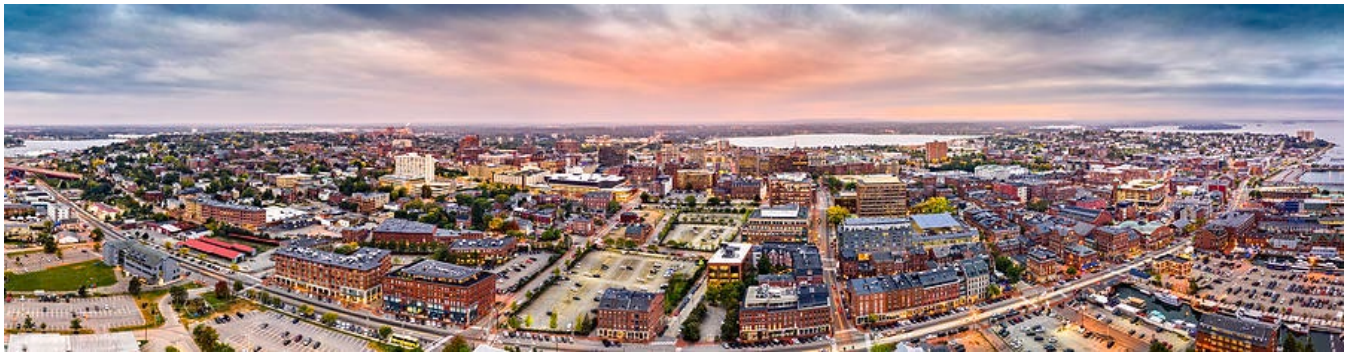
The Roux Institute at Northeastern University
2023 Student Summer Research Internship



The Roux Institute invites Undergraduate and Graduate level (with an emphasis on PhD candidates) students in engineering, data visualization/human data interaction, life sciences and medicine, and computer science to apply for an approximate 10-week summer research experience in Portland, Maine. The program includes:

- Paid internship of $5,000/Undergrad, $7,500/Graduate plus housing stipend
- An interdisciplinary research project mentored by Roux Institute Researchers
- Professional development on topics including mentoring, communication, entrepreneurial thinking
- Networking with other Roux Institute researchers and partner organizations
- Social activities in the Greater Portland area with researchers and entrepreneurs

TO APPLY, PLEASE SUBMIT YOUR APPLICATION AT THE LINK BELOW BY FEBRUARY 15, 2023

ROUX SUMMER INTERN APPLICATION LINK

Application requirements:

- A CV or Resume
- A one-page cover letter highlighting your research interests and areas of expertise that align with the proposed research project topics below (p. 2-3). *Please include a ranked order of your research project preferences in your cover letter, as well as within the application.*

The summer research internship is designed to build relationships with members of the Roux Institute community resulting in published work, new implementable technologies (e.g., prototypes, patents), and the opportunity to continue research work in the future after the internship period ends. For further questions on the program, please contact – Heather Seligman, h.seligman@northeastern.edu

RESEARCH TOPICS OF INTEREST FOR THE SUMMER EXPERIENCE:

UNDERGRADUATE OPPORTUNITIES:

- **Analyzing patient-level genetic data to predict disease outcome**
- **Reproducibility science**
- **Bioremediation of agricultural, municipal, and industrial waste**
- **Applications of augmented and virtual reality to biotech and STEM-related fields**

GRADUATE OPPORTUNITIES:

- **Artificial Intelligence and digital pathology for improving prostate cancer diagnosis/ grading and patient care**
- **Unsupervised learning of participant membership in subpopulations within cohort studies of the gut microbiota**
- **Leveraging wide field-of-view displays to augment memory, perception, and cognition in extended reality**
- **Enhancing medical augmented reality simulations through haptics**
- **Wearable devices for cognitive and emotional monitoring**
- **Predicting polymer additive manufacturing part quality using in-situ thermal sensor data, coupled with artificial intelligence / machine learning**
- **Investigation of low-pressure cold spray additive manufacturing of lunar regolith.**
- **Desalination using wave power**
- **Life-cycle assessment of recycled wind turbine blade materials**
- **Life-cycle assessment and carbon sequestration in materials**
- **Computational high-throughput screening of high-entropy corrosion resistant alloys**
- **Reliability-based control of moveable structures using weather forecasts and local measurements**

- **Materials and material properties for reclaimed and recycled E-glass laminates**
- **Determining newsworthiness of Twitter feeds using machine learning techniques**

UNDERGRADUATE PROJECT DESCRIPTIONS:

Analyzing patient-level gene data to predict disease outcome. We are looking for an undergraduate or graduate student with a background in bioinformatics, coding, or microbiology. The project's primary goal will be to learn how to structure and analyze large datasets, specifically, analyzing patient-level data to determine disease outcomes. In addition, the student will experience observational and genetic-level patient data to teach them the ethics involved in patient-level data, the skills to analyze real-world evidence, and the foundational knowledge of clinical trials and drug discovery, all essential skills to have today.

Reproducibility science. Billions of dollars are spent in healthcare research annually and yet there is no standardized process to evaluate the reliability or reproducibility of this generated clinical evidence. As a result, clinical decisions are routinely informed by findings from a single study, often examining a specific patient population at a single point in time. Rarely do investigators arrange to thoroughly evaluate how those findings fit within the greater body of evidence, depending on specific methods, or generalize across different populations. To fill this critical gap, we propose to develop a transparent and comprehensive systematic procedure to assess the reliability of published clinical evidence.

