes since the early 1950s. PFAS are recalcitrant, remain in subsurface soil, and leach into groundwater sources, posing significant health risks to both humans and the environment. Current groundwater remediation methods have been proven to be inefficient in degrading PFAS. To date, there are two PFAS with protective EPA health advisory levels, perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). Recent studies have demonstrated a new exposure pathway to PFOA and PFOS through precursor compounds, such as 6:2 fluorotelomer sulfonate (6:2 FTS) and N-Methyl perfluorooctane sulfonamido acetic acid (MeFOSAA) that over time degrade to form PFOA and PFOS. An innovative treatment system that utilizes megasonic frequency sonolysis in situ for efficient PFAS degradation (>90%) in contaminated groundwater is being tested at Clarkson University. The objective of this study is to investigate the efficiency of chemical oxidation of precursors by activated persulfate through heat, alkaline pH, iron-citrate, and hydrogen peroxide activation, and observe the effects of pre-treating contaminated groundwater with activated persulfate prior to treatment with sonolysis. Enhanced efficiency of a sonolytic treatment process with an activated persulfate pre-treatment to oxidize precursors is expected.

Acknowledgements: I would like to thank Dr. Michelle Crimi and Fiona Laramay for their guidance and mentorship, and the Honors Program for making this opportunity possible.
Proteomic Analysis of the Blood from Lake Trout
*(Salvelinus namaycush)*

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Persistent, bioaccumulative and toxic (PBT) chemicals like polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs) reside in the Great Lakes at alarming concentrations. The Great Lakes Fish Monitoring and Surveillance Program (GLFMSP) uses top-predator fish species, like *Salvelinus namaycush* (lake trout), as bioindicators of these PBT chemicals in the ecosystem. Due to the structure of these chemicals, they are able to bioaccumulate and biomagnify in the food web. Bioaccumulation of these compounds can lead to changes in transcribed genes, translated mRNAs, and thus, proteins produced and post-translational modifications of these proteins. Although lake trout are used in these programs, there is currently little information available about the proteome of this species. In this study, we aim to identify proteins in the blood of lake trout from the Great Lakes using pre-existing protein databases. Proteomic methods, mass spectrometry, and data analysis using software such as Mascot Daemon and Scaffold 4.3 will hopefully contribute to creating a developed, comprehensive protein database for the lake trout that can be used in future proteomic studies on legacy chemicals in the Great Lakes ecosystem.

Acknowledgements: This study was funded by the US Environmental Protection Agency Great Lakes National Program Office under Assistance no. GL-00E01285. This article has not been subjected to the Agency’s required peer and policy review and therefore does not necessarily reflect the views of the Agency and no official endorsement should be inferred.

Mentors: Dr. Costel Darie, Emmalyn Dupree, Department of Chemistry & Biomolecular Science, Clarkson University
Continuous Model of Dynamic Instability of Microtubules Considering Random Pausing

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Microtubules (MTs) are protein polymers found in all eukaryotic cells. They are crucial for normal cell development, providing structural support for the cell and aiding in the transportation of proteins and organelles. In order to perform these functions, MTs go through random periods of relatively slow polymerization (growth) and very fast depolymerization (shrinkage), a unique type of dynamics called dynamic instability. The onset of a MT shortening event is called a “catastrophe”, while the event at which a MT starts to grow again is called a “rescue”. Although MT dynamic instability has traditionally been described solely in terms of growth and shortening, MTs have also been shown to pause for extended periods of time. More specifically, microtubules may grow, pause for a while, shrink and then begin growing again. Here, we present a mathematical model to describe dynamic instability in terms of growth, shortening and (random) pausing. Our overall goal is to use this model to determine MT catastrophe and rescue rates, quantities that can be used to compare our model results with experimental findings.

Acknowledgements: I would like to thank Dr. White and Dr. Martin for their great support in modelling the dynamics of microtubules.

Mentors: Dr. Diana White, Department of Mathematics, Clarkson University; Dr. Jonathan Martin, Department of Mathematics, Clarkson University

Session 2, Computational Biology
Snell 177, 10:00 AM
Eurasia watermilfoil (Myriophyllum spicatum, EWM) is one of the most invasive species of aquatic plant in the US and Southern Canada. EWM causes significant biological damage to the lakes it invades, by outcompeting other native aquatic plants resulting in reduced-lake biodiversity. EWM also causes economic damage by decreasing lakefront property values through the creation of large beds of biomass that harm recreational activities. One possible control method is to augment EWM infested lakes with native milfoil weevils (Euhrychiopsis lecontei), since it specializes in consuming EWM. Many studies have augmented various lakes with weevils with varying degrees of success. Here, we hope to quantify these studies, to better understand why some augmentations were successful while others were not. To do this, we conduct a metadata analysis on the lakes for which weevils were added, and record factors (predictors) which we believe might provide useful information on predicting success (EWM decline). We record characteristics of the lakes (water depth, nutrients, etc), as well as the augmentation strategy (number weevils, season, etc). We have created a predictive classification model using support vector machines (i.e., Machine Learning Algorithm) to attempt and relate our model predictors to success or failure at controlling EWM.

Mentors: Dr. Diana White, Dr. Jonathan Martin, Department of Mathematics, Clarkson University, Dr. Micheal Twiss, Department of Biology, Clarkson University
An Agent-Based Modeling Approach to Understanding the Dynamics in a Protozoa-Bacteria System

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Here, we use an Agent-Based Modeling (ABM) approach to understand predator-pest dynamics, using a protozoa (predator) and bacteria (pest) system as our test system. Protozoa are single-cell organisms that feed off of bacteria. The objective of this project is to develop a simulation environment, similar to that used in the laboratory of Prof. Susan Bailey, in an attempt to gain insight into this complicated biological system. To initiate our model, we use preliminary data collected from the Bailey lab (e.g., protozoa growth and death rates). Simulation of ABMs are useful since they can give us exact dynamics (individual motion and interaction behavior) between protozoa and bacteria (the so-called agents of this model), where this approach is unique to other mathematical methods, like differential equations, since it allows us to keep track of the spatial location of each individual agent (protozoa and bacteria), over time. Here, we focus our attention on the bacteria Pseudomonas fluorescens SBW25, as well as the protozoan tetrahymena (both used in the Bailey lab), and show a variety of long-time simulation results using a handful of different parameter sets. We will explain these results in terms of the biology of the system.

Mentor: Dr. Jonathan Martin, Dr. Diana White, Department of Mathematics, Clarkson University

Poster #51, Ecology

ERC Atrium, 11:00 AM-12:30 PM
Fast and Accurate Continuous User Authentication by Fusion of Instance-based, Free-text Keystroke Dynamics

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Keystroke dynamics study the way in which users input text via their keyboards, which is unique to each individual, and can form a component of a behavioral biometric system to improve existing account security. Existing keystroke dynamics systems on uncontrolled free-text data use n-graphs that measure the timing between consecutive keystrokes to distinguish between users. Many algorithms require 500, 1000, or more keystrokes to achieve EERs of below 10%. With 500 or 1000 characters it takes a longer time to detect an imposter and significant damage could be done. Here, we propose an instance-based graph comparison algorithm to reduce the number of keystrokes required to authenticate users in the uncontrolled free-text environment. Commonly used features such as monographs and four different digraphs are used. Feature importance is determined and used to construct a fused classifier. Detection curves are produced with different numbers of keystrokes. The fused classifier outperforms the state-of-the-art with EERs of 7.9%, 5.7%, 3.4%, and 2.7% with 50, 100, 200, and 500 keystrokes.

Acknowledgments: This work is supported in part by the Clarkson Niklas Ignite Fellowship; and is based on work supported by the Center for Identification Technology Research (CITeR) and the NSF under Grant 1650503.

Mentors: Dr. Mahesh K. Banavar, Dr. Daqing Hou, Dr. Stephanie Schuckers, Department of Electrical and Computer Engineering, Clarkson University
MOF Synthesis and Modification for Smart Windows

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Metal-organic frameworks (MOFs) are a new class of crystalline porous materials made of metal nodes and organic linkers. Unlike traditional MOFs, we introduced a zwitterionic (ZW) ligand into our MOF. In its zwitterionic form, our MOF is transparent. When the MOF undergoes reduction, it changes to a deep blue or black color indicating it is in its radical form. We are able to reduce MOFs photochemically under UV light and electrochemically when we apply a potential. In this study, we examined a ZW Ni-based MOF. Our MOF is not photoactive and cannot be reduced photochemically. Also, we are not able to study the MOF when we electrochemically reduce it as it oxidizes back to its ZW form once it is removed from the electrochemical reduction setup. Therefore, we need to find a reducing agent to help chemically reduce our MOF. Using different reducing agents, we attempted to access and stabilize the radical form in order to study its various properties. We want to study the reduced form as it could potentially possess different electronic properties than the ZW form. Eventually, we will transfer this knowledge to bulk material and thin-film technology.

Acknowledgements: ASPIRE program, Community of Underrepresented Professional Opportunities (CUPO), Corning Inc. and NSF

Mentor: Dr. Mario Wriedt, Juby Varghese, Department of Biomolecular Science, Clarkson University
Dynamic Covalent Exchange and Self-Healing in Polyanhydrides

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Polyanhydrides (PAHs) have great potential for use in the biomedical field as drug delivery and resorbable adhesives as they exhibit characteristics such as biocompatibility, linear surface erosion, and shape memory [1]. Despite their advantages, PAHs aren’t commonly used commercially as they can be difficult to manufacture and store. Furthermore, they have also been shown to undergo a dynamic covalent exchange (DCE) that occurs between the anhydride moieties when stimulated [2]. DCE can be seen as a complication for shape memory purposes but is of great interest to our group as it can also act as the driving force behind the self-healing capabilities of the material. The goal of this work is to determine ideal conditions under which self-healing will take place, and develop a defined method of synthesizing and healing our PAHs to show that healed samples will have similar physical properties compared to undamaged samples. Healing experiments, which included notching the sample and then heating to accelerate DCE, followed by tensile testing and dynamic mechanical analysis. These experiments were performed using various compositions of PAH systems. It is expected that increased concentrations of the cross-linking monomer will increase the time and/or temperature required to achieve complete healing in the polymer.

Acknowledgements: The authors would like to thank the Clarkson University Honors Program for supporting this research.

Mentor: Dr. Devon Shipp and Kelly Tillman, Department of Chemistry and Biomolecular Science, Clarkson University
Understanding the Chemical Contribution to the Enhancement Mechanism in SERS

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The Raman spectrum of scattering is unique for every molecule; however, the intensity is extremely weak. If the scattering intensity is enhanced by several orders of magnitude, it can be used as a powerful technique for determining structural information of molecules. A method of achieving this involves adsorption of molecules on metallic nanoparticle surfaces, called surface enhanced Raman scattering (SERS). The enhancement mechanisms due to the chemical coupling between the molecule and surface has been measured experimentally and characterized using theoretical approaches. In our work, we carry out a study of the chemical enhancement of halide substituted benzenethiols interacting with a silver cluster. By changing the element and position of the functional groups on benzenethiol, we can modulate the direct chemical interactions between the benzenethiol molecule and the metal cluster. Additionally, we investigate the effect of a solvent environment on these systems. We calculate enhancement factors from density functional theory (DFT) using Amsterdam Density Functional package. This insight is aimed towards a deeper understanding of the chemical mechanism and its contribution to SERS as a whole.

Mentor: Dr. Dhara Trivedi, Department of Physics, Clarkson University
A Multi-Bar Kinematic Linkage for Partial Finger Prostheses

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The work presented here is part of a larger effort focused on the application of engineering design to restore dexterity and functionality to individuals who have undergone partial finger amputation. The objective of the design presented here is to obtain this goal through the use of mechanical linkages that use force input from the residual limb to power the prosthesis. There have been products that have accomplished this, such as Naked Prosthetics MCP Driver and PIP Driver. However, they are expensive and thus cost-prohibitive for many individuals with partial finger amputations. This sets an additional goal for the project to create a cost-effective product for the patient. Thus, a majority of the model incorporates 3D printed technology, which allows for the production of parts to be cheap and easy to reproduce. We have utilized this technology to design a linkage-based finger prosthesis for individuals with finger amputation of the intermediate and distal phalanges. The design attaches to the back of the hand and extends over the residual proximal interphalangeal (PIP) joint of the affected finger. This design leverages user-controlled flexion of the residual metacarpophalangeal (MCP) joint to actuate flexion of the proximal and distal interphalangeal joints of the prosthesis.

Acknowledgements: Clarkson University Honors Program, Clarkson University

Mentor: Dr. Kevin Fite, Department of Mechanical Engineering, Clarkson University
Utilizing RGB-D Video to Predict Cognitive Fatigue in Older Adults

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Fatal and non-fatal fall events in the elderly population have a detrimental effect on the physical and financial health of those involved. Elderly individuals undertaking tasks with heavy cognitive load may be more prone to fall events. Cognitive fatigue may have limited effect on a person's natural movement and posture as perceived by another human. Tracking joint movements on a finite computational scale can however detect cognitive fatigue of a magnitude imperceptible to even an experienced physical therapist. In this research, we collected data from 10 older adults using an off-the-shelf RGB-D camera. The collected color and depth data was processed using both the native Microsoft Kinect and OpenPose body key point detector. The variance of the joints before and after cognitive tasks are then analyzed in both 2D and 3D, and SVM and random forest based classifiers are used to predict if an older adult has performed cognitive tasks. This method of computational data analysis has allowed for the detection of induced cognitive fatigue using both 2D and 3D body key points. With consistent detection of fatigue, intervention can take place and prevent fall events and their unfortunate consequences.

Acknowledgements: Thank you to the Clarkson University Honors Program and the Terascale All-sensing Research Studio (TARS) at Clarkson University for providing an opportunity to conduct research over the summer.

Mentors: Dr. Sean Banerjee, Dr. Natasha Banerjee, and Sarah Inzerillo, Department of Computer Science, Clarkson University, Dr. Ali Boolani, Department of Physical Therapy, Clarkson University

Poster #26 Human Health Applications ERC Atrium, 11:00 AM-12:30 PM
Electrochemical Signal-Triggered Release of Biomolecules Functionalized with His-tag Units

Madhura Bellare, Vasantha K Kadambar, Paolo Bollella, Maria Gamella, Artem Melman, Evgeny Katz

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His-tagged molecular species, a ferrocene derivative and Protein A, were immobilized on electrode surfaces (Au and graphite) through formation of a chelated complex in the presence of Cu²⁺ cations used as bridging units. The complex was cleaved and the attached molecules were released from the electrode surface by applying reductive potential to the electrodes resulting in Cu²⁺ reduction, thus decomposing the chelated complex. The molecule release process was followed by cyclic voltammetry in case of the ferrocene derivative. His-tagged Protein A was additionally labeled with a fluorescent tag and its release was followed by fluorescence measurements in the solution and by impedance spectroscopy at the electrode. The studied release of the His-tagged redox species and biomolecules was considered as a new generic approach to the signal-controlled molecule release applicable in various biotechnological and biomedical applications.

Mentors: Dr. Artem Melman, Dr. Evgeny Katz, Department of Chemistry and Bimolecular Sciences
Comparative Evolution of *Pseudomonas fluorescens* in a Heterogeneous Environment

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Experimental evolution an approach used to examine how populations evolve over time in a controlled lab environment. Bacteria are an ideal organism to use because their short generation times result in rapid evolution. In the lab bacteria are commonly grown in homogeneous, well-mixed environments that do not mimic complex natural environments very closely. This project examines the growth and evolution of replicate populations of *Pseudomonas fluorescens* in two environments- liquid xylose media (M9 salts + xylose) and semi-solid xylose agar (M9 salts + xylose + 0.2% agar). Bacterial populations evolving in liquid are expected to lose their dispersal ability, and adapt rapidly to their environment. On the other hand, populations evolved in the semi-solid agar are expected to improve their dispersal ability in order to better locate food. To estimate the degree of adaptation that has occurred, the evolved populations are compared to their ancestors by measuring growth rates, direct head-to-head competitions, dispersal ability, and genome sequence comparison. Genomic DNA was extracted, sequenced, processed, and compared to the ancestral genome to identify the underlying genetic changes that have driven adaptive evolution in these populations. By comparing fitness and the genomes of evolved populations their ancestors, this study will determine the impact of heterogeneity on evolution.

Acknowledgements: We are grateful for Andrew Trudeau, Morgan McGrath, and Katie Tulowiecki for initiating this project.

Mentor: Dr. Susan Bailey of the Department of Biology, Clarkson University.
The need for affordable and functional prostheses for pediatric amputees is widespread, and often the families have difficulties finding affordable solutions that work well. With the evolution and affordability of 3D printing, 3D printed prostheses are an ideal solution to the problem that these families face. Additionally, with 3D printing technology, the printed prostheses can be scaled up as the user grows. A prosthesis is currently being developed for a pediatric amputee who has partial amputations of the thumb and the fourth and fifth phalange. Prototypes of 3 different designs are being developed to examine the pros and cons of each mechanical solution used and to ensure a multifaceted approach to the project. The prototypes are a cable-driven system that utilizes existing hand function to actuate the prosthetic phalanges, a mechanical linkage using force input from the residual phalange, and an alternative cable-driven system using silicone and/or a flexible 3D printed material to give movement. Further research into multi-material solutions will provide enhanced performance, comfort, and reduced sensitivity to failure within the prototype.

Acknowledgements: This work has been supported by the Honors Program, Corning, CUPO, McNair, and TRIO.

Mentor: Dr. Kevin Fite, Department of Mechanical and Aeronautical Engineering, Clarkson University
Broad Tolerance to Acidic Conditions by the Invasive Freshwater Gastropod, *Viviparus georgianus*

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The aim of this project was to discover how acidification induced by hydrochloric acid would affect the overall fitness of the invasive freshwater snail, *Viviparus georgianus*. This project consisted of two 24-hour LD-50 experiments and one long term experiment. In the LD-50 experiments, snails were cultured in a control tank and multiple experimental tanks with varying pH values. The experimental tanks had 1 mL to 10 mL of 1 in 100 diluted hydrochloric acid transferred into 1000 mL of water that was collected from the Raquette River. Incisions were made in the shells of two individuals in the control to mimic a predation event. The leading edge of the shell was photographed to determine how long it would take this species to completely regenerate in its natural conditions. The long term experiment included one control tank and two experimental tanks. The pH was manipulated in the two experimental tanks by injecting concentrations of hydrochloric acid that were chosen based on the data from the LD-50 experiments to lower the pH value. Individuals in each tank were closely observed and measured each day to detect changes in length, mortality, shell thickness, and regeneration rates.

Mentor: Dr. Andrew David, Department of Biology, Clarkson University

Poster #50, Ecology

ERC Atrium, 11:00 AM-12:30 PM
Economics of Anaerobic Co-Digestion of Cultivated Sugar Kelp on Nitrogen Bioextraction and Biogas Production at Water Resource Recovery Facilities

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Saccharina latissima (kelp) is fast-growing, bioextracts inorganic nitrogen from water, and is a third-generation biofuel feedstock via anaerobic co-digestion (co-AD). We explore economic trade-offs of kelp cultivation as biofuel feedstock and for bioextraction of nitrogen from coastal areas under the influence of water resource recovery facility (WRRF) ocean outfalls, whether alternative or supplement to tertiary nutrient management bioprocesses. Co-AD of harvested kelp was simulated at a WRRF. This increases NH4-N in WRRF anaerobic digesters, which is recycled through the WRRF, and increases effluent nitrogen necessitating a larger aquaculture site to remediate nutrients than if stand-alone digesters were used. GPS-X Pro and CapdetWorks (Hydromantis, Ontario, Canada) were used to scale WRRFs, simulate nitrogen discharge, and evaluate costs of configurations to meet nutrient effluent goals. Literature data and interviews were used to evaluate costs of kelp. Employing a mixed scenario of tertiary nutrient management bioprocesses with kelp nitrogen bioextraction reduced expansion of kelp aquaculture site requirements, but increased capital, operation and maintenance costs of WRRFs. Preliminary recommendations are made regarding maximum transport distances for off-site anaerobic digestion in stand-alone digesters as an alternative to anaerobic co-digestion at WRRFs based on costs.

Acknowledgements: Support for Madison Bredehoeft was provided by NSF Award No. 1659623 (Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity).

Mentor: Dr. Shane Rogers, Department of Civil and Environmental Engineering, Clarkson University

Session 1, Water & Waste Treatments 1
Use of Constructed Nesting Habitat by New York Freshwater Turtles: Nest Spatial Patterns and Microenvironmental Conditions

Olivia Brown

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High adult female mortality rates are a significant threat to freshwater turtle populations as females tend to nest along roadsides or cross roads while moving to and from nest sites. Hotspots of turtle road mortality have been identified and road crossing mitigation has been installed in St. Lawrence County, NY. Artificial nesting sites have been constructed and currently are being monitored as a possible means to reduce female mortality and increase hatchling survivorship; such nesting sites may reduce the risk that females encounter roads. This study is a survey of four created or managed turtle nesting sites to identify spatial patterns of nests at artificial nesting sites. The four sites are located near *Emydoidea blandingii* (Blanding’s turtle) habitat; data from 2015 to present will be included in the results. Using sensors, this study also examines how microenvironmental soil conditions at constructed and roadside nest sites differ in order to determine what features affect nest site selection and nesting success. The goal is to provide information that can be used to improve site design to attract more females and increase offspring survivorship at present and future nesting sites.

Mentors: Dr. Tom Langen, Department of Biology, Clarkson University, Dr. Glenn Johnson, Jase Briggs, Department of Biology, SUNY Potsdam
Comparing and Designing Airfoils to Determine the Best Geometry of a Blade for the Clarkson Ducted Wind Turbine

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Currently, a ducted wind turbine (DWT) operates on the roof of TAC at Clarkson University. The DWT uses a GOE 417A airfoil, a cambered plate that generates higher lift at lower wind speeds. Being a flat plate, the airfoil is both cost-effective and efficient, leading to a lower cost per kilowatt hour, our key metric. The geometry of the airfoil and hence the whole blade is essential to increasing efficiency on the turbine and thus improving the key metric. However, the most effective airfoil must be determined. Using the UIUC Airfoil Database to find airfoils and running simulations through XFOIL will allow the determination of the optimal blade for use on future generations of the DWT. In addition to testing known airfoils, a new design based on specific parameters will be created through a Matlab code composed by researchers. The new design will be tested in the simulation program to determine the lift-drag ratio and thus the efficiency. The expected findings are that there is a better airfoil shape for the Clarkson DWT than the one being used currently. If an optimum blade is discovered, the new design could potentially be constructed for physical testing and installation.

Acknowledgments: We would like to thank Clarkson University and the Honors Program for making this summer research possible and all members of the Applied Aerodynamics Lab for their help.

Mentors: Dr. Kenneth Visser, Aaron Kummer, Will Martin, Department of Mechanical and Aeronautical Engineering, Clarkson University
Thermal Simulation of a CPU based on HotSpot - an Open-Source Thermal Simulation Tool

Jhonatan Carbajal Palacios\textsuperscript{1}, Ming-Cheng Cheng\textsuperscript{2}, Yu Liu\textsuperscript{2}

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The demand for efficient microprocessors has been on a steady rise in the past few decades. This rise in demand in turn allowed for the development of multi-core processors. The strive for progress has consequently led to a heightened awareness of thermal problems involved with the increased power density arising from the growing number of transistors on microprocessor chips. This project seeks to simulate transient thermal behavior of an Alpha 21264/EV6 microprocessor for the verification of an efficient thermal simulation. The thermal simulator HotSpot is used to generate transient temperatures for different functional units of a 3-D integrated circuit. By using the generated transient simulations, dynamic thermal profiles are studied and the relationship is analyzed between the power generated in each functional units and the temperatures risen from the generated power to verify HotSpot’s transient modeling ability. Substandard thermal management can contribute to increased failure rates of micro-electronic devices, effectively reducing both the performance and the reliability of a device. For this reason, the progression of thermal-aware architecture based on accurate simulations is an immediate necessity for the prevention of hot spots arisen from inappropriate thermal management.

Acknowledgements: I would like to acknowledge the support of my mentors throughout the course of my research. They have helped me develop my critical thinking skills. I’d also like to acknowledge NSF Award #1852102 for the funding support.

Mentors: Dr. Yu Liu, Department of Electrical and Computer Engineering, Clarkson University & Dr. Ming-Cheng Cheng, Department of Electrical and Computer Engineering, Clarkson University
Development and Optimization of a Portable Paper-based Sensor for in Field Quantification of Ethanol

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Paper based sensors with varying colorimetric approaches have been recently developed for many different applications in the environmental, food and clinical fields [1]. The goal of this research is to develop a compact, paper based system for ethanol detection based on a unique combination of inorganic nanoparticles, enzymes and colorimetric dyes. Research work involves the immobilization of the dyes and the enzyme on paper, and optimization of experimental conditions for obtaining increased stability and shelf life. The presentation will describe the detection mechanism of color formation and the materials and methods used to fabricate the sensor. Specific results showing response to different concentrations of ethanol will also be discussed.

References:


Mentors: Dr. Silvana Andreescu, Brenna Kokosenski, Fatima Mustafa, Department of Chemistry and Biomolecular Science, Clarkson University

Session 1, Chemistry I Snell 118, 9:18 AM
Alterations in Gait in Relation to Feelings of Energy

Hannah Christiansen, Abby Avolio, Aurora Goodwin, Royce Nsiah, Te-Ree D. Parrish, Ali Boolani

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Energy and fatigue have been found to be separate yet overlapping moods. The purpose of this study was to determine the relationship between gait, posture, and feelings of energy. Participants (N=133, Male=50, Female=83, Age=25.80±7.96yrs, Height=173.12±8.71cm, Weight=74.28±15.27kg) were surveyed to analyze current mood states, diet, exercise regimen, and average mental workload. Participants were given multiple cognition tests before gait and posture were measured with a 2-Minute Walk Test and a mCTSIB. A backwards linear regression was used to determine the association between gait, posture, and feelings of energy.

Acknowledgements: This work has been supported by CUPO, TRIO, and the McNair Program.

Mentor: Dr. Ali Boolani, Department of Physical Therapy, Clarkson University
Rainwater Harvesting for Improved Water and Food Security in Kinyamaseke, Uganda

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This research explores the use of rainwater harvesting (RWH) systems in rural Kinyamaseke, Uganda to improve water and food security. Kinyamaseke is an impoverished town that suffers through seasons of drought; their main water source contains dangerously high levels of *E. coli* indicating fecal contamination. These factors cause severe disease and death among the residents. Efforts towards alleviation of these problems include the addition of rainwater harvesting systems to collect clean, usable water for households. Lack of information about climate and water usage practices lead to difficulty in designing a proper RWH system. Understanding conservation behavior and the quality of stored rainwater will inform appropriate design, including water collection surface and storage requirements as well as best potential uses of captured water from the RWH system. The potential for a coupled aquaponics system is explored, along with utilization of water for irrigation purposes, as opposed to drinking or domestic uses. Installation of a test RWH and aquaponics system for the Cornell Cooperative Extension Farm in Canton, NY allowed for a trial run to examine possible malfunctions or obstacles.

Acknowledgements: Clarkson Honors Program for allowing me to conduct this research, Legal and Charitable Aid Uganda for the opportunity to work with their community

Mentor: Dr. Shane Rogers, Department of Civil and Environmental Engineering, Clarkson University
The Effects of a Cation Exchange Membrane on Ammonia Inhibition and Anaerobic Digestion Efficiency

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A system was designed to lower the ammonia levels of the anaerobic digester leading to more efficient biogas production. The system used is based on previous research done at the lab scale, where layering channels of digestate and potassium-based draw solution leads to NH₄⁺ crossing the membrane to the higher-pH draw solution. Behind, it leaves NH₃ a volatile and thus more easily removable form of nitrogen. It is removed via bubbling columns and then trapped in a sulfuric acid trap. By removing ammonia we mitigate the effects of ammonia inhibition on methanogenesis, which is the microbial process of creating biogas. We determine its efficiency by studying the contents entering and leaving the digester and see how it changes. Specifically, how its breakdown is changed with the newly installed membrane. There are two main tests being done on the influent and effluent: solids and chemical oxygen demand (COD). There are two secondary tanks on the digester. We will connect the membrane to one of them and compare the experimental membrane tank with the control tank. We are beginning to gather baseline data on the control system. Once the membrane is installed we will begin to collect experimental data on its efficiency.

Acknowledgements: Support for Charles Cole was provided by NSF Award No. 1659623 (Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity).

Mentors: Jacob Hunt, Dr. Stefan Grimberg, Department of Civil and Environmental Engineering, Clarkson University
Matching Shoeprints of a Suspect with Shoeprints Obtained from a Crime Scene Through Rigid Registration

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Approximately 20,000 innocent people are currently in the United States prison system. One in four inmates who have been exonerated since 1989 were initially convicted with false or misleading forensic evidence. In this project, our objective is to accurately match shoeprint images collected from a crime scene to that of the corresponding suspect. In current investigative settings, shoeprints are matched manually by forensic experts or by computer-aided landmark registration. Moreover, there is no objective similarity measure for the subsequent matching. Our goal is to formulate a similarity measure based on the computational registration of the shoeprint impressions.

Acknowledgements: I would like to extend my appreciation to the National Science Foundation for providing financial support with NSF Award #1852102 and also to the faculty and administrative personnel of Clarkson University for their continuous encouragement and support and access to their facilities and systems.

Mentor: Dr. Arashant Athavale, Department of Electrical and Computer Engineering, Clarkson University.
An IMU (Inertial Measurement Unit) is a system that fuses accelerometer, gyroscope and, optionally, magnetometer data to return an estimated orientation, velocity and position. JSON is a file format that is used for transporting data structures serially. Our system implements an IMU that takes in JSON-formatted sensor data from Android devices over WiFi and outputs JSON-formatted, fused IMU estimates. The benefit of standardizing the format for the input and output of the system is that it ensures modularity and improves the potential for parallel processing. For example, the output of the system can be the input of a series of filters, logging systems, or databases that are not necessarily working on the same computer or thread. IMU’s are commonly used in localization, but provide inaccurate positional estimations over time unless supplemented with an anchor-based localization method (such as triangulation or trilateration). Since our system was designed to be modular, it can handle multiple indoor localization methods, such that each method (including the IMU) can seamlessly be fused with other methods to improve positional estimation accuracy.

Acknowledgement: This work was supported in part by the NSF DUE award 1525224.

Mentor: Dr. Mahesh Banavar, Department of Electrical & Computer Engineering, Clarkson University
Comparing and Designing Airfoils to Determine the Best Geometry of a Blade for the Clarkson Ducted Wind Turbine

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Currently, a ducted wind turbine (DWT) operates on the roof of TAC at Clarkson University. The DWT uses a GOE 417A airfoil, a cambered plate that generates higher lift at lower wind speeds. Being a flat plate, the airfoil is both cost-effective and efficient, leading to a lower cost per kilowatt hour, our key metric. The geometry of the airfoil and hence the whole blade is essential to increasing efficiency on the turbine and thus improving the key metric. However, the most effective airfoil must be determined. Using the UIUC Airfoil Database to find airfoils and running simulations through XFOIL will allow the determination of the optimal blade for use on future generations of the DWT. In addition to testing known airfoils, a new design based on specific parameters will be created through a Matlab code composed by researchers. The new design will be tested in the simulation program to determine the lift-drag ratio and thus the efficiency. The expected findings are that there is a better airfoil shape for the Clarkson DWT than the one being used currently. If an optimum blade is discovered, the new design could potentially be constructed for physical testing and installation.

Acknowledgments: We would like to thank Clarkson University and the Honors Program for making this summer research possible and all members of the Applied Aerodynamics Lab for their help.

Mentors: Dr. Kenneth Visser, Aaron Kummer, Will Martin, Department of Mechanical and Aeronautical Engineering, Clarkson University
The Use of GPUs to Parallelize Causation Entropy

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Understanding the framework of a network structure in a dynamic system is very crucial to be able to comprehend and predict its behavior. Often the underlying network structure is unknown and must be estimated from data. There are a few models which includes: Shannon Entropy, Granger Entropy, and methods built off Shannon’s Entropy (transfer and causational entropy). The problem with most of these models is that they are continuous, and estimation can be very slow due to the calculation space being so large and the variable number increasing almost exponentially. In this research, we investigate a specific version of entropy where the multivariate Poisson model is being used. Because serial code for multivariate Poisson modeling is very slow, we turn to parallelization, specifically using GPUs and the paradigm OpenACC. We aim to utilize the sheer computing power that a GPU can provide if programmed correctly to make calculations with higher dimensions computationally feasible.

Acknowledgements: I would like to thank the National Science Foundation for funding Award #1852102 that provided me with the funds to make research possible. I would like to extend my appreciation to Clarkson University for hosting me and my peers research.

Mentors: Dr. Daqing Hou and Dr. Jeremie Fish, Clarkson University
Children’s Understanding of Randomness: A Pilot Study

Gracie DeLaBruere¹, Annie E. Wertz², H. Clark Barrett³, Peter M. Todd⁴, Andreas Wilke¹

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Previous research suggests that the hot hand phenomenon, a tendency to perceive illusory streaks or clumps in random sequences of data, is a human universal tied to humans’ evolutionary history of foraging for clumpy resources. The present study investigates how this misperception of randomness develops ontogenetically. We will investigate randomness perception in 3-5 year old children when they are playing a sequential cartoon turtle foraging card task. Cards will be laid out in front of the children in a predetermined, random sequence. A cartoon turtle will be placed on the table and as the turtle travels down the line of cards the children will have to opportunity to predict the presence or absence of a plant one card location at a time. The results from this study will help assess if expectations of clumpy resource distributions are already present in children and how they might develop over time. Currently, the misperception of randomness has not been studied from a development perspective.

Mentor: Dr. Andreas Wilke, Department of Psychology, Clarkson University

Poster #2, Psychology & Human Behavior ERC Atrium, 11:00 AM-12:30 PM
Examination of Isotropy Assumption in Isogrid Structures through Analysis and Experiments on 12 Isogrid Variations

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An isogrid is a lattice structure with a high strength to weight ratio making it an ideal structure to use for spacecraft. Isogrids were originally designed to yield isotropic properties; however, current studies have shown a contrary argument with limited experimental testing [1, 2]. The isogrid is theorized to be isotropic because of the equal distribution of forces induced by the structure’s geometry. To determine the isotropy of an isogrid, truss, plate, and shell analyses are executed to predict failure among a dozen various isogrid specimens. Each isogrid specimen varies in geometry to determine the effect of various parameters on the isotropy of the structure. Specifically, variations in lattice shape, lattice size, and border presence. In addition, experimental tests are conducted by applying compressive loads to the specimens using a universal testing machine with digital image correlation (DIC) to determine the strain for comparison of the analytical and experimental results. Preliminary results from the truss analysis demonstrate that the structure is anisotropic because the stresses in the isogrid vary between locations; whereas an isotropic structure should have a uniform distribution of stresses.

Acknowledgements: Thanks to Matthew Bakowski for experimental assistance and Steven Hopkins for coding assistance. Advice and revisions provided by Dr. Merrett has helped with the entire study. Special thanks to Dr. Marcias Martinez for experimental assistance and for providing the lab equipment.

Mentor: Dr. Craig G. Merrett, Department of Mechanical and Aeronautical Engineering, Clarkson University
Modeling the Growth and Sustainable Control of Invasive Eurasian Watermilfoil

Isabel Dengos

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Eurasian watermilfoil (EWM - Myriophyllum Spicatum) is an invasive aquatic plant which was first introduced into North America in the 1940s (originating from Europe, Asia, and North Africa). Like other invasive plants, EWM has the ability to grow and spread quickly, forming dense monocultures, due to its ability to outcompete many native aquatic plants. We begin by expanding on previous theoretical models [1, 2] to describe the growth of EWM in a dense single stand, using an ODE approach. This model is used to predict the total biomass of a single patch of EWM over a single growing season. We then perform a sensitivity analysis to understand if small variations in some model parameters lead to large deviations in end-of-season biomass. Those parameters which lead to large increases in end-of-season biomass might provide insight into how we might control/reduce plant growth. Future work will include spatial modeling to understand EWM spread within each season and between seasons. Further, we can use such models to determine the effectiveness of two different commonly used control strategies: localized hand pulling and placement of bottom covers/mats.


Mentors: Dr. Diana White, Dr. Jonathan Martin, Department of Mathematics, Clarkson University, Dr. Michael Twiss, Department of Biology, Clarkson University
Quantitative \textit{in vivo} Study of Nitric Oxide Production in Zebrafish Embryo

\textbf{Aaditya S. Deshpande}\textsuperscript{1}, Eduard Dumitrescu\textsuperscript{1}, Kenneth Wallace\textsuperscript{2}, Silvana Andreescu\textsuperscript{1}

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The metabolic reactions in live organisms may result in the imbalance of their internal chemical environment i.e. leading to the formation of Oxygen and Nitrogen containing free radicals. Their concentration dynamics cause positive as well as negative effects. Nevertheless, the detection of oxidative stress markers is still a difficult task due to their low concentration, high reactivity, and short life-time in biological settings. Electrochemical sensors possess advantage over conventional reactive oxygen species (ROS) detection methods.

This poster presentation covers our recent results in the development and use of electrochemical microelectrodes for \textit{in vivo} detection of nitric oxide (NO) as representative marker of oxidative stress. The performance of the developed microsensors is demonstrated using zebrafish (\textit{Danio rerio}) embryos as a biological model. Nitric oxide concentrations are measured at single organ level in live embryos, without additional perturbation beyond electrode insertion. The measurements are verified by carrying out fluorescence imaging and pharmacological manipulation. Our results validate the potential of electrochemical techniques to generate information about oxidative stress markers in biological settings.

Mentors: Dr. Kenneth Wallace, Department of Biology, Clarkson University, Dr. Silvana Andreescu, Department of Chemistry and Biomolecular Science, Clarkson University
Dynamic Mode Decomposition of Fluid Flow

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Dynamic Mode Decomposition (DMD) was first introduced in the fluid mechanics community for analyzing behavior of nonlinear systems. DMD algorithm processes empirical data generated by nonlinear dynamics and calculates eigenvalues and eigenmodes (“DMD modes”) of an approximate linear model. In fluid dynamics, the DMD modes can be used for many purposes, such as predicting future behavior, identifying periodic behavior of fluid flows, and isolating special patterns in the flow. Computationally, DMD can be interpreted as an Arnoldi-like method based on the Koopman operator.

References:

Acknowledgments: Sathsara Dias is an inaugural Clarkson Ignite Fellow since January 2019. S. Dias and his mentors acknowledge Ken Solinsky ’71 for sponsoring the Ignite Program.

Mentors: Dr. Marko Budišić, Department of Mathematics, Dr. Brian Helenbrook, Dr. Pat Piperni, Department of Mechanical and Aeronautical Engineering, Clarkson University
Novel Methacrylate-Based Bone Cement

**Jenette DiLaura¹, Arielle Floyd², Devon Shipp²**

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Poly(methyl methacrylate) (PMMA)-based bone cements are commonly used in orthopedic surgery, and as such must satisfy several performance requirements. First, an ideal bone cement must reach a peak temperature that does not exceed fever temperature during curing. There should also be a high percent conversion of the alkene into polymer, ideally resulting in all of the monomer reacting through polymerization to form the cement. This is important since unreacted monomer present in the cement significantly increases toxicity. In order to maintain mechanical properties, bone cements should have a glass transition temperature well above body temperature. The cement mixture should have a doughy consistency so that a surgeon is able to shape the cement to fit along the patient’s bone. Current commercially available bone cements meet these criteria, but ideally, they should also degrade at the same rate that a bone heals - there is currently no such material available. In this work, we are looking to produce PMMA-based bone cements that will also incorporate degradable units in the polymer network. Data will be collected in order to determine the exothermic temperature rise, glass transition temperature, percent conversion, and degradation profile of such degradable PMMA-based bone cements.

Mentors: Arielle Floyd, Department of Chemistry and Biomolecular Science, Clarkson University
Generating Probability Distributions for Network Synchronization Regarding Basin Stability

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The growth in analysis of increasingly complex networks creates the need for robust methodology to assess the probability of the network to synchronize, with applications ranging from neural networks to dynamic power grid stability. The human brain provides examples of how synchronization can be adverse such as in Parkinson’s tremors. Alternatively, the power grid provides an example of when synchronization is desirable as lack of synchronization can lead to cascading power failures. To predict the network synchronization of such systems after a disturbance, it is vital to determine the local stability. The Pecora-Carroll Model was chosen as the model for network synchronization. Generation of a hypercube forming initial conditions around the system’s attractor (typically containing most synchronous states) was accomplished with the concept of Basin Stability. From this hypercube, random values were sampled as initial conditions to the network. Utilizing HPC techniques via GPU’s, the simulations were sped up as the process becomes increasingly computationally expensive with each increase of network nodes and initial conditions. Simulations ran for 1000 different sets of initial conditions. The solutions of the simulations were used to determine a resultant probability distribution of the system’s likelihood to stabilize.

Acknowledgements: Funded by the National Science Foundation, REU Award #1852102.

Mentor: Dr. Jeremie Fish, Department of Electrical and Computer Engineering, Clarkson University
Herein we present a controlled enzyme-based logic Exclusive NOR (XNOR) gate designed in a chemical fashion. The Boolean logic operation XNOR was based on urea and ethyl acetate as inputs, which are processed through urease and esterase, thus producing ammonium hydroxide and acetic acid, respectively. Both reaction products induced \textit{in situ} changes of the initial pH of buffer solution, which resulted to be acidic in the presence of acetic acid and basic in the presence of ammonium hydroxide. Therefore, the \textit{in situ} pH change produced a variation of the enzymatic activity of pyrroloquinoline quinone dependent glucose dehydrogenase (PQQ-GDH) in a logic fashion, depending on the combination of the input signals applied. The enzymatic activity was spectrophotometrically assayed by using phenazine methosulfate (PMS) as primary electron acceptor and 2,6-dichloroindophenol (DCIP) as final electron acceptor. Furthermore, the XNOR gate was also implemented immobilizing PQQ-GDH onto a buckypaper electrode modified with 1-pyrenebutanoic acid succinimidyl ester (PBSE). In this case, the enzymatic activity variation induced by \textit{in situ} pH change due to urease/esterase catalytic reactions was monitored through electrochemical measurement of cyclic voltammograms (CV). Finally, XNOR triggered proteins release system was studied. The PQQ-GDH electrodes were connected to iron-crosslinked-alginate modified graphite electrodes containing protein A functionalized with fluorescein (FITC). The protein release was analyzed by following fluorescence measurements. The present system represented the first realization of the enzyme-based XNOR gate functionally integrated with the downstream actuation process in the form of the signal-stimulated release.

Mentor: Dr. Evgeny Katz, Department of Chemistry and Biomolecular Science, Clarkson University
A 3D Printing Platform for Development of Bioink Based Wearable Sensors

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The ability to manufacture functional sensors rapidly would be beneficial for numerous applications in healthcare, environmental monitoring, food, and cosmetic industries. However, sensors are inherently complex and often arranged into composite architectures composed of multiple components. Therefore new fabrication methods are needed to create sensors that could be manufactured rapidly. Emerging additive manufacturing methods like 3D printing and 3D bioprinting, enable printing different biomaterials into intricate 3D architectures which could be used for sensing. This work focuses on advancing the capabilities of biosensor fabrication. Specifically, a multimaterial bioprinting method capable of producing 3D biosensor constructs by co-printing hydrogel biocomposites, nanoparticles, enzymes and polymers. To demonstrate that such a platform could be used for this purpose, a new UV sensor was determined to be fabricated. To create a UV sensitive sensor that gives a colorimetric response to UV light, photocatalytic nanoparticles were used with dyes, which would degrade on exposure to UV thereby giving a colorimetric response to UV exposure. To test the versatility of this additive manufacturing platform, three different dyes were used as components of a printable bio-ink which was then be used to 3D print these sensors.

Mentor: Dr. Silvana Andreescu, Department of Chemistry and Biomolecular Science, Clarkson University

Poster #73, Chemistry

ERC Atrium, 11:00 AM-12:30 PM
Synthesis of New Zirconium Based Zwitterionic - Metal-Organic Frameworks by Sequential Linker Reinstallation

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Metal-Organic Frameworks (MOFs) are a class of crystalline porous materials composed of metal clusters or ions and organic linkers to form multi-dimensional frameworks. Their high surface area and large pore volume combined with their tunable nature make them ideal candidates for potential applications such as gas storage, small molecule separation and sensing. Within the large family of MOF materials, Zr-based MOFs are one of the most promising groups mainly due to their structural diversity and excellent stability. Zwitterionic (ZW) ligands when utilized in MOFs induce an electrostatic field gradient on their surfaces due to their well-separated charges. Thus, their incorporation into MOFs can create organic charged surfaces (OCSs) which lead to polarization effects on guest molecules, improving the host-guest interaction. The objective of this project is to design and synthesize a new Zr-based ZW-MOFs analogous to the well known Zr-based MOF UiO-68 from rigid pyridinium-based ZW ligands. This work focusses on the synthetic procedure known as Sequential Linker Reinstallation (SLR). This procedure entails introducing a labile linker to inert Zr-MOFs (UiO-67.5) to increase the framework’s flexibility. This enables the installation of the desired ZW linker. Subsequent use of ZW ligands in Zr-based MOFs synthesis will change the physicochemical interaction properties of the guest molecules with the frameworks, leading to promising adsorption-based applications.

Mentor: Shefa Alomari, Dr. Mario Wriedt, Department of Chemistry and Biomolecular Science, Clarkson University
Antimicrobial resistance (AMR) is a growing problem across the world. Hospitals and medical centers have seen the rise of superbugs; bacterial strains that are unresponsive to common antibiotics like penicillin. According to the NIH, in a paper published in 2018, AMR is predicted to cause more than 10 million deaths every year after 2050. AMR is already responsible for approximately 700,000 deaths a year. AMR is a growing problem in agriculture, both with livestock and crops. Decades of using the same herbicides to treat common crop diseases like tomato speck, and rice blight has lead to a recent increase in larger and larger losses to disease related crop failure. We are reaching the point where the evolution of these pathogens is outpacing our discovery of chemical deterrents. The goal of my research is to find and develop alternative effective treatments to the pathogens that worst affect our fields. I plan to approach this problem using biocontrol methods to attack bacterial pathogens. This can include increasing the concentrations of naturally present bacterial pathogen predators like protozoa, as well as developing novel reagents like bacteriophage - viruses that infect bacteria. Using experimental evolution techniques, I aim to genetically modify said viruses to more effectively prey upon the bacteria that prey upon our plants.

Mentor: Dr. Susan Bailey, Department of Biology, Clarkson University
Roller coasters have ups and downs, upside downs, thrills, twists, and turns. Teaching the math and physics of roller coasters brings similar ups and downs, twists, and turns. The development of roller coasters provides data for students to analyze and compare to real life experiences. We will present the details of coaster segment combinations and the checkpoints, as well as an introduction to g-forces that riders experience. The card game consists of initial track segments including lift hills, roll backs, and launchers followed by thrilling loops, camelbacks, corkscrews, cobra rolls, helixes, and horseshoe turns. The cards finishing tracks include brakes and roll ups. Pre-set cards with fixed coaster segment dimensions allow students to construct a roller coaster of their own, which includes specific checkpoints to ensure a working and safe roller coaster design. Each card segment has been mathematically modeled in MATLAB, including the track shape, pitch, and roll. The tracks can be compiled into a single data set which can be input into NoLimits2, a roller coaster simulating platform allowing students to ride their coaster. Additionally, our lab consists of a virtual reality simulator and Oculus VR headsets which allow the rides to become more real to the students.

Acknowledgements: I would like to thank Dr. Ramsdell for his guidance and help during this research project and for the opportunity to work with the IMEPTUS roller coaster camp.

Mentor: Dr. Michael Ramsdell, Department of Physics, Clarkson University
Mapping Extended Red Emission with Clarkson’s Reynolds Observatory: Creating the First ERE Map of NGC7129

Carlie Fowler, Joshua Thomas

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We have developed the methodology and programs necessary to use Clarkson’s Reynolds Observatory to look for extended red emission (ERE). ERE is a little known and poorly understood optical photoluminescence that occurs in areas containing dust and far-ultraviolet photons. The leading theory is that ERE is produced by ionized polycyclic aromatic hydrocarbons (PAHs). To get more insight into the ERE, we observed several nebulae thought to exhibit this phenomenon. Previously, we found a positive result in NGC7023 and a null result for LDN1780. The next step of this research was to search for ERE in unmapped areas of space, specifically starting with nebula that had been confirmed as ERE nebula using spectroscopy. Preliminary results of the first ERE map of NGC7129 will be presented. Our ultimate goal is to identify candidate stars behind ERE clouds to see if there is a connection between diffuse interstellar bands (DIBs) and ERE.

Acknowledgements: I would like to thank Dr. Thomas for his guidance and help during this research project, Emily Kehoe, Maurice Peploski, and Taylor Ormasen for helping in the data collection process, and the Clarkson University Honors Program for providing my room and board for the summer.

Mentor: Dr. Joshua Thomas, Department of Physics, Clarkson University
Magnetic and Electrically Conductive Polypyrrole Nanoparticles as Highly Effective Materials for Heavy Metal Removal and Sensing

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Heavy metals such as arsenic, cadmium, chromium, nickel, and lead are a well-known source of pollution of air, water, and soil. Their presence in the environment can cause harmful effects in plants, animals, and humans. To address the consequences of heavy metals pollution, there is a need for technology to detect, capture and remove heavy metal from the environment. This presentation reports the synthesis and characterization of polypyrrole (PPy) - magnetite (Fe$_3$O$_4$-PPy) nanoparticles, prepared via a chemical oxidative polymerization process using polyvinyl alcohol as a surfactant. The Fe$_3$O$_4$-PPy nanoparticles have spherical shape and size ranging from 110 to 220 nm and are characterized by high magnetic properties and good electrical conductivity. The particles displayed high sorption capacity for arsenic removal from contaminated water, evaluated using Atomic Absorption Spectroscopy (AAS). Their high affinity for contaminants was also used to develop a highly sensitive detection technique using the principles of nano-impact electrochemistry.

Mentors: Dr. Daniel Andreescu, Department of Chemistry and Biomolecular Science, Clarkson University

Poster #46, Environmental Treatment ERC Atrium, 11:00 AM-12:30 PM
As Facebook has become more prevalent, it has become an important target for hackers, so it is imperative that novel techniques are developed to protect against attacks. A key point that requires more cybersecurity occurs after a hacker has gained access to a user’s account. If this point is made more secure, the amount of damage caused could be limited or potentially eliminated. A possible countermeasure to implement is continuous user authentication through behavioral biometrics; however, data must be collected to determine if user behavior profiles can be generated for Facebook. To accomplish this, a web extension was made in Javascript to be used by volunteers as they use Facebook to collect data about their behavior. This behavior can be which posts they spend more time looking at or what posts they like. We were able to find that this data can be individually associated with a volunteer. Therefore, our results show that continuous user authentication can be implemented for Facebook.

Acknowledgements: 2018 Facebook Secure the Internet Grant

Mentor: Daqing Hou, Department of Electrical and Computer Engineering, Clarkson University
Determining Optimal Techniques to Create Complete Streets that are Effective in the Northern New York Environment

**Nick Frost, Autumn Lennon, Erik C. Backus, PE**

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With motor vehicles being at the center of focus for today’s road infrastructure, roughly 6,000 pedestrians die in car accidents each year and another 129,000 experience non-fatal injuries (Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, 2017). Coupled with environmental concerns and decreasing physical activity, these factors indicate that many of our current roads are no longer safe or effective. Complete streets are those that the United States Department of Transportation has defined as streets that are “designed and operated to enable safe use and support mobility for all users” (US Department of Transportation, 2015). Different communities have discrete needs, so designing an effective complete streets program becomes a challenge. Therefore, an analysis of past methods needs to be completed to determine which traffic calming techniques are effective or not in certain situations. In order to determine the best techniques for a specific program or design application, the Analytical Hierarchy Process with weighted matrices will be employed.

Mentors: Erik Backus, Autumn Lennon, Department of Civil Engineering, Clarkson University
Optimizing Parameters for Bayesian Model of RA Prediction Using Information Theory

Daniel T. Fuller\textsuperscript{1}, Shantanu Sur\textsuperscript{2}, Sumona Mondal\textsuperscript{1}

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The effects on Rheumatoid Arthritis (RA) due to the coexistence of comorbid conditions and associated interactions is a deeply understudied area of modern health science analytics. Meaningful analysis of these higher order effects and their interactions with RA is important to predict prognosis and therapeutic decision making. In order to address this, we proceed with Bayesian modeling of the system and then optimize our feature selection with an information theoretic approach. Information theory maintains deep ties with statistical decision making and uncertainty quantification. The Akaike Information Criterion and its generalized versions estimate the amount of information lost when modeling data and represent powerful tools for optimizing models between overfitting and underfitting. We evaluate the estimated information loss over different parameters and likelihood selections and further compare the optimized output to the results of the same process under a classical statistical design. This allows us to demonstrate the advantage of Bayesian inference in encompassing the maximum likelihood estimation while providing robust error bounds. The optimized parameter estimates that are obtained allow for confident interpretations of the relationships between our variables of interest and a better insight into the observed associations between these comorbid conditions and RA.

Acknowledgements: This work is supported by the Lawrence ’57 and Antoinette Delaney Ignite Research Fellowships.

Mentors: Dr. Sumona Mondal, Department of Mathematics, Clarkson University, Dr. Shantanu Sur, Department of Biology, Clarkson University
This research focuses on development of a model to simulate existing viable anaerobic digestion technology for farmers with small livestock herds. Clarkson designed, installed, and operates a pilot-scale system with sensors for pH, temperature, biogas, and flow at the Cornell Cooperative Extension of St. Lawrence County (CCE-SLC) Learning Farm in Canton, NY. The system was recently upgraded with a food waste grinder, screw press, and greenhouse to facilitate co-digestion of food waste, solid separation for reuse as bedding, and reuse of biogas to heat the greenhouse. In this work, we monitor biochemical characteristics of anaerobic digester feed, effluent, and separated solids and liquids to facilitate a mass balance for the anaerobic digestion process at the CCE-SLC anaerobic digester and construction of an improved process simulation. The simulation will be used to improve ongoing K-12 STEM education programming and dairy farm operator outreach programs at the CCE-SLC. Results from the first two months of study will be reported.

Acknowledgements: Support for Sasha Gallimore-Repole was provided by the McNair Scholars program.

Mentors: Dr. Shane Rogers, Dr. Stefan Grimberg, Department of Civil and Environmental Engineering, Clarkson University
Using Trimeric $\text{M}_3(\mu_3\text{-O})$ Clusters as Building Blocks In Mechanochemical Synthesis of Robust Zwitterionic Metal–Organic Frameworks

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Metal-Organic Frameworks (MOFs) are hybrid crystalline porous materials that are composed of metal ions or clusters connected by polytopic organic linkers. MOFs are known for their enormous surface areas and large solvent-accessible voids. MOFs have versatile topologies, which can be tailored to meet demands for different applications such as small-molecule storage and separation, catalysis, and sensing. By incorporating zwitterionic (ZW) linkers in the frameworks a charged organic surface is induced in the MOF pores leading to intramolecular electrostatic fields. Polarizable guest-molecules can be attracted to these fields yielding enhanced guest-framework interactions. In addition, using trimeric $\text{M}_3(\mu_3\text{-O})$ clusters ($\text{M} = \text{Fe}^{3+}, \text{Cr}^{3+}, \text{Fe}^{3+}/\text{Cr}^{3+}, \text{Fe}^{3+}/\text{Co}^{2+}, \text{Fe}^{3+}/\text{Ni}^{2+}$) as a building block in ZW-MOF synthesis allows for more chemically complex frameworks such as mixed-metal ZW-MOFs, which will facilitate developing new hybrid materials with highly desirable practical application properties. Mechanochemistry has been shown to be a rapid and green method to synthesize a wide range of popular MOFs under mild conditions. This work demonstrates the use of mechanochemistry for the synthesis of a pyridinium-based ZW-MOFs employing the trimeric clusters as a metal node in the frameworks.

Acknowledgements: Support for Alejandro Garcia was provided by NSF Award No. 1659623 (Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity).

Mentor: Shefa Alomari, John Hadynski, Dr. Mario Wriedt, Department of Chemistry and Biomolecular Science, Clarkson University
The beginnings of the Children of God (COG) seemed innocent in late 1960s California. It seemed like a bunch of Christian missionaries singing and preaching the word of God, under the leadership of David Berg. However, COG was really a cult that abused the words “love” and “sex.” COG believed in spreading the word of God through sex, including behaviors of rape, molestation, and incest. The normalization of this behavior injured the mental health of many members of the COG community. News reporting added to this damage by focusing on the abuses of children, but not women. This was a problem because it devalued the pain the women felt and made it harder for women to move on. There was also too much emphasis on moral outrage rather than facts, missing an opportunity to heal. Based on an examination of news articles covering COG from the US, Thailand, and Argentina (1968-2005), I ask: how can the news better report on complicated environments like cults without appealing to the morality of the masses and excluding the pain of certain victims?
Multi-Material Classification for using Thermal Data to Understand Swipe Interactions with Natural Surfaces

Jacob Gately\textsuperscript{1,2}, Matthew Kolessar Wright\textsuperscript{1}, Soumyabrata Dey\textsuperscript{1}, Natasha Kholgade Banerjee\textsuperscript{1}, Sean Banerjee\textsuperscript{1}

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In this project we plan to utilize machine learning techniques to differentiate materials based on their interactions with thermal signatures provided by a user. By differentiating materials in this fashion we will be able to improve upon previously conducted research that determines the pressure provided by a user when interacting with a material. Previous research has shown that material type can have a large effect on swipe pressure classification. As such, a material specific classifier will often substantially improve the detection accuracy. Our project seeks to automate the material detection process so as to remove the need for human intervention. Our goal is to create a classifier that can identify a material by placing it into one of seven categories: blackboard, chair fabric, cloth, concrete, drywall, laminate, and wood. We will create this classifier using training data where users use a finger to leave ten thermal signatures on five different samples of all seven materials. This provides 350 samples per user, which in addition to fifteen total users will provide 5250 data points to both train and test the classifier. Our project expands the capabilities of the field by increasing the versatility and applicability of previous research.

Mentors: Dr. Souymabrata Dey, Dr. Natasha Kholgade Banerjee, Dr. Sean Banerjee, Department of Computer Science, Clarkson University
Understanding Computational Methods for Molecular Modeling

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The properties of a molecule play a critical role in its effectiveness in certain scientific and practical applications. In order to determine the optimal choice from a large possibility of molecules, a comprehensive understanding of each molecule’s properties is required. Unfortunately, determining this information from experimental methods is both costly and inefficient. Because of this, there is a great demand for efficient methods of obtaining this data efficiently with an understanding of the physical principles involved. Computational and theoretical approaches to obtaining molecular data hold great potential to achieve this goal. However, due to the extreme complexity of molecular systems, determining accurate data through computational methods can require large amounts of computing power. Due to this, various modeling methods are employed with each having tradeoffs regarding necessary computational power and data accuracy. In order to implement any of such theoretical methods, it is the first and most important step is to optimize the structure or molecule to its energy minimum. We utilized Python’s Psi4 program package, specifically using its optimized geometry and energy functions to study the optimization process. Using a variety of molecules, including diatomics, H₂O, and benzenethiol, we will show the effectiveness of Psi4 computational method.

Mentors: Dr. Dhara Trivedi, Department of Physics, Clarkson University

Session 2, Chemistry 2
Snell 118, 10:33 AM
Approaching Agricultural Management Trade-offs using Agent-Based Modeling

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There is an increased need for agricultural management tools due to the growing issue of water scarcity. One tool that is rising in popularity is agent-based modeling. In agent-based modeling, each individual agent is able to make their own decisions based on their own behavior rules, making it possible to represent a heterogeneous population. We plan to create an agent-based model that incorporates the interactions between farmers, the community, and policy makers to better understand the issue of water scarcity in relation to interactions between groups. The model will be built in NetLogo to allow for simulations to be run to evaluate the impacts of policy change on the agricultural community.

Acknowledgements: Clarkson University Honors Program

Mentor: Dr. Kathleen Kavanagh, Department of Mathematics, Clarkson University

Poster #32, Sustainable Communities, ERC Atrium, 11:00 AM-12:30 PM
Revitalizing the SLIP-FALLS-STEPm Lab

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Over the past thirteen years, the Sliding Linear Investigative Platform For Analyzing Lower Limb Stability Syncronized Tracking EMG and Pressure measurements, known as SLIP-FALLS-STEPm has evolved in its purpose in understanding the human body detection of movement. One of the few labs in the world studying standing, this lab has collected over 500 subject data to date. This year, the computer that ran the lab since its infancy, has died. This summer has been dedicated to revitalizing all the past work. The final critical condition that remains to be studied is the standing support with no swaying.

Acknowledgements: This summer has been a great privilege and life changing experience thanks to the McNair Scholars program offered through the Community of Underrepresented Professional Opportunities (CUPO). The guidance, encouragement, patience and ongoing support by my faculty mentor, Dr. Charles Robinson, has shaped my summer. Thank you so much.

Mentor: Dr. Charles Robinson Department of Electrical and Computer Engineering, Clarkson University
Data Collection from User Behavior for Continuous Authentication Within Gmail

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There are 1.2 billion monthly active Gmail users. Most of these user’s accounts all house valuable information that may become accessible to hackers that wish to benefit. In an attempt to limit or eliminate the breadth of influence hackers may have on using other email accounts, a browser extension is under development to record all user actions that Gmail receives. With Javascript event listeners and purpose built algorithms it is possible to know almost every action taken by the user. Once enough information is gathered from the Gmail account owner, it is expected that there will be ways for an AI to differentiate account owner behavior from a foreign account user (hacker). When the AI notices this, the account owner will be notified and will have the ability to lock the account. If these processes are successful, this research may ultimately provide another level of security to those who use Gmail.

Mentor: Dr. Daqing Hou, Department of Electrical and Computer Engineering, Clarkson University
Using Hydraulic Modeling to Generate Stage-Discharge Rating Curves with Comparable Accuracy to a Traditional Measured Rating Curve

Clarreese Greene,1,2 Ian Knack2, Tyler Smith2

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Hydrological modeling aids in the prediction of streamflow as well as an understanding of water systems, directly supporting studies on climate change, infrastructure design, and water resource management. These models require discharge data (typically produced via a rating curve) for calibration to produce reliable forecasts. The traditional approach of developing a rating curve is based on extensive collection of water level and discharge data. Due to this expense, it is of significant value to develop this information using a hydraulic model and a small number of streamflow measurements. In this study, the traditional approach is compared with a model-based approach. This study used few collected field measurements, a one-dimensional hydraulics model (HEC-RAS), and historical data to generate stage-discharge rating curves for two different rivers. This method requires the calibration of the Manning’s bed roughness for the HEC-RAS model using the observed flows and water levels. This procedure resulted in good and consistent model results during calibration and validation. This study showed hydraulic modeling to be an accurate and inexpensive method to develop a stage-discharge rating curve.

Acknowledgements: Support for Clarreese Greene was provided by NSF Award No. 1659623 (Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity).

Mentors: Dr. Ian Knack, Dr. Tyler Smith, Department of Civil and Environmental Engineering, Clarkson University
Promoting Opportunity Awareness in Non-Urban Communities

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As many large intercity communities make their way into the 21st century by adopting a more environmentally friendly and holistic planning system, most non-urban communities struggle to advance in a sustainable way, most often due to a lack of community awareness and a pervasive resistance to change. This lack of awareness and information is addressed in the concept of “knowing the unknown.” How can a non-urban community promote change and opportunity awareness among its citizens when it is unaware of the available options? The goal of this project is to better understand what obstacles limit a community’s awareness and what practices could be undertaken to combat these obstacles. The research involves numerous semi-structured interviews with experts and town stakeholders as well as several case studies and deep literary analysis of previously conducted work. All of this culminates in what the researchers have dubbed a “Comprehensive Awareness Plan for Engagement” or CAPE that could be generalized as a structure for non-urban communities moving to increase change and involvement in their area.

Acknowledgements: Clarkson University Honors Program

Mentors: Dr. Stephen Bird, Institute for Sustainable Environment, Clarkson University
Ammonia Inhibition on Methane Production

**Aaliyah Harris\(^1\)**, Stefan Grimberg\(^2\)

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In the United States, about 37 million tons of food is wasted annually and diverted to landfills where large amounts of greenhouse gases such as methane and carbon dioxide are released into the atmosphere. Anaerobic digestion (AD) is a preferred waste management strategy and a biological process that takes complex insoluble compounds in FW and breaks them down in order to produce renewable energy in the form of biogas that can be used for heat and power, and a nutrient-enriched digestate that could serve as fertilizer. In the first stage of AD, organic compounds are broken down into a simpler form, volatile fatty acids (VFAs) are produced during the next two stages, and methane is produced in the last stage. During the AD of food waste, ammonia is produced; ammonium ions (NH\(_4^+\)) and free ammonia nitrogen (NH\(_3\)). Although ammonia is essential to bacteria growth, high concentrations of free ammonia nitrogen (FAN) above the threshold concentration is toxic to methanogens, the microorganisms that produce methane. This ultimately inhibits the digestion of food waste and limits the generation of methane. Therefore, ammonia removal and recovery during FW AD may provide a solution to reduce ammonia inhibitions and ultimately increase energy generation.

Acknowledgement: Support for Aaliyah Harris was provided by NSF Award No. 1659623 (Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity).

Mentor: Dr. Stefan Grimberg, Department of Civil and Environmental Engineering, Clarkson University
Climate change, pollution, and increased resource use are significant challenges globally. One challenge is encouraging housing residents to adopt pro-environmental behaviors (PEB). PEB can be implemented in residential housing systems through a variety of methods such as resource use feedback, action education, or developing motivations. In 2013, Clarkson housing units were renovated with electricity and water meters to record utility usage. From 2013-2018, we collected survey and utility data in several different interventions that combined several strategies. Extensive analysis was done in the first three years, but we can now incorporate all six years of data. In this particular project, we focus only on apartments that collected bedroom electricity because the data is granular and allows us to categorize individuals. The survey blocks used assessed several different aspects of environmental values and beliefs. For instance, environmental emotions, and motivation towards the environment. We are now integrating actual individual use with results from these survey blocks to understand the relationship between values and beliefs with utility usage. This analysis will allow us to better understand our research question: What are the motivational, ideological, and affective underpinnings of electricity consumption?
The Application of Foam Fractionation in Plasma Water Treatment of Per- and Polyfluoroalkyl Substances (PFAS)

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This project investigates foam fractionation as a PFAS pre-concentration step followed by the electrical discharge plasma treatment of the foam fractionate. The foam fractionation process removes PFAS from contaminated water by bubbling air which causes these amphiphilic molecules to concentrate in the foam. The foam is removed from the fractionation unit and treated by the plasma process in an enhanced contact electrical discharge plasma reactor that has already been demonstrated for the treatment of low concentration PFAS (up to 10 mg/L). The foam fractionation process lowers the overall treatment cost because it allows the plasma process to treat small volumes of high PFAS concentrations (> 100 mg/L) rather than directly treating large volumes of small concentrations of PFAS which requires plasma reactor scaleup. The laboratory foam fractionation process and the properties of the final foam fractionate will be compared to those of an actual PFAS fractionation site.

Mentors: Xudong Su and Dr. Selma Mededovic Thagard, Department of Chemical and Biomolecular Engineering, Clarkson University, Dr. Thomas Holsen, Department of Civil and Environmental Engineering, Clarkson University
Terrestrial Gastropods Accumulating Mercury in a St. Lawrence River Wetland

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The Upper St. Lawrence River (USLR) is shared by the U.S. and Canada. After over 60 years of maintaining stable water levels within the river, Plan 2014 was implemented in 2017, resulting in natural fluctuations of water levels. However, 29% of wetlands that were developed under the stable water levels are receding with water fluctuations, therefore potentially methylating and mobilizing the mercury (Hg) that has accumulated within these wetlands. In order to quantify the bioavailability and bioaccumulation potentials of Hg in varying zones of these wetlands, we sampled terrestrial organisms, specifically Succinaidae (Gastropoda; amber snails), within an aquatic interface zone that experiences flooding and drying periods and a wet zone that remains submerged in water for most of the year. Snails from these zones were collected, measured, and compared for their total Hg content, and the results were analyzed by ANOVA. Overall, we hypothesize that amber snails collected at the terrestrial-aquatic interface zone will contain the highest Hg content. The results from this project will help develop an understanding of the availability of mobilized Hg as a function of water levels within the St. Lawrence River and will provide implications of human and ecosystem health impacts.

Acknowledgements: Support for Maya Hoon was provided by NSF Award No. 1659623 (Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity).

Mentor: Dr. Michael Twiss, Department of Biology, Clarkson University

Session 2, Riverine Environments  Snell 110, 10:09 AM

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Improving Methods of Cognitive Fatigue Measurement Through RGB-D Video Analysis

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Tests designed to measure static balance abilities of the elderly in a physical therapy environment usually involve physical therapists performing clinical analysis on holistic observations of body motion. In this research, we are working with the Department of Physical Therapy to break down the analysis of cognitive fatigue based on the 25 joint variances of multiple subjects. Computational video-based analysis allows us to more precisely evaluate the physical effect cognitive fatigue has on a subject. Using a RGB-D camera, a Microsoft Kinect SDK, and a keypoint detection software OpenPose, which tracks 25 body points concurrently, is more efficient and accurate than human observation, which can only focus on one area at a time and is subjective in nature. Analyzing joint coordinates on a 2D and 3D plane, SVM and random forest based classifiers are used in conjunction with data augmentation techniques to create a model that most accurately predicts cognitive load on a subject. When an individual is identified as a fall risk, our goal is to provide intervention to prevent injury as well as the financial burden of medical visits.

Acknowledgements: The author would like to thank Corning, Inc. for their support and funding, as well as the Honors Program for the opportunity to continue research over the summer.

Mentors: Dr. Sean Banerjee, Dr. Natasha Banerjee, Department of Computer Science, Clarkson University, Dr. Ali Boolani, Department of Physical Therapy, Clarkson University

Session 1, Biomedical Science & Engineering 1
Copolymerization of Methyl Acrylate with N-Vinyl Pyrrolidone and N, N-Dimethylacrylamide

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Poly (N-vinyl pyrrolidone) (PNVP) and poly(dimethylacrylamide) (PDMA) are hydrophilic polymers that are widely used in hydrogel materials such as adhesives, ink, contact lens, etc. Methyl Acrylate (MA) is another common monomer, although more hydrophobic than PNVP and PDMA. The aim of this study was to study the copolymerization of MA with N-vinyl pyrrolidone (NVP) or N, N-dimethylacrylamide (DMA), which is expected to provide tunability of the hydrophilic/hydrophobic balance of the polymers. Copolymers were synthesized with different initial monomer ratios of MA/NVP and MA/DMA using conventional radical polymerization and reversible addition-fragmentation chain transfer (RAFT) polymerization.

Acknowledgements: I would like to thank CUPO McNair Summer Research Program for giving me the opportunity to engage in research this summer. I would like to thank my mentor Dr. Devon Shipp for allowing me to participate in his research group. I would like to thank Yongneng Wu, my graduate mentor, for guiding and supporting me through each experiment performed this summer.

Mentor: Dr. Devon Shipp, Yongneng Wu, Department of Chemistry and Biomolecular Science, Clarkson University

Poster #39, Chemistry ERC Atrium, 11:00 AM-12:30 PM
Understanding Community-Educational Partnerships in Sustainability Planning

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With non-urban communities making up the majority of the US’s agricultural area, there is an increased need for non-urban communities to become sustainable. Because non-urban areas hold such importance for our economy, developing systems for them to become sustainable will potentially help the US become more sustainable as a whole. However, communities may lack resources, funding, and expertise. A less costly solution is partnering with schools. Higher education can contribute to the development of sustainability initiatives and partnerships that benefit institutions and communities while achieving operational and academic sustainability mandates. The benefits of a community-educational partnership may seem straightforward, however there are other aspects that need to be evaluated. What if the university itself lacks access to sustainability and SHPS, and cannot afford to partner with a community? There is a vast amount of Post-secondary institutions. They differ in size, location, and most importantly resources. The variations between post-secondary institutions ultimately affect how much progress they can make towards sustainability. The goal of this research project is to determine the steps post-secondary institutions with less resources can take to bridge the gap between their efforts and the efforts of better funded institutions, as it pertains to sustainability and community partnership.

Mentors: Dr. Stephen Bird, Department of Humanities & Social Sciences, Clarkson University, Erik Backus, Department of Civil & Environmental Engineering, Clarkson University

Session 1, Education                  Snell 129, 9:18 AM
Poster #31, Sustainable Communities   ERC Atrium, 11:00 AM-12:30 PM
How do People Respond on Twitter to Celebrity Suicides?

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We examined how the average US person responds on Twitter to reports of celebrity suicides. Using python, we scraped Twitter to examine what people posted following the suicides of five celebrities. We first hypothesized that characteristics of the celebrity who died by suicide (i.e., gender, number of children) and characteristics of the Twitter user (i.e., celebrity versus non-celebrity, time of post) would impact the content of Tweets about the celebrities’ death. We predict celebrity suicide reports will elicit high numbers of Tweets of sharing stories (personal narrative, memories of celebrity), followed by Tweets spreading awareness (mental health, news of death), and a low number of Tweets that are critical (insensitive, angry). We also hypothesized that celebrity characteristics, Twitter user characteristics, and use/behavior characteristics will moderate the association between celebrity influence/public perception and Tweet content. We predicted that female celebrities who die by suicide will elicit more negative Tweet content (more insensitive posts, more negative emotion conveyed) compared to male celebrities who die by suicide. This study is important in understanding how people publicly discuss celebrity suicides and will provide information about how stigma associated with depression and suicide is conveyed following highly publicized celebrity suicides[1].

1) Guntuku et al. (2017) and Ueda et al. (2017)

Acknowledgements: We would like to thank CUPO, and specifically LSAMP and CSTEP, for funding our summer research.

Mentor: Dr. Jennifer Knack, Department of Psychology, Clarkson University
Signal-stimulated molecule release, being motivated by many biotechnological and biomedical applications, has been extensively studied over decades, resulting in a large variety of physical and chemical systems operating differently and responding to different signals. Among various molecule-releasing systems responding to different activating signals (optical, magnetic, chemical, mechanical, temperature change, etc.), electrochemical systems represent one of the most important and challenging research directions. The electrochemical cleavage of bonds based on the redox transformations is a very powerful and successful approach in clean model systems; it may be significantly complicated in the presence of other redox species appearing in complex biological media. Thus, more universal approaches to the electrochemically stimulated cleavage of chemical bonds should be investigated. Here we report a new linker with a hydrolyzable aryl ester bond at basic pH for electrode modification. Basic pH locally produced at the electrode surface upon electrochemical reduction of O$_2$ resulted in the hydrolytic cleavage of the aryl ester bond and release of the immobilized fluorescent dye used as a model compound.

Mentors: Dr. Artem Melman, Dr. Evgeny Katz, Department of Chemistry and Bimolecular Sciences, Clarkson University
Electrochemical release of His-tagged proteins by destruction of NTA-Cu(II)-protein complex

Vasantha Krishna Kadambar, Madhura Bellare, Paolo Bollella, Evgeny Katz, Artem Melman

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Stimuli responsive release of biomolecules from surfaces such as gold and carbon is gaining importance for past couple of decades due to its application in biomedical field. Electrochemically induced release of biomolecules from the surfaces is one of such techniques. The simplicity of the electrochemical techniques brings-in wide opportunity for loading and releasing biomolecules from the electrode surfaces. Here-in we report the loading and electrochemical release of His-tagged proteins from the electrode surfaces such as gold and graphite. Reversible chelation of His-tagged proteins on Ni-NTA surfaces is studied for decades. Competing ligands such as imidazole and EDTA are used for releasing the His-tagged proteins from the Ni-NTA surfaces. However, switching the metal to Cu(II) instead of Ni(II) brings an opportunity for releasing the His-tagged proteins by the reduction of Cu(II) to Cu(I) or metallic copper. The affinity of Cu(I) towards complexation with NTA and His-tag is substantially lower than Cu(II) which facilitates the release of the protein. Also, Cu(II) can electrochemically be reduced. We use Cu-NTA crafted graphite and gold electrode for the coordinative loading of His-tagged proteins and electrochemical reduction of metal ion for the release of the proteins from the surface. In this study we used a redox mediator coupled model peptide (ferrocene-hexahistidine) and a model recombinant protein called “Protein A” as examples for loading and electrochemical release.

Mentors: Artem Melman, Evgeny Katz, Department of Chemistry and Bimolecular Sciences

Poster #70, Chemistry ERC Atrium, 11:00 AM-12:30 PM
The Development of a Lab to Find the Mass of Jupiter

Emily Kehoe, Joshua Thomas
Department of Physics Clarkson University

We will be presenting a new project being developed for the astrophysics course at Clarkson University. The astrophysics course is an applied upper-level physics course with some theory. We are basing this lab off of a lab that uses simulated data to measure the mass of Jupiter. We intend to provide students with real images of Jupiter acquired here at Clarkson’s Reynolds Observatory. Using real data will give students a sense of real-life relevance, with the goal of improving student's understanding of the subject. The students will have to make measurements on the positions of the moons in the images to construct their data-set that will be the input to generate a Lomb-Scargle periodogram. From the discovered periods, students can use Kepler’s Third Law to calculate the mass of Jupiter. The main goals of the project were to acquire the data-set and develop the procedure given to the students. The intended learning outcomes for the students are to develop transferable skills that can be applied anywhere, not just in astrophysics.

Acknowledgements: Clarkson University Honors Program

Mentor: Dr. Joshua Thomas, Department of Physics, Clarkson University
Discovery of Methods to Optimize the Optical Flow Comparison of Two Satellite Images

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This presentation offers research findings over a ten-week period towards finding ways to optimize the mathematical comparison procedure of two MATLAB datasets; images in the case of this study. The approach used within trying to find these optimizations include down-sampling of the dataset as well as attempts to parallelize the MATLAB computer code to run on multiple cores including CUDA using an NVIDIA GPU and processor cores using an eight thread Intel CPU. Down-sampling has proven to be the easiest to implement using built in functions within an addon provided by MATLAB. Parallelization also offers an addon within MATLAB to make it easier to implement though it has yet to prove more powerful than down-sampling and more research is required to come to definitive conclusion regarding that form of optimization compared to down-sampling. Such research has shown and resulted in a successful minimization of the time required to compare two sets of data.

Acknowledgements: I have been sponsored by the High Performance Computing arm of the National Science Foundation REU undergraduate research site hosted at Clarkson University; NSF Award #1852102.

Mentor: Dr. Erik Boltt, Department of Electrical and Computer Engineering, Clarkson University

Poster #21, Physics & Physical Simulations  ERC Atrium, 11:00 AM-12:30 PM
An Automated System to Determine the Focus of a Microscope for Use in Material Deformation Analysis

Peter-John King\textsuperscript{1}, Christian Gummerson\textsuperscript{2}, Ajit Achuthan\textsuperscript{3}, Sean Banerjee\textsuperscript{1}, Natasha Kholgade Banerjee\textsuperscript{1}

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Microscopy is an important tool in examining the microscopic properties of a material undergoing deformation. Current research in this field is hindered due to several technical challenges. One of these include the long time it takes to complete one test sample. This problem stems from the constant need to refocus the microscope during the experiment. Several computer-assisted microscopes have been developed to autofocus a material sample. However, these microscopes are often too expensive for use in many laboratories. This research presents an alternative hardware system which can be used to focus a readily available microscope. Several autofocus algorithms have already been developed for use in cameras and microscopes, but they are often limited by speed, accuracy and/or reliability. Furthermore, these algorithms may not be suitable for a hardware system external to the microscope. We are presenting a novel algorithm that performs autofocus using hill-climbing over focus features extracted using techniques such as variance of grayscale intensities, Laplacian focus identification, and use of DCT coefficients.

Acknowledgement: I would like to thank the Honors Program, and TARS Research Laboratory for funding this research. I would also like to thank Dr. Ajit Achuthan and Janith Kankanamge for providing the equipment and assistance necessary for data collection

Mentors: Dr. Sean Banerjee, Dr. Natasha Banerjee, Department of Computer Science, Clarkson University, Dr. Ajit Achuthan, Department of Mechanical and Aeronautical Engineering, Clarkson University

Session 2, Image Analysis
Poster #58, Engineering Design

Snell 129, 10:09 AM
ERC Atrium, 11:00 AM-12:30 PM
Turbidity Control System for Clarkson’s Underwater LiDAR Lab

Keli Kingston¹, Derek Pelkey¹, Luke K. Rumbaugh², Kevin V. Mack²

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Current projects at Clarkson University include underwater LiDAR and rangefinding in turbid water. During experimentation, it is necessary to test our rangefinding systems at different turbidity levels. This requires the addition of obscurant material into the Underwater LiDAR Lab’s large water tank. Previously, the liquid obscurant material was added by hand until the desired turbidity was reached. The work done here aims to create an automated dispensing system which can bring the water tank to the desired turbidity level. The control system uses a microcontroller to receive commands from the tank lab computer and dispense the correct amount of material. The system delays for a short time to allow the material to disperse evenly throughout the tank, then takes feedback from the turbidity sensor to see if more material must be added. This process is repeated until the correct turbidity level is reached.

Mentors: Dr. Luke Rumbaugh, Department of Electrical and Computer Engineering, Clarkson University
Correlating her6 expression to Notch signaling in the embryonic zebrafish intestine

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Intestinal development in juvenile zebrafish is dependent upon multiple signaling pathways, such as the IGF, EGF and Notch signaling pathways, each of which control numerous aspects of epithelial proliferation. The Notch signaling pathway is known to be vital in the cellular decision between secretory cell and enterocyte in the intestine. We currently understand that the her6 gene is expressed following Notch signaling. We seek to correlate her6 expression with Notch signaling activity. The her6 gene is homologous to the hes-1 gene in humans and chickens, which encodes for transcription repressing proteins. Here, we will begin to identify whether the her6 expression follows the same pattern of Notch signaling during various developmental time periods.

Acknowledgements: Clarkson CUPO, NSF LSAMP

Mentor: Dr. Kenneth Wallace
Non-enzymatic Point of Care (POC) Colorimetric Paper-based Sensor for Uric Acid Detection

Brenna Kokosenski, Fatima Mustafa, Silvana Andreescu

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In this study, a simple, easy to fabricate, and user-friendly paper-based sensor will be developed for the detection of uric acid. Uric acid is a purine-based metabolite that comes at the end of the degradation pathway of adenosine triphosphate (ATP). It also can be found in human blood as a result of a high purine content nutrition system. The normal level of uric acid in blood is 31-70 ppm in male and 25-56 ppm in female [1], while the level is higher in urine which reaches 336 ppm [2]. Elevated concentrations of uric acid in blood, as a result of a decrease in exertion via urine, results in accumulation of urates in joints leading to gout [3]. Therefore, monitoring uric acid levels in blood might provide an early alert before the occurrence of disease. Our proposed method of uric acid detection is non-enzymatic and is based on the redox activity of CeO₂ nanoparticles which can oxidize 3,3’,5,5’-tetramethylbenzidine (TMB) dye, producing a blue color. The blue color of the oxidized form of TMB dye disappears when it comes in contact with uric acid.

References:

Acknowledgements: This project is funded by NSF, Grant No. 156149

Mentor: Dr. Silvana Andreescu, Department of Chemistry and Biomolecular Science, Clarkson University
Encapsulation of Single Molecule Magnets in Metal Organic Frameworks for the Creation of High-Density Information Storage

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Ultrahigh-density data storage materials are the key components for next generation computing. Single Molecule Magnets (SMMs) are potential candidates for such an application due to their unique magnetic characteristics. Specifically, SMMs exhibit magnetic hysteresis and slow relaxation of magnetization at low temperatures. This allows them to serve as magnetic bits of information. It has been proposed that these properties will allow SMMs to be used in the creation of ultrahigh-density information storage devices to be used for read-and-write processes. However, before their practical applications can be explored, it will be necessary to isolate and organize the molecules in 2D or 3D networks while being in a protected environment to enable read-and-write processes. Metal organic frameworks (MOFs), porous materials composed of metal clusters and organic ligands, have been proposed as hosts for SMMs because their large pores and tunability enable them to isolate the molecules from each other, protecting the desired properties of the SMM. Herein, we detail attempts to encapsulate a single molecule magnet into a metal organic framework (SMM@MOF) and subsequent characterizations enable the future developments of spintronic devices combining functional properties of both SMMs and MOFs.

Mentors: Monu Joy, Dr. Mario Wriedt, Department of Chemistry & Biomolecular Science, Clarkson University
Producing Stamped Aluminum Blades for the Second Generation of Clarkson’s Ducted Wind Turbine

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Small, ducted wind turbines are quickly becoming a viable option for clean energy, as they increase the flow rate of air through the area swept by the turbine, thus increasing the efficiency of the turbine. The second generation of Clarkson’s ducted wind turbine is currently under development, and the main task at hand is to design and stamp a set of five aluminum blades for this new model. The mold that will be designed in SolidWorks must have properties so that the aluminum sheet pressed over the blade will spring back to the blade geometry desired. This geometry is given to us by mRotor, a code that computes the optimum blade geometry for specified atmospheric conditions. This requires precise calculations and modeling to get the stamped blades to have the exact aerodynamic properties intended. This will result in a set of blades that can be easily reproduced, and make future development much easier. This new turbine will be installed on Clarkson property, where a test site will be prepared with the hardware and software necessary to analyze the data collected.

Acknowledgements: We would like to thank Clarkson University, the Honors Program, and the members of the Applied Aerodynamics Laboratory for supporting our research this summer.

Mentors: Daniel Valyou, Benjamin Kanya, Dr. Kenneth Visser, Department of Mechanical and Aeronautical Engineering, Clarkson University
How Post-Secondary Schools Can Effectively Implement Sustainability Education into Their Curriculum

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Sustainability is arguably the most important word of the present and future. It has been explored in many projects, but here we investigate how it should—and must—be taught at the post-secondary level. Students of all academic disciplines need to be exposed to environmental sustainability to bring new ideas, and a sense of environmental awareness, into the workforce. This research project is a broad exploration of how to successfully implement sustainability education into a post-secondary curriculum, and the impact that this has on the school as a whole. Sustainable Holistic Planning Systems (SHPS) such as The Association for the Advancement of Sustainability in Higher Education, and Second Nature, are programs designed specifically for post-secondary schools. These SHPS allow schools to set goals that lead them towards sustainability, where they can receive awards, certifications, and build their reputation in the environmental community. By studying published literature on sustainable planning and universities with SHPS in place, I will offer suggestions on how to improve the sustainability curriculum. By presenting effective ways for post-secondary institutions to implement sustainability, more students will enter the workforce with a sense of environmental responsibility, and will hopefully bring the ideas of sustainability into all fields of work.

Acknowledgements: Clarkson University Honors Program

Mentors: Dr. Stephen Bird, Toby Harmon, Institute for Sustainable Environment, Clarkson University
Determining the Best Practices for Complete Streets that would be applicable to the Northern New York Context

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With today’s road infrastructure focused on vehicles, about 6,000 pedestrians die from car accidents a year and 129,000 experience non-fatal injuries (Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, 2017). This along with increasing physical inactivity and environmental concerns suggests that current street designs are no longer safe or effective. The solution to this problem lies within a comprehensive complete streets program. The United States Department of Transportation defines complete streets as streets that “designed and operated to enable safe use and support mobility for all users” (US Department of Transportation, 2015). Each community is different with specific needs, which makes designing an effective complete streets program for various communities challenging. Therefore, an analysis of what methods have been implemented in the past needs to be completed, to determine what traffic calming techniques worked in one area and which did not. The Analytical Hierarchy Process (AHP) will be used to rank the features of various traffic calming measures and ascertain which practices are most applicable to the Northern New York context.

Mentors: Erik Backus, Department of Civil Engineering, Clarkson University
Mercury Content in Terrestrial Arthropods Along a Moisture Gradient in an Upper St. Lawrence River Wetland Ecosystem

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The Upper St. Lawrence River (USLR) is shared between the United States and Canada. The International Joint Commission (IJC) is responsible for enacting plans to regulate water levels throughout the USLR and Lake Ontario. Stabilized water levels drastically disrupted the natural diversity of wetlands within the USLR. During the stabilization of water levels, Hg was accumulating in the landscape, becoming trapped in wetland soils. In 2017, Plan 2014 was enacted by the IJC, restoring natural water level fluctuation. With the wetland interface being hydraulically altered by Plan 2014, it has been hypothesized that the legacy Hg deposits will become increasingly bioavailable, thus mobilizing Hg into the food chain. In order to measure Hg mobilization, we focused on arthropods of the order Opiliones (commonly referred to as daddy longlegs), and other ground-dwelling organisms, which were collected throughout a riparian wetland. Total Hg was quantified within these organisms and used to test the hypothesis that organisms collected within the ecotone region will have the highest Hg concentrations. This work is important because the mobilization of potentially methylated Hg can be determined as a function of changing water levels, which brings about a potential for Hg biomagnification within wetland ecosystems.

Acknowledgements: Support for Thomas Leonard was provided by NSF Award No. 1659623 (Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity)).

Mentor: Dr. Michael R. Twiss, Department of Biology, Clarkson University

Session 2, Riverine Environments
Mercury on the Move: Threats to Public and Ecosystem Health

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The Upper St. Lawrence River (USLR) is shared between the United States and Canada. Stable water levels disrupted the natural diversity of wetlands within the USLR, and Hg accumulated, becoming trapped in wetland soils. Wetlands are being hydraulically altered by Plan 2014, which simulates natural water level fluctuations. It has been hypothesized that legacy Hg will become mobilized into food chains, as a consequence. In order to measure Hg mobilization, we collected insects and gastropods throughout a riparian wetland. Total Hg was quantified within these organisms and statistical tests were used to test the hypothesis that organisms collected within the ecotone region will have the highest Hg concentrations. Public health and wetland ecosystem biodiversity are threatened by the biomagnification of potentially methylated Hg, a potent neurotoxin that organisms throughout the food chain may consume (e.g., insects, fish, birds, humans). Our study produces findings that show it is imperative for policymakers in the United States and Canada to utilize this information and collaborate in governance in compliance with the United Nations’ Sustainable Development Goals (3, 6, and 15). This effort seeks to ensure that public health is unharmed, contamination is reduced, and wetland ecosystem biodiversity is maintained.

Acknowledgments: Support for Thomas Leonard and Maya Hoon was provided by NSF Award No. 1659623 (Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity).

Mentor: Dr. Michael Twiss, Clarkson University: Biology Department

Poster #48, Ecology ERC Atrium, 11:00 AM-12:30 PM
A Machine Learning Approach Towards Multi-Material Classification with Thermal Imaging

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Recent advancement in sensor data analytics demonstrated almost any natural surface can be treated as a touch-screen to interact with a computing device. For this purpose, the transferred heat from human hand to a surface is considered as a measure to detect interaction. As transferred heat is sensitive to the thermal properties of materials, detection of material type is utmost important. In this study, we recorded finger tapping data on natural surfaces for 10 different users interacting with 7 material types. A thermal camera is used for the same. We hypothesized that the amount of heat transferred from a finger tip to a surface and the transferred heat decay pattern would differ for different materials. This information is fed in a machine learning algorithm to automatically detect the surface material type.

Mentors: Dr. Souymabrata Dey, Dr. Natasha Kholgade Banerjee, Dr. Sean Banerjee, Department of Computer Science, Clarkson University
Electrochemical Sensors for the On-site Detection of Toxic Metal Ions in Environmental Water Systems

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Easy to use devices for the rapid detection of toxic metal ions in drinking water are essential for improving monitoring, identification and management of water resources. In 2014, over 100,000 residents of Flint, Michigan, were exposed to high levels of lead in their drinking water, leading to serious environmental and health issues. The problem faced by Flint is a perfect example of the need for an on-site detection system that can sense the presence of high concentrations of toxic metal ions in the environment. In this work, an easy to use method for metal ion detection in natural water samples was developed. Collection of ions at the electrode surface was achieved by optimizing a nanostructured layer consisting of metal nanoparticles and a conductive polymer, which improved detection sensitivity and selectivity. The method was demonstrated for the detection of As, Pb and Hg in natural waters, using anodic stripping voltammetry (ASV). Local water samples will be tested for heavy metal ion content and validated using lab-based methods, including atomic absorption spectroscopy (AAS) and ICP-MS.

Acknowledgements: Support for Leah Livernois was provided by NSF Award No. 1659623 (Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity).

Mentors: Farideh Hosseini Narouei, Dr. Silvana Andreescu, Department of Chemistry and Biomolecular Science, Clarkson University
Rheumatoid Arthritis (RA) is a chronic and debilitating auto-immune disorder affecting joints and internal organs that requires diagnosis and management under rheumatologist supervision. However, RA patients living in rural areas experience many barriers to proper care due to a severe shortage of rheumatologists. One potential strategy to improve care for rural RA patients is to identify the critical factors in diagnosing and predicting the disease. In this work, we use Bayesian logistic regression to model the relationship between RA and its common comorbidities such as high Body Mass Index, depression, and systolic blood pressure. Using data from the National Health and Nutrition Examination Survey for modeling, our goal is to accurately quantify uncertainty to make meaningful inferences. We use wrapper feature selection methods for their high accuracy in identifying the important comorbidities for predicting the disease in individuals. We use the area under the receiver operating characteristic curve and average precision to measure and maximize discrimination ability. Model classification is optimized using $F_\beta$ and balanced accuracy metrics to appropriately balance failures to identify and false diagnoses of RA and maximize the beneficial impact of our project. The results of this analysis will be discussed in our presentation.

Mentors: Dr. Sumona Mondal, Department of Mathematics, Clarkson University, Dr. Shantanu Sur, Department of Biology, Clarkson University
Time-of-Flight (ToF) Cameras for Underwater Situational Awareness

Kevin V. Mack\textsuperscript{1}, William D. Jemison\textsuperscript{1}, Luke K. Rumbaugh\textsuperscript{1}, Mahesh K. Banavar\textsuperscript{1}, David W. Illig\textsuperscript{2}

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Recently developed commercial Time-of-Flight (ToF) cameras have been used to accurately and reliably measure scene depth with high resolution in applications such as automotive LiDAR. Due to the fact that the commercial off-the-shelf (COTS) cameras use IR light, there is a desire to adapt this technology for applications in underwater environments, where IR light is heavily absorbed. In this work, we establish a methodology for using modified commercial ToF cameras in turbid water. We express the need for hardware and software modifications to the camera and demonstrate initial results in the efficacy of the camera in an underwater test scenario.

Acknowledgements: Thank you to Daniel Tam and Maria Medeiros, ONR Code 333, for support of this and related projects
This study focuses on upgrading a Dynatup 8250 Drop Weight Impact Tester in order to measure displacement, force and velocity of impact. The Impact tower will be modified to be compatible with a three-dimensional Digital Image Correlation system (DIC) which will provide full field view of the impact zone. All the measurements are to be performed with respect to time. The gathered data is further used to determine kinetic and impact energy. In addition, the use of this system will be able to observe impacts on composite materials and to determine the correlation between quasi-static indentation and Impacts.

Mentor: Dr. Marcias Martinez, Department of Mechanical and Aeronautical Engineering, Clarkson University
Utilizing Cell Transplantation to Visualize the Effect of Secretory Cells Loss in Mutant ascl1a during Post-Embryonic Period

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In zebrafish, stem cell niches are located at the base of the folds of the intestine. As with mammals, we suggest that secretory cells at the interfold base play roles in both positive and negative regulation of stem cell proliferation. We hypothesize that removing secretory cells will primarily affect stimulation of stem cell proliferation. We therefore utilized mutants that lack secretory cells in the intestinal epithelium to determine the effect on stem cell proliferation. One such mutant is ascl1a, which is responsible for initiation of all secretory cell lineages. ascl1a mutants do not survive beyond embryogenesis. To analyze mutants during the post-embryonic period, we transplanted mutant cells into wild type embryos. This generates patches of mutant cells within an otherwise normal intestine, visible throughout development with a GFP marker being continuously expressed in intestinal epithelial cells. The main objectives are to demonstrate that transplanted ascl1a mutant cells survive in wild type embryos in the post-embryonic period, confirm that there are no secretory cells within GFP positive regions and determine what changes in proliferation occur within the epithelium of the mutant cells. These experiments will allow us to further determine the regulatory roles of different components of the stem cell niche.

Acknowledgements: The authors would like to thank Dr. Kenneth Wallace and Morgan Prochaska for their support, as well as the Clarkson University Honors Program.

Mentor: Dr. Kenneth Wallace, Biology Department, Clarkson University
Proteomic Analysis of the Heart Tissue from Lake Trout (*Salvelinus namaycush*)

Zaen Manzoor\textsuperscript{1}, Emmalyn J. Dupree\textsuperscript{1}, Bernard Crimmins\textsuperscript{2}, Dr. Thomas M. Holsen\textsuperscript{2}, Costel C. Darie\textsuperscript{1}

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The Laurentian Great Lakes are a hub for civilization and wildlife, however, legacy persistent, bio accumulative and toxic (PBT) chemicals like polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs) reside in these lakes at alarming concentrations. The Great Lakes Fish Monitoring and Surveillance Program (GLFMSP) uses top-predator fish species, like *Salvelinus namaycush* (lake trout), as bioindicators of these chemicals in the ecosystem. Due to the structure of these chemicals, they are able to bioaccumulate and bio magnify in the food web. Bioaccumulation of these compounds can lead to changes in transcribed genes, translated mRNAs, and thus, proteins produced and post-translational modifications of these proteins. Although lake trout are used in these programs, there is currently little information available about the proteome of this species. In this study, we aim to identify proteins in the heart of lake trout from the Great Lakes using pre-existing protein databases. Proteomic methods, mass spectrometry, and data analysis using software such as Mascot Daemon and Scaffold 4.3 will hopefully contribute to creating a developed, comprehensive protein database for the lake trout that can be used in future proteomic studies on legacy chemicals in the Great Lakes ecosystem.

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Mentors: Dr. Costel Darie, Emmalyn Dupree, Department of Chemistry and Biomolecular Science, Clarkson University

Poster #53, Ecology

ERC Atrium, 11:00 AM-12:30 PM
Applications of Polymer Particles Made by Thiol-Ene Emulsion Polymerization

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Polymer particles when made via thiol-ene emulsion polymerization are easy and efficient to produce[1]. They also have potential applications in a variety of applications, from medical to environmental fields. The radical-mediated thiol-ene method of polymerization allows the particles to be highly functionalized with excess thiols or enes simply by adjusting the relative amounts of thiols or enes added into the polymerization. The excess thiols or ene can be present at the particle surface, and the surface functionality of the particles can be used many applications, such as in water filtration. Furthermore, if the particles was to be made porous through use of a porogen, then the total surface area available for reaction would increase, thus increasing reactivity. Porous particles have been produced by thiol-ene suspension polymerization[2], which tends to have a higher particle size distribution than the emulsion method used and developed by our group. The goal of this work is to increase the surface area of these particles through increased porosity, and to increase the thiol functionality such that the particles can be used in water remediation applications.

References:

Acknowledgements: The authors would like to thank David A. Walsh for supporting G. Martin while at Clarkson University.

Mentor: Dr. Devon Shipp, Kyle Cassidy, Department of Chemistry and Biomolecular Science, Clarkson University

Poster #40, Chemistry ERC Atrium, 11:00 AM-12:30 PM
Notch Receptors Involved in Choice between Intestinal Epithelial Enterocytes or Secretory Cells

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Previously, we have found that cells in the embryonic zebrafish intestinal epithelium undergo a period of binary choice between enterocytes or secretory cells. As with mammals, we have found that the choice is initiated by expression of an increased achaete-scute like transcription factor, *ascl1a* beginning at 44 hpf. High levels of *ascl1a* initiate the secretory cell fate and appear to induce expression of the Notch ligand *deltaD* beginning at 50 hpf within developing secretory cells. Notch receptor activation between 64 to 74 hpf in surrounding cells appears to signal the enterocyte fate. Here we begin to investigate which of the four zebrafish Notch receptors are involved in signaling to distinguish between secretory or enterocyte development.

Acknowledgements: The author would like to thank CUPO and LSAMP for supporting the project.

Mentor: Dr. Kenneth Wallace, Department of Biology, Clarkson University
The goal of this study is to develop sustainable eradication practices for invasive European water chestnuts (\textit{Trapa natans}) in the Hudson River Basin. This weed out-competes native vascular plants and reduces diversity of aquatic life in habitats it infests. Control methods include chemical treatment (2,4-dichlorophenoxy acetic acid) or manual or machine harvest and disposal. However, water chestnuts can reduce dissolved inorganic nitrogen and the risk of eutrophication; its biomass represents a previously-untapped second generation biofuel feedstock via anaerobic digestion. Here, we aim to improve estimates of the areal extent, density, biomass, and nutrient contents of water chestnuts in the Hudson River Basin as a function of lifecycle using aerial and underwater drone photography, ground proofing, manual and laboratory measurements, and GIS tools. This information will improve understanding of nutrient mass flows as affected by water chestnuts, and thus knowledge regarding potential environmental consequences of poorly-designed eradication programs. We also seek to identify viability of water chestnut seeds as a function of residence time during anaerobic co-digestion with sewage sludge, food waste, and dairy manure. Recommendations to assure seed kill during anaerobic digestion can facilitate beneficial reuse of digestate without further spreading invasive species.

Acknowledgements: I would like to thank the Honors Program for supporting me in my research this summer.

Mentor: Dr. Shane Rogers, Department of Civil and Environmental Engineering, Clarkson University
High School Education and Outreach: Application of Unmanned Aerial Vehicles (UAVs) and Underwater Drones for Environmental Applications

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Recent developments leading to low cost drones with high resolution imaging capabilities have spurred their increased use towards emergency response and monitoring applications. The use of drones for myriad applications will certainly increase in the future. Thus, knowledge of applications of drones and skills development regarding their safe operation are needed for future professionals to be technologically literate. In this project, we engaged middle and high school students in activities and training to develop drone operation skills, improve safe operation practices, and teach students about applications of unmanned aerial vehicles (UAVs) and underwater drones, with a focus on environmental applications. The program was conducted at Clarkson’s Center for Environmental Innovation and Education, Beacon Institute for Rivers and Estuaries, located on Denning’s Point in the Hudson River. Students learned about the use of drones for recreation, emergency response, and structural, agricultural, and environmental monitoring. Our ongoing research employing UAVs and underwater drones for monitoring invasive European water chestnuts (*Trapa natans*) was used as a model system. Students also engaged in activities to introduce them to the operation of UAVs, build piloting skills, and practice environmental monitoring. Lesson modules, demonstration materials, and activities developed are presented along with participant feedback.

Acknowledgements: I would like to thank the Honors Program for supporting me in my research this summer.

Mentor: Dr. Shane Rogers, Department of Civil and Environmental Engineering, Clarkson University

Poster #47, Environmental Treatment ERC Atrium, 11:00 AM-12:30 PM
The Application of Foam Fractionation in Plasma Water Treatment of Per- and Polyfluoroalkyl Substances (PFAS)

Margaret McDonald\(^1\), Pieter Heyn\(^2\), Xudong Su\(^1\), Thomas Holsen\(^2\), Selma Mededovic Thagard\(^1\)

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This project focuses on the filtration and degradation of PFAS from contaminated waters. The PFAS is filtered out of the water using foam fractionation which is a process that bubbles air into the water to capture these amphiphilic molecules. The foam fractionate, containing a high concentration of PFAS, is then removed from the foam fractionator and treated with an enhanced contact electrical discharge plasma reactor in order to break down the molecules of the PFAS. Plasma has already been shown to treat low concentrations of PFAS on its own. Paired with the foam fractionation process, the plasma can then treat small volumes of high PFAS concentration foam fractionation, lowering the overall treatment cost. The samples of PFAS levels taken throughout the project will be compared to previous experiments that did not involve foam fractionation with the goal of increasing the efficiency of the degradation process.

Mentors: Pieter Heyn, Dr. Thomas Holsen, Department of Civil and Environmental Engineering, Clarkson University, Xudong Su, Dr. Selma Mededovic Thagard, Department of Chemical and Biomolecular Engineering, Clarkson University

Poster #43, Environmental Treatment ERC Atrium, 11:00 AM-12:30 PM
Development of a Myoelectric Thumb Prosthesis

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Individuals whom have had full thumb amputations often have difficulty finding affordable and functional prostheses, in part due to the difficulty of reproducing the natural range of motion of the thumb. To address this issue, a 3D printed model actuated by a low-cost servo motor is being developed for a pediatric amputee with a full thumb amputation. Using electromyography (EMG) sensors and an Arduino board, the prosthesis is controlled by muscle contractions in the affected-side forearm of the amputee user. Future research efforts will explore methods of under-actuation that would allow kinematically-coupled flexion and opposition for improved grasp functionality.

Acknowledgments: This work has been supported by Clarkson University Honors Program, Corning Inc., CUPO, TRIO, and the McNair Program.

Mentor: Dr. Kevin Fite, Department of Mechanical and Aeronautical Engineering, Clarkson University
3D Prismatic Meshes for Use in Computational Fluid Dynamics with Parallel Computing

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The finite element method is a numerical technique often used to solve partial differential equations (PDEs) arising in various fields of physics, such as electromagnetics and fluid dynamics. In two dimensions, this involves partitioning the domain into a mesh of polygonal ‘elements’, usually triangles, and approximating the solution to the PDE within each element. The aim of this work is to extend an existing two-dimensional finite element code used for multi-phase flows into three dimensions by taking an unstructured base triangular mesh and extruding it into a mesh of triangular prisms, which is structured in the direction perpendicular to the base. This code will be parallelized via domain decomposition with the use of a message passing interface (MPI). A partitioning algorithm will be developed that balances load and minimizes communication cost across processors while maintaining the structured discretization of the prismatic mesh. This algorithm will be supported by information obtained via a literature review. The finished product will help engineers and researchers solve equations in fluid dynamics both faster and more accurately.

Acknowledgements: This work is funded by the National Science Foundation Award #1852102.

Mentor: Dr. Brian Helenbrook, Department of Mechanical and Aeronautical Engineering, Clarkson University
Neural Network-Based Dereverberation and Benchmarking

Niccolò Meniconi\textsuperscript{1}, Mahesh K. Banavar\textsuperscript{2}, Blaine Ayotte\textsuperscript{2}, Chinmay Sahu\textsuperscript{2}

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Reverberation degrades the quality of a recorded acoustic signal and decreases the intelligibility of speech, both in music halls and regular indoor spaces. Traditional means of recovering a non-reverberated sound source require us to estimate the room transfer function (RTF), assuming that the reverberation model of the room is a linear and time-invariant, which is not generally the case. In environments where these assumptions do not hold, alternative methods of dereverberation must be used. These methods include introduction of non-linearities into specific components of the system and automatic modeling systems that admit non-linearities, such as neural networks. The following study compares different system identification techniques, such as the direct calculation of the Weiner solution, LMS, ARYW and RLS, with a supervised neural network approach, and their ability to estimate the room impulse function of a time variant non-linear system. The study reveals that Neural Network-based dereverberation is computationally expensive but is able to filter time-variant non-linear systems more effectively than traditional system identification techniques.

Acknowledgments: This work is supported in part by the NSF REU award #1852102.

Mentors: Dr. Mahesh K. Banavar, Blaine Ayotte, Chinmay Sahu, Department of Electrical and Computer Engineering, Clarkson University
Plasma Water Treatment of Highly Electrically Conductive Solutions: Investigation of Interfacial and Bulk Liquid Chemistry

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Plasma-based Water Treatment (PWT) has been shown to be effective for the degradation of aqueous surfactants in groundwater; however, reactive species formed during the treatment and the efficacy of contaminant degradation is dependent on the electrical conductivity of the solution. To understand how solution composition and electrical conductivity impact the degradation of rhodamine B, a model surface-active organic contaminant, and what species are responsible for the degradation, several inorganic salts were used to achieve conductivities between 0.3 mS/cm and 45 mS/cm and two headspace gases have been used. When argon was used as the processing gas, increasing the conductivity is accompanied by first a decrease and then increase in removal rate of rhodamine B with a minimum at 1.2 mS/cm when using chlorine-based salts. When helium was used, the removal rate was constant between 0.3 mS/cm and 1.2 mS/cm then increased for higher solution conductivities. This suggests that the plasma-liquid contact area plays a significant role in the degradation of rhodamine B at low conductivity and that reactive chlorine species formed during PWT play a major role in the degradation of rhodamine B at high conductivity. This shows promise for plasma treatment of conductive solutions such as reverse osmosis reject.

Mentors: Chase Nau-Hix and Dr. Selma Mededovic Thagard. Department of Chemical and Biomolecular Engineering, Clarkson University
Nitrogen Removal after Methanogenesis in Anaerobic Digestion

Patrick Neu, Stefan Grimberg, Jacob Hunt

Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity), Institute for a Sustainable Environment (ISE)

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Due to the amount of food waste that is produced on campus at Clarkson University, an anaerobic digestor has been designed and built on campus to reduce the amount of food waste that is dumped in landfills. The existing digestor’s methane production was found to be inhibited by the nitrogen present in the food waste. Removal and recapture of nitrogen has been the focus of this project. With a properly designed nitrogen removal and recapture system, the production of biogas increases. Since nitrogen exists in the form of ammonia during this process its toxicity towards the environment prevents us from releasing it after removal. To properly remove and contain the nitrogen produced during anaerobic digestion, sulfuric acid columns and a cation-exchange membrane were designed and constructed to remove the nitrogen through the principle of mass transfer. The installation of these columns and the rest of the designed downstream process of the digestor has been the focus of this research. After installation data can be taken on the amount of biogas produced and nitrogen removed and correlate the results to both the biogas levels before the downstream process was installed and to the data taken from a lab scale model.

Acknowledgements: Support for Patrick Neu was provided by NSF Award No. 1659623 (Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity)).

Mentors: Dr. Stefan Grimberg, Dr. Shane Rogers, Department of Civil and Environmental University, Clarkson University, Dr. Michael Twiss, Department of Biology, Clarkson University, Jacob Hunt, Institute for a Sustainable Environment, Clarkson University
Challenges and Best Practices Non-Urban Communities Encounter Implementing Sustainable Holistic Planning Systems

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The goal of this research is to find the strengths and weaknesses of non-urban communities when implementing sustainable holistic planning systems (SHPS). SHPS is a framework that enables a network of people in a region to succeed in economic, social, environmental, political, and other developments. While there are many programs for sustainability, currently SHPS are far less common for non-urban communities in comparison to urban communities. Non-urban communities encounter challenges in implementing SHPS, thus require assistance in developing best practices that are unique from urban contexts. The objective of SHPS is for communities to grow and become more resilient and self-sufficient over the long-term. This poster will present the results of the analysis of a selected variety of limited case studies and a scholarly literature review to identify the challenges, solutions, and unresolved issues that non-urban communities encounter when implementing a limited number of SHPS programs (e.g. LEED for Communities (LFC), Climate Smart Communities (CSC), etc.).

Mentors: Dr. Stephen Bird, Department of Humanities and Social Sciences, Clarkson University, Erik Backus Department of Civil and Environmental Engineering, Clarkson University

Poster #30, Sustainable Communities ERC Atrium, 11:00 AM-12:30 PM
Evaluation of Utilizing High Granularity Data in Building Energy Simulation Development and Calibration

Leila Nikdel\textsuperscript{1}, Susan E. Powers\textsuperscript{1}, Alan Schay\textsuperscript{2}, Daqing Hou\textsuperscript{2}

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Building energy Simulation tools such as EnergyPlus have been commonly used to investigate different energy savings strategies. Different calibration methods have been proposed to improve the accuracy of results and predictions. In this study, high granularity measured data for hot water, electricity and inside temperature over 5 months in 2014 were incorporated in the simulation of one student housing building in Clarkson University campus. Loads and schedules for lighting and equipment were calibrated based on the measured electricity consumption. Moreover, two different calibration processes (simple and sophisticated) were conducted for natural gas use. First, the infiltration rate manually was calibrated so that the CV-RMSE of measured and simulated monthly natural gas use was minimized to 5.2\%. Second, using Apidae’s optimization techniques, 19 parameters were selected and adjusted by Particle Swarm Optimization (PSO) algorithm to bring the CV-RMSE below 7.6\% in a test suite of 20 calibrated models. Although calibrated models were verified for electricity use predictions in 2017 and 2018, they were not acceptable for natural gas use predictions due to the occupant behavior manipulation (observed through measured inside temperatures.) Hence, it is highly suggested that window opening behavior of occupants be incorporated in infiltration rate calculations in EnergyPlus.

Mentors: Dr. Susan Powers, Institute for a Sustainable Environment, Clarkson University, Dr. Daqing Hou, Department of Electrical and Computer Engineering, Clarkson University
Comparing Probabilistic Genotyping (PG) Software For Accuracy and Bias

Mariama Njie\textsuperscript{1}, Marzieh Babaianjelodar\textsuperscript{2}, Stephen Lorenz\textsuperscript{2}, Izzi Grasso\textsuperscript{2}, Abigail V. Matthews\textsuperscript{2}, Graham Northup\textsuperscript{2}, Jeanna Matthews\textsuperscript{2}

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A variety of PG software applications are used around the world to compute the likelihood that a suspect’s DNA is present in an evidence sample. Courts in the US are frequently allowing software vendors to claim trade secret protection to avoid third party review of their systems internals, jeopardizing defendant's rights to understand and confront the evidence against them. We are analyzing and comparing different PG systems such as EuroForMix, LRMix and FST, to see the degree to which their results differ. The vital questions we want to answer is whether PG software are accurate and unbiased.

Mentor: Dr, Jeanna Matthews, Department of Computer Science, Clarkson University
The purpose of this study was to determine the relationship between current feelings of depression and gait. Subjects (N=133, Male=50, Female=83, Age=25.80±7.96yrs, Height=173.12±8.71cm, Weight=74.28±15.27kg) completed a series of surveys reporting prior 24-hour activity and current mood states using the Profile of Mood Survey (POMS). Subjects then completed a series of cognitive tasks, the mCTSIB to measure posture, and a 2-minute walk test. Gait and postural control data was collected using the APDM mobility monitors. The interaction between current depression scores and gait parameters were examined.

Mentor: Dr. Ali Boolani, Clarkson University Department of Physical Therapy and Department of Physician Assistant Studies
All Sky Camera: Next Phase in Automating the Reynolds Observatory

Taylor Ormasen, Joshua Thomas

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In astronomy and meteorology, an all sky camera can be used to capture the complete sky within its field of view. To fully automate the Reynolds Observatory, there must be an off-site, effective means for evaluating the weather conditions of the observation point. We previously utilized the website ClearDarkSky.com to predict the sky’s clarity. In combination with the all sky camera, these tools can determine the potential adequacy of data collection. Though just one step toward total automation, my project will serve all future research just as the existing automated components of the Reynolds Observatory have endured. Installing a professional, all-inclusive system would be costly. For our approach, we designed our own structure by employing a Caddx Mini FPV Quadcopter Racing Drone camera, a dome encasement, a podium, a transmitter, and controls. The goal is for the structure to function as a webcam, broadcasting from the Reynolds Observatory and remotely accessible from any computer. This project is conducive to the Pre-Frosh research timeline and unlike most astronomical activity, it is not weather dependent. It has been the perfect opportunity to become familiar with the equipment, software, and collaborate both in the lab and at the observatory.

Acknowledgments: I would like to thank the Clarkson University Honors Program and The Clarkson School Early College Program for granting me this experience.

Mentors: Dr. Joshua Thomas, Carlie Fowler, Emily Kehoe, Department of Physics, Clarkson University
Reflectivity on Airport Traffic Ways

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The purpose of my research project is to determine how long it takes paint on airport traffic ways to wear down and lose its reflectivity over time as well as which factors may be impacting this process. Creating this paint wear forecasting algorithm will help airports determine how long until they need to be serviced. Python scripts will be used on the first stage of this research project to clean and organize the data which is exported from a Mongo Database. Shapely, a Python package, will be helping me verify information extracted from this database regarding the Cartesian points plotted and the reflectivity at those specific points. After the dataset has been extracted and organized, it will be analyzed using different methods to help define different levels of reflectivity that will further establish a more efficient and objective method of determining how long a painting service may last.

Mentor: Tyler Conlon
Mercury Mobilization Hotspots in St. Lawrence River Wetlands

Autumn T. Osgood\textsuperscript{1}, Evie S. Brahmstedt\textsuperscript{1}, Maya Hoon\textsuperscript{2}, Thomas Leonard\textsuperscript{3}, Michael R. Twiss\textsuperscript{1}, & Thomas Holsen\textsuperscript{1}

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The St. Lawrence River has been controlled through damming since 1958. Evident consequences of the dam were loss of shoreline wetlands and increased abundance of \textit{Typha} species (cattails) due to lack of natural water level fluctuations. Plan 2014 was enacted in 2017 in order to mimic natural water levels in the river and restore riparian wetland biodiversity. Plan 2014 may have unintended consequences of mercury mobilization. Mercury that was once trapped in areas may now have the ability to mobilize due to water fluctuations. The mobilization of mercury will allow it to be available to organisms and therefore mercury may accumulate in the food-chain. In order to determine the magnitude of this mercury mobilization, invertebrates were collected from several different areas based on their proximity to and within the wetland and will be tested for mercury concentration. Invertebrates were collected in locations from completely terrestrial to the terrestrial/wetland interface to observe if differences in mercury concentration between varying wet and dry conditions. Benthic invertebrates were also collected to determine if mercury levels differed based on proximity to the wetland. The concentration of mercury in the invertebrates will not only provide information on mercury mobilization and concentration of mercury in organisms throughout a wetland, but will also help paint the picture of wetland health following implementation of a large project aimed at restoring wetland health and biodiversity.

Mentor: Dr. Michael R. Twiss, Clarkson University: Biology Department

Poster #75, Env. Science & Sustainability ERC Atrium, 11:00 AM-12:30 PM
Electrochemical Ammonia Recovery for Improving Efficiency of Food Waste Anaerobic Digestion

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Anaerobic digestion is a process which can be used to treat food waste. Food waste anaerobic digestion (FWAD) is a valuable way to reduce the waste going to landfills and produce methane which can displace fossil fuels. The microbes used in FWAD produce ammonia in the process. Excess ammonia can inhibit the microbes which makes the process of FWAD ineffective. Ammonium recovery from the digestate reduces the amount of ammonia inhibition that occurs, improving the efficiency of the process. The recovered ammonia can also be used as fertilizer. In considering an effective system of electrochemical ammonia recovery, electrodialysis (ED) cells were used as models. Electrochemical ammonium recovery was mediated by electrolysis and redox couples. Comparisons of these systems conductivity separations and working voltages under varying current density and electrode type were made. The current densities tested were 25 and 50 A/m². For the redox couples 75 A/m² was also tested. The best ammonia recovery occurred at 50 A/m² for the electrolysis and 75 A/m² for the redox couples. The redox couples also required a substantially lower working voltage. Overall the most efficient ammonia recovery occurred at higher current densities using redox couples.

Acknowledgments: We would like to thank the Honors Program for giving us this opportunity to conduct this research. We would also like to thank Dr. Taeyoung Kim, Weikun Chen and Gowri Mohandass for mentoring us throughout this project.

Mentor: Dr. Taeyoung Kim, Weikun Chen, Gowri Mohandass, Department of Chemical and Biomolecular Engineering, Clarkson University
Carbon-Based Polymer Nanocomposites for Energy Applications

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Carbon-based polymer nanocomposites have considerable potential in energy production and storage applications because of their good electrical and mechanical properties, corrosion resistance, ease of processing, and low cost. Some of the allotropes of carbon (e.g., graphite, graphene and carbon nanotubes) are associated with characteristics like high conductivity, large surface area, low mass density, and good chemical compatibility with common polymers, which make them suitable for such applications. Thus, carbon-based polymer nanocomposites are of significant interest as materials for advanced electrochemical supercapacitors, lithium-ion battery electrodes, solar cells, and fuel cells. This poster presents results from our research on the design and development of carbon-based polymer nanocomposites as (a) electron- and ion-conducting polymer electrolyte membranes for lithium-ion batteries; (b) porous bipolar plates for effective water management in PEM fuel cells; and (c) electrodes for supercapacitors. Material characterization using a variety of thermal, spectroscopic, electrochemical, and mechanical characterization techniques are discussed.

References:

Mentor: Dr. Sitaraman Krishnan, Department of Chemical and Biomolecular Engineering, Clarkson University

Poster #68, Chemistry ERC Atrium, 11:00 AM-12:30 PM
Analyzing Community Engagement Processes in the Development of Sustainable Holistic Planning Systems in Non-Urban Community Contexts

Anna Poe¹, Erik C. Backus², Stephen Bird³

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Sustainability has become increasingly important in urban development, with a growing awareness of the relationship between the natural and built environment in communities. Part of the push toward sustainable planning is the development of Sustainable Holistic Planning Systems, which attempt to tackle problems such as climate and anthropogenic environmental change in ways that are “smart and connected” (Backus et al., in development). A limitation to this shift is that it largely neglects the non-urban. The lack of financial, technical, and staff resources (EPA, 2014), characteristic of many non-urban environments hinder large-scale planning efforts. For this reason, effective community engagement is vital to the success of SHPS projects, especially in non-urban contexts. This project aims to explore the effectiveness of various methods of engagement in sustainable planning processes in non-urban communities. We look specifically at the Complete Streets initiative, created by Smart Growth America to promote safer, more walkable communities. The research design has two components, the first being a review of scholarly literature regarding conventional community engagement methods. The second component is an exploratory case study of community engagement strategies in the Complete Streets effort in Gouverneur, NY, which we will later assess for effectiveness in this non-urban context.

Acknowledgements: Support for Anna Poe was provided by NSF Award No. 1659623

Mentors: Erik Backus and Dr. Stephen Bird, Clarkson University.

Session 2, Sustainability & Human Behavior  Snell B10L, 10:21 AM
Programming A Virtual Reality Foraging Environment

Megan Porga¹, Noah Chicoine², Belisena Hall¹, Sarah Moran¹, Katelynn Mays¹, Schuyler Meyer³, Alex Lee³, Andreas Wilke¹

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Our previous research suggests that the hot hand phenomenon, a tendency to perceive illusory streaks or clumps in sequences and grids, is a human universal tied to humans’ evolutionary history of foraging. For our next study, we plan to examine behavior and decision-making strategies of humans in simulated foraging scenarios through the use of Virtual Reality. Using C#, we are writing a program in Unity that will present participants with a field of hidden resources distributed with predetermined autocorrelations. Participants will search for carrots hidden below the ground in a field of stems, which participants will pull from the ground. Their goal is to collect as many resources as possible. A parameter file will detail the exact locations of resources in the virtual search environment, and as participants collect resources, a behavioral output file will be written documenting data such as movement, head rotation, time, and whether each resource pull is a hit or miss. Other features such as a timer, compass, resource count, and grid visibility will be incorporated into the program in a way that they can be toggled on and off depending on experimental conditions.

Mentor: Dr. Andreas Wilke, Department of Psychology, Clarkson University

Poster #3, Psychology & Human Behavior   ERC Atrium, 11:00 AM-12:30 PM
Uncertainty Analysis in Modeling Cardiac Electrophysiology

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Modeling cardiac electrophysiology is crucial to understand healthy heart activity for the improvement of health care providers’ ability to assess the condition of a patient's heart and make early diagnoses. In the past, models have been used to diagnose cardiac diseases and aid in plans of treatment and surgery, but these applications are relatively limited due to the omitting of uncertainty analysis [1]. This project uses the Aliev-Panfilov model of the heart cell channels, involving several ordinary differential equations, to simulate and predict action potentials of heart cell channels. The uncertainty in model parameters will be visualized and quantified with its probability density function, which will be formed with the utilization of OpenMP. High-performance computing allows for an increase in the speed and efficiency of the uncertainty analysis. The continuation and scaling of this method of uncertainty analysis will allow for the modeling of the entire cardiovascular system and give a better understanding of the complete electrophysiology of a healthy or diseased human heart.

Reference:  

Acknowledgement: Funded by the National Science Foundation Award #1852102

Mentor: Dr. Yuncheng Du, Chemical and Biomolecular Engineering, Clarkson University

Reference:

Acknowledgement: Funded by the National Science Foundation Award #1852102

Mentor: Dr. Yuncheng Du, Chemical and Biomolecular Engineering, Clarkson University
The Microencapsulation of a UV Filter Substance in Metal-Organic Frameworks

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Metal-organic frameworks (MOFs) are crystalline porous materials composed of metal clusters or ions connected by polytopic organic linkers. These materials have high surface areas and large pore volumes which can capture a variety of guest molecules, allowing them to have an assortment of functional applications. This work entails the synthesis of previously reported MOFs and the loading of a guest UV filter substance for cosmetic purposes through in-situ and post synthetic modification (PSM) methods. This was confirmed using powder x-ray diffraction (PXRD), thermogravimetric analysis (TGA), and UV-Vis diffuse reflectance spectroscopy (DRS). By using MOFs for microencapsulation of UV filters this can increase stability, extend effective application of the functional guest molecule, and minimize contact between the skin and harmful byproducts of UV absorption such as superoxides.

Acknowledgements: We would like to thank Estée Lauder and the National Science Foundation (NSF) for their interest and funding for this project.

Mentors: John Hadynski, Dr. Mario Wriedt, Department of Chemistry & Biomolecular Science, Clarkson University
Overcoming Ammonia Inhibition in Anaerobic Digesters by Adaptive Laboratory Evolution at the Community Level

Estefanny Quispe

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Anaerobic digestion (AD) is an established technology to divert organic waste from landfills and farms while obtaining green value-added products. Nitrogen-rich feedstock increases ammonia in AD to toxic levels for methanogens, reducing biogas production. Understanding microbial community structure and function in AD can improve our ability to engineer ammonia-tolerant consortia to overcome this limiting condition as an alternative or complement to more demanding membrane technologies. In this research, we investigate microbial community structure and function from different AD systems by whole genome sequencing (WGS). MG RAST pipeline analysis was used to determine diversity and abundance at family and genera level related to the digester performance and feedstock. Key players in methanogenesis with and without ammonia inhibition were identified for future work. Feedstock characteristics and microbial communities were different among reactors. An acetoclastic methanogen (*Methanosarcina*) was dominant (19.6%) at 4g/L TAN; two hydrogenotrophic methanogens (*Metanoculleus* and *Alkaliphilus*) were abundant (12.4 and 11.5%, respectively) at 8g/L TAN. Under high ammonia, methane production rate reduced over 20%. These findings imply that progressive ammonia adaptation to obtain robust microbes that can handle better this environmental stress in anaerobic systems is possible, contributing to the efforts of improving the efficiency of this sustainable practice.

Mentor: Dr. Shane Rogers, Dr. Stefan Grimberg, Department of Civil and Environmental Engineering, Clarkson University
Usage Scenario Oriented Continuous User Authentication on Mobile Devices

Aratrika Ray, Daqing Hou, Mahesh K. Banavar, Stephanie Schuckers

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Our work is about individual authentication based on usage patterns of mobile devices, thereby aiming to identify non-legitimate or unauthorized imposters. Continuous authentication is defined as identifying and authorizing a legitimate user of a mobile device throughout the timespan of device-usage. We have therefore developed an Android application, which captures important mobile device usage scenarios like on-Touch events (single touches, scrolls, double taps, long presses), motion events (acceleration, gyroscope, rotation), same motion events during reading of fingerprint, key-press data and tracing patterns of different polygons as to capture guided behavior of users. These fall under behavioral biometrics. As per our state-of-the-art [1], we are replicating the authentication of a user based on their strokes/ scrolls. We have extracted 30 useful features from the raw stroke data and trained a binary SVM classifier to identify one user against all others. In one versus all binary classification with increase in strokes our accuracy of identifying an individual has increased. To test the effect of temporal proximity of data on accuracy, we have divided our collected stroke data into sessions. To test the effect of the number of consecutive strokes on accuracy, we average the classification score of k strokes. The individual authentication accuracy for 1, 3 strokes are 84% and 91%, and gradually improve. With 8, 9, and 10 strokes the accuracy of identifying an individual reaches 100%. At present, we are proceeding on calculating EERs of other sessions.

Acknowledgements: This work is supported by CVS Health through Center for Identification Technology Research (CITeR).

Mentors: Dr. Daqing Hou, Dr. Mahesh K. Banavar, Dr. Stephanie Schuckers, Department of Electrical and Computer Engineering, Clarkson University
Cervical Cancer Cell Response to Supramolecular Mimic of Extracellular Matrix

Morgan Reynolds\textsuperscript{1,2}, Damien Samways\textsuperscript{1}, Shantanu Sur\textsuperscript{1}

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Recent research suggests the extracellular matrix (ECM) strongly influences the behavior of cancer cells, however, the mechanisms underlying such effects are not fully understood. Here we study the interaction of ECM with human cervical cancer cells using molecularly designed self-assembled peptide amphiphile (PA) nanofibers as an artificial mimic of ECM. PAs were exposed to cultured cells in a soluble form or as a coated substrate, and we focused primarily on the dynamic cell response through live-cell imaging. When cationic PA was added to the culture media in a soluble form, it induced death in the majority of the cell population within tens of minutes, preceded by characteristic cellular events of lysosomal pH elevation, cytoskeletal disassembly, and nuclear shrinkage. We are currently investigating the signaling mechanisms initiated by the soluble form of PA that eventually lead to cell death. Using PA as a coating, we are studying the effects PA materials have on cell morphology and movement, and the cytoskeletal adaptation underlying such changes. The findings of this study could be useful in the development of more effective cancer treatments in the future.

Acknowledgements: Clarkson University Honors Program

Mentor: Dr. Shantanu Sur, Department of Biology, Clarkson University
Dynamic Mechanical Analysis of Polyanhydrides: A Stress Relaxation Study

Anne Rolsma\textsuperscript{1}, Mikenzie Barankovich\textsuperscript{2}, Mason Kozody\textsuperscript{3}, Kelly Tillman\textsuperscript{1}, Devon Shipp\textsuperscript{1}

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Polyanhydrides (PAHs) have a significant potential in the biomedical field. One exciting discovery we recently made was that crosslinked PAHs are actually covalently adaptable networks (CANs). These networks are of interest due to their ability to self-heal, reconfigure, and recycle polymeric materials. The dynamic covalent exchange process that we are studying occurs throughout the anhydride moieties. Our goal is to monitor this exchange through stress relaxation testing to determine the relaxation modulus as a function of temperature which can be used to calculate the activation energy of the anhydride exchange. This activation energy is a function of both chemical and physical properties, and is investigated by varying the crosslink density of the polyanhydride network. Through understanding the relationship between activation energy and composition, the reconfiguration properties of crosslinked PAHs can be optimized.

References:

Acknowledgements: The authors would like to thank the Department of Chemistry and Biomolecular Science at Clarkson University for supporting this research.

Mentor: Dr. Devon Shipp, Kelly Tillman, Department of Chemistry and Biomolecular Science, Clarkson University
Tuning Self-Assembly of Porphyrins at the Liquid-Solid Interface

Joshua Roys

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This poster will review the utilization of non-equilibrium deposition conditions to tune spontaneous growth at the solid-liquid interface. Manipulation of the specific growth environment affects the manner of intermolecular and molecule-substrate interactions observed at the sample-substrate interface allowing for the preferential, if not selective, formation of stable and metastable supramolecular structures. The careful control of environmental conditions such as spin coater rpm, solvent, and substrate will detail the specific non-equilibrium deposition procedure required for the effective growth of supramolecular porphyrin structures. The growth behavior of the studied systems will be examined with a home-built scanning tunneling microscope (STM), and the collected data will be supported by electronic structure calculations to ensure the appropriate assignment of structural models to the observed supramolecular features as well as properly characterize the intermolecular and molecule-substrate forces present. Future work will focus on the contrast between supramolecular porphyrin species on highly ordered pyrolytic graphite (HOPG) and gold on mica (Au(111)/mica) substrates, and the effects of various growth conditions on both systems. Upon completion of a homebuilt ultrahigh vacuum (UHV) STM, these systems will be studied with precise temperature, contaminant, and deposition control that will provide further insight into the control mechanism of the supramolecular products.

Mentor: Dr. Ryan Brown, Department of Chemistry and Biomolecular Science, Clarkson University
Optimized Modified Time Delay of Arrival for Biomedical and Geo-hazard Applications

Chinmay Sahu$^{1,2}$, Mahesh K. Banavar$^{1,2}$, Jie Sun$^{1,3}$

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Irregular heartbeats at the root of atrial fibrillation (AFib) have been observed as reentrant electric rhythms induced by spiral waves. Eliminating the center of the rotor or wave core using treatments such as ablation therapy has been shown to be effective in treating AFib, but its success relies crucially on accurately locating the core. Here, we present a modified time difference measurement based algorithm to estimate the spiral wave core in a heart with AFib. Our mTDOA algorithm, which is a modified version of the time delay of arrival (TDOA) algorithm, can solve the localization problem without knowing the time of origin of the reentrant rhythm, or the speed of propagation of electric signals along the surface of the heart. We also propose a variation of the mTDOA algorithm, which solves the problem assuming unknown differential signal propagation speed. We validate the effectiveness of both algorithms using Fitzhugh-Nagumo based heart simulation models. Our algorithms can also be extended to other applications such as forest fires and tsunamis to estimate the sources and speeds of fire growth and wave propagation, respectively.

Mentors: Dr. Mahesh K. Banavar, Department of Electrical and Computer Engineering, Clarkson University, Dr. Jie Sun, Department of Mathematics, Department of Physics, Clarkson University.
Polymer Mechanochemistry: From Mechanically Triggered Reactions to Mechanoresponsive Materials

Samantha Salim, Dr. Xiaocun Lu

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Polymer mechanochemistry is an emerging research area towards the development of next-generation mechanoresponsive materials and sensors. Polymers incorporated with mechanosensitive molecular species (mechanophores) could exhibit mechanochromism and structural transformation in response to external mechanical forces. Mechanochemistry provides an alternative way to trigger chemical reactions other than conventional thermal-, electro-, and photo-activation processes, serving as an emerging development tool for synthetic chemistry and stimuli-responsive materials. One of the research focuses on polymer mechanochemistry is to design and synthesize efficient mechanophores with a mechanistic understanding of bond-activation mechanisms. Constrained geometries simulate external force (CoGEF) is a powerful DFT-based algorithm to predict and validate molecular actions under constraint bond deformation. Various heterocyclic molecular species have been investigated using DFT-CoGEF calculations for a better understanding of the structural effects such as conjugation length, macrocyclic tension, and electron density, as well as the synergetic effects of multiple-mechanophores. The other research focus on polymer mechanochemistry is to develop efficient force transduction environments to transfer mechanical force from the macroscopic level to the molecular level. Polymer chains with various molecular weight, chain rigidity, and local viscosity are being investigated to optimize transduction efficiency of external mechanical forces.

Mentor: Dr. Xiaocun Lu, Department of Chemistry and Biomolecular Science, Clarkson University
Purinergic Modulation of KCa3.1 Channels in Cervical Cancer Cells

Lyuba Salih\textsuperscript{1}, Michael Sanborn\textsuperscript{2}

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Cervical cancer is a major cause of cancer-related deaths in middle to low-income countries and could potentially be detected and cured with improved biomarkers. Here, we confirm that plasma membrane KCa3.1 channel proteins are upregulated in CXT2 cervical cancer cells relative to healthy cells. These mediate changes in plasma membrane potential and intracellular Ca\textsuperscript{2+} signaling evoked by the important inflammatory signal, ATP. Further work will determine the physiological significance of the channels upregulation to the growth and migration of cervical cancer cells.

Acknowledgements: Ronald E. McNair Post-Baccalaureate Achievement Program

Mentor: Dr. Damien Samways, Department of Biology & Pre-Health, Clarkson University
Localized Surface Plasmonic Resonance (LSPR) optical biosensors have been a growing field in the past few years. LSPR optical biosensors utilize the oscillation of free electrons or plasmons on the nanostructure surface, allowing high sensitivity of light intensity changes on the surface of the sensor. Whenever refractive index on the surface is changed so is the resonant frequency, allowing localized surface plasmon nanoparticles to be used for sensing application. These biosensors are mainly used for detection of analytes, which can be used to detect diseases like cancer. The simulation, fabrication, and experimentation of this sensor is the first step to proving that LSPR based biosensing works with Gallium Nitride-based semiconductors. The future end goal is to create a more compact optical sensor. The goal is to integrate the light source and gold gratings to help eliminate error for higher accuracy and to lower overall product cost. This study reveals the steps taken for simulation and experimentation on a regular LSPR optical sensors to prove that this phenomenon will take place on a Gallium Nitride surface with a separate light source (light emitting diode). Once this proof of concept is achieved, the next step will be fabricating the compact sensor.

Mentor: Dr. Chee-Keong Tan, Department of Electrical and Computer Engineering, Clarkson University
The Mechanistic & Physiologic Effects of Plasma Membrane-Peptide Amphiphile Interactions

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Peptide amphiphiles (PAs) offer a diverse supramolecular biomaterials platform with the promise of a wide range of applications. Consisting of a short peptide with a lipid tail attached to one end, the PA molecules self-assemble into long, one-dimensional nanofibers in aqueous media that emulate the extracellular matrix (ECM). In this work, a weak beta-sheet forming cationic PA was utilized that was previously shown to enhance growth factor signaling. While a strong cellular response was observed, the mechanism of the PA nanofiber interaction with the plasma membrane is not fully understood. This led to the hypothesis that cell response to PA is associated with an alteration in cytosolic Ca\textsuperscript{2+}, a major cell signaling messenger molecule. Preliminary data demonstrates an increase in cytosolic Ca\textsuperscript{2+} concentration following exposure to the PA, likely suggesting the main source of Ca\textsuperscript{2+} elevation to be intracellular in nature. Interestingly, this Ca\textsuperscript{2+} elevation was inhibited in the presence of phospholipase C (PLC) inhibitor U-73122, suggesting a PLC-mediated signaling cascade upstream of the Ca\textsuperscript{2+} release from intracellular stores. Future work will be devoted to the elucidation of the molecular events at PA-cell membrane interfaces that lead to the observed activation of the PLC signaling cascade.

Mentor: Dr. Damien Samways, Dr. Shantanu Sur, Department of Biology & Pre-Health, Clarkson University
How Effective Are Pro-Environmental Messages? Evaluating the Link between Message Content and Environmental Concern and Commitment

Anja Savic\textsuperscript{1,2}, Lisa Legault\textsuperscript{1,3}

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Given the increasing impact of human behavior on environmental degradation, a question of growing importance asks: how to instill individuals’ personal motivation to sustain pro-environmental behavior? The potential of message framing in motivating pro-environmental behavior has shown mixed results in various fields. Additionally, little is known about how messages affect electricity and water conservation. In this work, we use a theoretical foundation that combines personal versus social framing and positive versus negative affect to create four message structures. Through questionnaires and focus groups, we aim to assess participants’ pro-environmental attitudes and responses to each message. Moreover, we test whether participants’ level of environmental concern interacts with type of message, hypothesizing that fear- and humor-based messages with a social/normative framing are more engaging for those with little environmental concern, whereas hope and guilt-based messages with personal framing will be more engaging for those with high environmental concern. Participants evaluated the emotional content of each of the 8 messages, and the degree to which the message motivated pro-environmental behavior. Results are expected to increase our understanding of how to effectively communicate the importance of conservation in a way that inspires environmental awareness and concern on an immediate emotional level.

Acknowledgments: Support for Anja Savic was provided by NSF Award No. 1659623 (Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity)).

Mentors: Dr. Lisa Legault, Dr. Susan Powers, Institute for Sustainable Environment, Clarkson University

Session 2, Sustainability & Human Behavior

Snell B10L, 9:45 AM
This research explores rainwater harvesting (RWH) systems to improve access to clean water in rural Kinyamaseke, Uganda. Kinyamaseke experiences two dry seasons per year, during which time residents suffer from drought and associated food and water shortages. RWH systems can store water from the rainy season for use during periods of drought if properly designed. During a recent trip, members of Clarkson’s Engineers for International Sustainability noted several school buildings with partial RWH systems. This research and development designs functional RWH systems for schools in the Kinyamaseke region. Use of collected water at the schools for aquaponic agriculture is considered owing concurrent groundwater development and water treatment plant projects in progress. We present preliminary designs that include digital weather stations and low-cost water quality and quantity sensing systems that facilitate development of education programs such as meteorology hydrology, soilless agriculture, aquaculture, sensing technology, and environmental sustainability while also providing valuable data to support future RWH designs in the region.

Acknowledgements: Clarkson Honors Program for allowing me to conduct this research, Legal and Charitable Aid Uganda for the opportunity to work with their community

Mentor: Dr. Shane Rogers, Department of Civil and Environmental Engineering, Clarkson University
Exploring User Motivation Reflection Similarity Using NLP Tools

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Natural Language Processing has moved beyond traditional Bag-of-Words techniques, to using engines that exploit vast corpora of training data. With modern tools, it is possible to compare statements on similar subjects that may use completely unrelated terms, due to ingrained knowledge of the English language. This presentation will explore using Google’s Universal Sentence Encoder and IBM Watson to compare and classify freeform personal reflections on conservation motivation. Such reflections are integral to the work of the Smart Housing Project, but currently require the analysis of a subject matter expert. With new tools, the classification process of such reflections can be automated, providing a more tailored user experience.

Mentor: Dr. Daqing Hou, Department of Electrical and Computer Engineering, Clarkson University
Benchmarking Concurrent Algorithms in Go and C++

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As the need for more computing power in scientific research and engineering continues to accelerate, the use of concurrent programs has become more widespread. Go is a relatively young computer language that attempts to make concurrent programming easier and faster. Benchmarking multiple concurrent algorithms on various levels of hardware, using different techniques for concurrency, in Go and C++ will show if Go is currently a viable language for fast, concurrent programs for research and engineering.

Acknowledgement: Funding for this research was provided by NSF Award #1852102

Mentor: Dr. Faraz Hussain, Department of Electrical and Computer Engineering, Clarkson University
Understanding Control Theory Through the Inverted Pendulum

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The problem of stabilizing an inverted-pendulum pivoting about a moving base is a challenging control problem that is commonly used to expose engineering researchers to nonlinear dynamics, nonholonomic behaviors and applications of linear and nonlinear control theory. The simple unstable mechanical system consists of two degrees of freedom (translation of the base and rotation of the pendulum) actuated by a single control effort (the force applied to the translating base). The nonlinear dynamic system includes a stable equilibrium point when the pendulum is in a downward position and an unstable system when the pendulum is at a perpendicular upward position. The inverted-pendulum problem presents two challenges: (1) swinging up the pendulum from its resting position to an inverted upright perpendicular position and (2) putting the unstable pendulum into a state of equilibrium once it has reached the inverted position. The objective of this work is the development of a benchtop pendulum prototype that can be used for instruction of applied linear and nonlinear control techniques. This presentation will overview the detailed design of the two-degree of freedom pendulum system and the Lagrangian Mechanics based derivation of the nonlinear equations that describe the coupled motion of the two degree-of freedom system.

Mentor: Dr. Kevin Fite, Department of Mechanical and Aeronautical Engineering, Clarkson University
The Role of Myosin XV on *Drosophila* Bristle Patterns

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The pattern of sensory bristles on the thorax of *Drosophila* is driven by inhibitory, contact-dependent signaling between bristle precursor cells and epithelial cells. Filopodia at the basal surface of thoracic cells mediate contact between distant cells. Myosin XV, an actin-based motor protein, is important for the formation, extension, and lifetime of filopodia¹. Interfering with myosin XV expression in vivo or in *Drosophila* cell culture results in fewer, slower and shorter-lived filopodia¹. We hypothesized that myosin XV knockdown would produce a change in the pattern of bristle cells which require filopodia function. We used the GAL4/UAS system to express myosin XV RNAi or control RNAi in either bristle cells only or in all thoracic cells. We used confocal microscopy to image pupal thoraces and quantified the pattern of bristle cells. Downregulation of myosin XV expression in bristle cells alone does not result in pattern defects. Expression of myosin XV RNAi in all thoracic cells leads to the disruption of bristle patterning. Our data suggests that myosin XV function is important for wildtype bristle patterning in *Drosophila*. Future research can investigate the role of myosin XV in contact-dependent inhibitory signaling.

References:
Liu et. al., 2008, *Development*, 135(1), 53-63

Mentor: Dr. Ginger Hunter, Department of Biology, Clarkson University
Efficacy of Anaerobic Co-digestion with Macroalgae

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The overall goal of this research is to improve understanding of environmental and economic trade-offs associated with use of seaweed aquaculture for nutrient bioextraction as an alternative to tertiary nutrient management bioprocesses to meet nutrient effluent goals at water resource recovery facilities (WRRFs). The disposition of seaweed is proposed as a third-generation biofuel feedstock via anaerobic co-digestion (co-AD) with existing waste streams. Potential options explored include co-AD with sewage sludge at WRRFs, with dairy manure in stand-alone (non-discharging) farm digesters, or with food waste in stand-alone food digesters. The objective of the research is to quantify biomethane potential of *Saccharina latissima* (sugar kelp), the most common seaweed aquaculture product, when co-digested with either wastewater treatment sewage sludge, dairy manure, or food waste. Our hypothesis is that biomethane potential will be greater in stand-alone manure and food waste digesters owing adaptation to plant-based substrates and greater buffering capacity than WRRF anaerobic digestion systems. Preliminary data from ongoing trials indicates that anaerobic co-digestion increases biogas evolution rates only slightly over the sole substrates. Models of the co-AD processes are being assimilated in GPS-X Pro to facilitate comparison between bioprocess kinetics and will be discussed.

Acknowledgements: Support for Angelika Sonne was provided by NSF Award No. 1659623 (Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity)).

Mentor: Dr. Shane Rogers, Department of Civil and Environmental Engineering, Clarkson University
Characterization of MMT Clays for Low-Cost High-Performance Ceramic Composite Separators for Lithium-Ion Batteries

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Energy storage is a field of engineering which demands innovation to continue to support a more technological world. Currently, Lithium-Ion batteries are the standard for practical, and portable energy storage, but they present limitations in terms of large energy storage capabilities, and high-temperature performance. SRS Holdings, from Alfred, New York, proposes that if the separator in the battery were a ceramic composite, as opposed to the current polymer standard, that the energy storage capabilities and temperature tolerance would increase. To do so, a clay and a polymer must be selected to best suit the parameters for theoretical high-energy storage. The clays must be void of conductive materials and water, and the polymers must be compatible with the clays to create the proposed separators. To characterize the clays for the composite, X-Ray Diffraction, Scanning Electron Microscopy, Thermal Gravimetric Analysis, and Energy Dispersive X-Ray Spectroscopy techniques will be employed.

Acknowledgments: Clarkson Honors Program, SRS Holdings

Mentor: Dr. Marilyn Freeman, Department of Mechanical Engineering, Clarkson University
Design and Development of a Home-Built Scanning Tunneling Microscope (STM)

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This poster will review the design and development of two home-built scanning tunneling microscopes (STM) for operation in a controlled, ambient-pressure environment and in ultrahigh vacuum (UHV). Both STMs utilize an inertial approach mechanism without external vibrational isolation. Our design rigidly connects tip-sample junction, and thus is insensitive to low-frequency vibrations which can disrupt scanning probe microscopies. A stainless steel capillary tube which acts as the tip holder rests on two pairs of tungsten carbide balls inside the cylindrical tip carrier. By using this cylindrical design, motion of the tip is constrained to only rotation about and linear translation along the cylindrical axis. A shuttle system was designed for the UHV STM to minimize delay in data acquisition arising from sample and tip exchanges. This system utilizes a combination of specialized tools and rotary/linear feedthroughs to transfer multiple samples and tips between chambers without breaking vacuum. Housing for the scanner assembly has been designed to allow for easy removal without the need to break existing electrical connections. The quatrefoil shape used for the sample holder allows for it to be locked in place, minimizing any undesired motion of the sample.

Mentor: Dr. Ryan Brown, Department of Chemistry and Biomolecular Science, Clarkson University
Generation of CRISPR Modified Bovine Intervertebral Disc Eeporter Cell Lines for Culture and Scaffold Assessment

Kevin Susice, Petra Kraus and Thomas Lufkin

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Severe and chronic low back pain is frequently caused by intervertebral disc (IVD) degeneration, which imposes a considerable socio-economic burden worldwide. Cell based regenerative medicine approaches are moving into clinical trials, yet thorough molecular characterization of IVD cells in general and possible fate changes in response to culturing methods and scaffolds, require more attention. In mouse, gene knock-in reporter cell lines long served as tools for cell-fate assessment, though the mouse is not an ideal model organism to study cells of the mature human IVD. The bovine coccygeal IVD is an accepted research model to study IVD mechano-biology and disc homeostasis; however, classic genetic engineering of bovine cells is difficult. Here, as a proof-of-principle, we use CRISPR technology to insert the fluorescent reporter egfp into the Pax1 locus of bovine nucleus pulposus cells with some demonstrated stem cell characteristics. The generation of bovine fluorescent reporter cell lines will be a great tool for the live-monitoring of molecular responses of IVD cells to different culture and scaffold conditions in vitro.

Acknowledgements: This work was supported by the Bayard and Virginia Clarkson Endowment to Prof. Thomas Lufkin.

Mentors: Dr. Thomas Lufkin, Dr. Petra Kraus, Department of Biology, Clarkson University
The lack of accessible open-source multi-physics benchmark suites has presented a challenge in uniformly evaluating simulation performance across related disciplines. Most of the available benchmarking tools require licensing and do not provide access to source codes, facilitating the need for a comprehensive suite of benchmarks to easily and reliably test simulation performance. Through the compilation of 16 benchmarks that measure performance indicative of multiple physics algorithm designs, research in the field will benefit from an open-source suite that is modifiable and free to use. The benchmark codes have been modified to successfully build on a modular computer architecture simulator (i.e, gem5), allowing for the suite to be run in a stable, uniform, virtual X86 environment.

Acknowledgments: This project was funded by NSF Award #1852102.

Mentor: Dr. Yu Liu, Department of Electrical and Computer Engineering, Clarkson University
Rheumatoid arthritis (RA) is a chronic autoimmune inflammatory disease that most commonly affects the joints. Incidence of RA is strongly influenced by socioeconomic and behavioral factors, as well as health-care finance. For this study, we focus on the quantification of these associated factors’ financial impact on adult RA patients. We build a model for RA incidence using diabetes, ethnicity, age, chronic stress, family-income poverty ratio as predictors. Using the National Health and Nutrition Examination Survey (NHANES) data, we develop a logistic regression model to examine associated factors’ impact on reported RA diagnosis. Prior to conducting statistical analyses, appropriate data cleaning and preprocessing were done. Cross-validation is used for assessing the predicative accuracy on the model. Furthermore, bootstrapping is implemented to identify any bias that might have originated from filtering the original data or from the model itself. This study is expected to improve the knowledge-base and accurately assess how these factors impact the patients’ financial health.

Mentors: Dr. Sumona Mondal, Department of Mathematics, Clarkson University, Dr. Shantanu Sur, Department of Biology, Clarkson University

Poster #25, Human Health Applications ERC Atrium, 11:00 AM-12:30 PM
Aqueous Film-Forming Foams Containing Per- and Polyfluoroalkyl Substances and their Precursors: Characterization and Treatment Options

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Per- and polyfluoroalkyl substances (PFAS) are chemical compounds that have been used in numerous industries, commercial applications, and extensively in aqueous film-forming foams (AFFF) for fire-fighting activities. They are environmentally persistent compounds and reported to cause adverse effects on human health. According to the USEPA, currently available industrial formulations of AFFF should be free from long-chain perfluoroalkyl acids (PFAAs) which are the most commonly found PFAS in the environment and thought to be the most problematic. This project is centered on characterizing three industrially formulated and currently available AFFF samples to determine whether PFAAs can be destroyed by oxidizing the PFAS precursors using various advanced oxidation processes (AOPs) and utilizing plasma treatment for the oxidized samples. Preliminary measurements of 12 PFAA and 10 precursors with an LC-MS/MS have shown high concentrations of short-chained PFAA, traces of long-chain PFAA, and a significant amount of PFAS precursors. The 6:2 fluorotelomer sulfonate (6:2 FTS) was present at high concentrations in the three samples. Preliminary treatment experiments were performed by adjusting the dosage of the oxidation treatments in diluted AFFF samples. Once the optimization of the oxidation treatments is completed, oxidized PFAA will be removed by the plasma treatment for complete treatment of AFFF.

Acknowledgements: Support for Sopuruchi Uwakwe was provided by NSF Award No. 1659623 (Advancing Sustainable Systems and Environmental Technologies to Serve Humanity (ASSETs to Serve Humanity)).

Mentors: Dr. Shane Rogers, Department of Civil and Environmental Engineering, Clarkson University and Dr. Michael Twiss, Department of Biology, Clarkson University

Session 2, Water & Waste Treatments

Snell 175, 10:09 AM

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Implementing the Cornell Local Roads Program Pavement Management System for the Town of Phelps (NY)

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Many small and rural municipalities have traditionally performed reactive, informal, non-integrated recordkeeping and field inspection activities when scheduling maintenance, repair, and replacement of their roads. Work typically occurs on high traffic routes after the public lodge complaints. Low traffic routes get overlooked, however, and deteriorate until repair becomes needlessly expensive. This summer, I worked for the Cornell Asset Management Program (CAMP) Summer Intern Project to implement a Pavement Management System that helps municipalities avoid these traditional problems. The internship started with a three-day training at Cornell University where I learned how to recognize frequently observed road conditions and use specialized GIS software called Cornell Asset Management Program-Roads and Streets (CAMP-RS). Then, for ten weeks I implemented and tested CAMP-RS with the Highway Department, Town of Phelps, Ontario County, NY. This required me to conduct a field-based pavement inventory of every road within the Town’s jurisdiction. With this data, we used CAMP-RS to create a five-year maintenance plan which I presented to the Town Board. The Highway Department believes that future use of CAMP-RS will provide solid maintenance, repair and replacement forecasts for budget requests and grant-writing opportunities.

Acknowledgements: Cornell University, the NYS Department of Transportation, and the Federal Highway Administration supports the CAMP Summer Intern Project. I thank the Town of Phelps Highway Department, Barb Middlebrook, Town Bookkeeper, and the Town Board for funding this internship opportunity.

Mentors: Geoffrey Scott, Cornell Local Roads Program, Cornell University, Terry Featherly, Highway Superintendent, Dan Bremer, Assistant Highway Superintendent, Town of Phelps, NY

Poster #29, Sustainable Communities ERC Atrium, 11:00 AM-12:30 PM
The Smart Housing Project at Clarkson University focuses on developing a utility feedback and motivational messaging system that encourages apartment residents to decrease their electricity and water consumption. Each apartment is made up of individuals who consume varying levels of electricity, creating a need for a messaging system that uniquely targets each of these individuals. However, as most utility feedback systems provide only overall apartment utility usage, it is necessary to understand the range of utility users in each apartment and how they compare to the overall apartment. This sub-project investigated the extent to which overall apartment energy consumption is indicative of individual resident’s energy consumption using six years of electricity data collected with electrical circuit sensors in apartments. Apartment electricity consumption was compared to individual bedroom electricity consumption by categorizing each bedroom and apartment based on daily median electricity consumption over the entire semester. The bedrooms and apartments were labelled as conservative, typical, consumptive, and ultra-consumptive with 20th, 60th, and 85th percentiles as bin markers. The subsequent analysis showed that 42 percent of the residents would receive the correct messaging system if the determining factor for the messaging system was the apartment electricity consumption.

Acknowledgements: Much gratitude for the sponsorship from CSTEP and the directors of CUPO at Clarkson University who made this project possible. Special thanks to entire Smart Housing team, including Susan Powers, Stephen Bird, Lisa Legault, Alan Schay, and others.

Mentors: Dr. Susan Powers, Institute for Sustainable Environment, Clarkson University
Improving Biometric Data Collection and Security

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Growth in technology creates the need for improvement in security. By using data collected from the public over multiple years, it is possible to study and improve the way machines identify humans. Biometric recognition recognizes individuals through physiological or behavioral characteristics. In our research, we collect biometric samples from individuals to improve biometric recognition systems. By making the biometric collection software more user friendly using a simple scripting language, the subjects can collect their samples themselves. This allows collectors to help in ways other than running the software, creating a faster and more efficient method of collecting data. As part of data collection, we create spoofs (fake biometrics made from artificial materials) to test the recognition systems for resistance to attacks. Using pictures of eyes and faces we mimic possible attack methods to trick iris identification machines into false identification. Holding up pictures of eyes to one's face, it is possible to have scanners falsely activate. Using this method, different vulnerabilities of the machines can be identified and improved in order to make them less susceptible to these attacks. All sorts of different printing paper, cameras, and sensors are used to collect the strengths and weaknesses of these different machines.

Mentor: Dr. Stephanie Schuckers, Department of Electrical and Computer Engineering, Clarkson University

Poster #14, Data Analytics

ERC Atrium, 11:00 AM-12:30 PM
Biological Control via Alternative Food to Predator

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Biological control is a means by which pest/invasive populations are kept in check by the use of natural enemies of the pest, or perhaps even parasites, pathogens or a combination thereof. The classic work of Srinivasu et. al. demonstrates how such a process can be facilitated, by providing additional food to an introduced predator to control a target pest. A critical assumption in the literature is that the additional food is constant. Theoretical studies carried out previously in this direction indicate that incorporating mutual interference between predators can stabilize the system. In this work, Beddington–DeAngelis type functional response has been used to model the mutual interference between predator. The conditions for eradication of pest is derived and the main concern is to determine whether the model exhibit different bifurcation. Various biological implications of our mathematical results are drawn in conclusion.

References:

Acknowledgements: This research is guided by Dr. Rana Parshad ,Dr Jonathan Martin. We thank our colleagues from Clarkson University who provided insight and expertise that greatly assisted this research.

Mentor: Dr. Rana Parshad, Department of Mathematics, Iowa State University, Dr. Jonathan Martin, Department of Mathematics, Clarkson University
Metal-organic frameworks (MOFs) are crystalline porous materials composed of metal ions or clusters connected by polytypic organic linkers. The topologies, pore environments, and functionalities of MOFs can be controlled through the choice of metal and organic building blocks, such as the use of zwitterionic (ZW) linkers which form charged organic surfaces within the MOF cavities and can polarize and attract guest molecules. Although MOFs are deemed insulators, we induced conductivity in a series of zwitterionic MOFs through the growth of freestanding thin-films on a conductive substrate and their infiltration with electrolytes. This approach enables using electrochemical stimulus for the reversible generation of pyridinium radicals – an unprecedented platform to access redox-active sites in MOFs. These films can switch between the states of charged and uncharged pore surfaces accompanied by distinct color changes through radical formation creating an electrochromic stimulus-responsive material with tunable adsorption properties. The color palette can be fine-tuned in the single crystalline and thin-film forms by altering the metal and/or ZW organic components which result in unique electrochemical/chromic properties. These investigations pave way for the systematic design of novel multi-functional materials with redox-switchable and multi-stimuli responsive properties, such as smart windows and the selective capture and release of pollutants.

Acknowledgements: NSF and Corning Inc.

Mentors: Dr. Mario Wriedt, Juby Varghese, Department of Chemistry and Biomolecular Science, Clarkson University
On the Complexity of Quantum Transducers

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Quantum generalizations of Markov models in machine learning were introduced recently. We show that quantum transducers provide a natural and useful framework to study these Markov models and their corresponding computational problems. The complexity of these problems can be analyzed via this connection.

References:

Acknowledgement: This material is based on research sponsored by Air Force Research Laboratory under agreement number FA8750-18-1-0104.

Mentor: Dr. Christino Tamon, Department of Computer Science
Learned Environments for Smart Localization

Tianqi Yang\textsuperscript{1}, Mahesh K. Banavar\textsuperscript{1}, Jie Sun\textsuperscript{2}

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We present two approaches to localization in GPS-denied environments, built on a machine learning framework. In the first approach, we train a neural network to model the scattering characteristics of a given environment, which allows the network to estimate the location of the target, given anchor locations and noisy distance measurements between the anchors and the target. In the second approach, we use autoencoders in order to denoise the anchor to target distance measurements perturbed by noise. The first approach is shown to perform better than conventional optimization-based approaches and the autoencoder is shown to be effective in denoising the distance measurements.

Acknowledgements: This work was supported in part by the NSF CRII Award 1464222.

Mentors: Dr. Mahesh K. Banavar, Department of Electrical and Computer Engineering, Clarkson University, Dr. Jie Sun, Department of Mathematics, Clarkson University
Mutations in human myosin XV are associated with hereditary hearing loss (1). Myosin XV is an unconventional actin-motor protein. Inhibiting the expression of Myosin XV protein via RNAi in Drosophila results in a disorganized cytoskeleton and embryonic defects (2), as well as sensory bristle patterning defects in pupae. It is unknown if loss of Myosin XV causes deafness in flies. We hypothesized that if we use CRISPR/Cas9 to knock out Myosin XV, we should see similar phenotypes as Myosin XV RNAi. Our strategy is to replace the coding region of Myosin XV with a dsRed gene, specifically pJet1.2STOPdsRed. We will be using two methods of knockout; a full knockout and a partial knockout which require the building of two donor plasmids and four sgRNAs. Our ultimate goal is to provide a new tool to study the role of Myosin XV in Drosophila.

Reference:


Mentor: Dr. Ginger Hunter, Department of Biology, Clarkson University
Thank You to everyone who participated and attended!

Dr. Anthony Collins, President  OIT
Dr. Robyn Hannigan, Provost  Duplicating
Grounds and Maintenance  Sodexo
Faculty/Staff Advisors and Mentors

RAPS Committee
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Dr. Mahesh Banavar  Dr. Yu Liu  Dr. Shantanu Sur
Dr. Stephen Bird  Dr. Artem Melman  Dr. Joshua Thomas
Evie Brahmstedt  Dr. Craig Merrett  Dr. Diana White
Sujan Fernando  Dr. Sumona Mondal  Dr. Mario Wriedt

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Dr. Douglas Bohl  Jacob Hunt  Dr. Shane Rogers
Dr. Ali Boolani  Dr. Faraz Hussein  Dr. Damien Samways
Dr. Ryan Brown  Dr. William Jemison  Dr. Stephanie Schuckers
Dr. Michelle Crimi  Dr. Kathleen Kavanagh  Dr. Devon Shipp
Dr. David Crouse  Dr. Taeyoung Kim  Dr. Shantanu Sur
Dr. Andrew David  Dr. Tom Langen  Dr. Chee-Keong Tan
Dr. Costel Darie  Dr. Yu Liu  Dr. Dhara Trivedi
Dr. Pedro Fernandez-Caban  Dr. Craig Merrett  Dr. Michael Twiss
Sujan Fernando  Dr. Sumona Mondal  Dr. Steven Wojkiewicz
Dr. Jeremie Fish  Dr. Ali Othman  Dr. Mario Wriedt

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