Bioremediation of agricultural, municipal and industrial waste. The Roux Institute Biotechnology Laboratory at the University of Southern Maine is seeking a motivated undergraduate research assistant with background in Microbiology, Biochemistry, Biotechnology, or other related areas to conduct research to characterize genetically engineered and wild-type microbial strains for municipal and industrial wastewater bioremediation and agricultural waste valorization.
The successful candidate is expected to have knowledge of cell culture techniques. In addition, the student will perform fermentation with the microbial strains and analyze the spent broth for waste remediation and/or its conversion into valuable products. The candidate will perform analysis such as PCR, qPCR, SDS-PAGE, Western blot and use other analytical assays for the quantification of microbial metabolites.

Applications of augmented and virtual reality to biotech and STEM-related fields. We are looking for motivated undergraduate students to continue our project in creating awareness of Biotechnology and STEM opportunities using the Microsoft HoloLens 2 technology. The summer research will expand on the initial success of phase I of this project, creating an augmented and virtual reality-related curriculum that parallels the life sciences high school curriculum. The student should have a

background in Computer Science, Game Design, Digital Media, or a related field, or have experience in biotechnology or biotechnology-related fields, like microbiology.

GRADUATE PROJECT DESCRIPTIONS:

Artificial Intelligence and digital pathology for improving prostate cancer diagnosis, grading and patient care. Prostate cancer (PCa) is the third most commonly diagnosed cancer worldwide, after lung and breast cancer and the fifth cause of cancer-specific death in males. It is the common non-skin malignancy in men and second leading cause of mortality from cancer. Furthermore, it is estimated that 1 in 6 American men will be affected by this ailment during their lifetimes. The increased volume of prostate biopsies and a shortage of urological pathologists are major challenges in prostate cancer diagnosis and grading. We aim to develop algorithms for prostate cancer diagnosis and grading based on machine learning and Artificial Intelligence (AI) applied to digitized slides of prostate cancer tissue. The tool will provide pathologists with an accurate diagnosis, thus reducing the time for diagnosis and treatment.

Unsupervised learning of participant membership in subpopulations within cohort studies of the gut microbiota. The infant gut microbiota's composition depends on external factors, e.g., birth delivery mode, diet, etc., and individuals within cohorts often show variability. We will seek to measure this variability in statistical measurements and its impact on the statistical inference of model parameters.

Leveraging wide field-of-view displays to augment memory, perception, and cognition in extended reality. Wide Field-of-View (FOV) virtual and eXtended-Reality (XR) displays have the potential to leverage more of the information carrying capacity of the human visual-perceptual system. These displays cover not only the focal region, but also the peripheral region of our FOV and thus enable opportunities for novel AR/VR/XR interface design and information presentation techniques that leverage the distinct qualities of these two regions. Can we apply knowledge of these qualities drawn from the fields of Perceptual and Cognitive Psychology to improve users' performance in memory, spatial, and perceptual tasks when using AR/VR/XR systems? In this project, we will use wide FOV head-mounted displays to design display and interaction techniques and evaluate them in a series of user studies.

Enhancing medical augmented reality simulations through haptics. There is strong literature around the need for medical simulation to allow health care workers to maintain their skills in procedures that are infrequently done. Yet, rural health care workers have less opportunity to practice infrequent procedures if not for lower cost solutions that do not involve $80k mannequins and extensive equipment and personnel. To address this need, Augmented Reality based approaches have been

proposed to increase learning in the medical simulation environment. This project will focus on studying how adding haptic feedback to the Hololens-based neonatal care simulation will improve the learning experience and how it enhances the overall effectiveness of the AR based medical training simulations. As time and interests allow, the student will collaborate on the design and build of AR simulations and haptic models with the goal of building a POC system and publishing this work at the end of the summer.

Wearable devices for cognitive/emotional monitoring. This project will focus on modeling human cognitive state (e.g., boredom, frustration, joy, engagement, etc.) from commercially available biometric sensing present on wearable devices. The effort includes designing and building applications to map biometric sensing to cognitive state through heuristics and conventional ML, evaluating these models, and writing up research results for academic publication.

Predicting polymer additive manufacturing part quality using in-situ thermal sensor data coupled with artificial intelligence machine learning. Extrusion based polymer additive manufacturing processes, also known as fused deposition modeling (FDM), are ubiquitously used both for personal use and in makerspaces across the world. Part quality from these processes can be significantly diminished by minor changes in process conditions, i.e., changes to ambient temperature or humidity, bed levelness, nozzle temperature, etc., which can result in loss of part. This project utilizes images from an IR thermal camera attached to a polymer FDM print head, coupled with physics-based models, to in-situ predict the bond strength between as-built polymer filaments. Experimental observations are then used to relate filament bond strength to part quality. Where possible, data analytics strategies, including artificial intelligence and/or machine learning are utilized to predict part quality directly from thermal images.

Investigation of low-pressure cold spray additive manufacturing of lunar regolith. In-situ resource utilization on the moon refers to repurposing the lunar soils (regolith) to make mission critical parts, infrastructures, or their repair. This project investigates the use of a novel low pressure cold spray additive manufacturing technique for creating or repairing parts and/or habitats from lunar regolith. The goal is not only to show that low-pressure cold spray can deposit lunar regolith (simulant) but also to understand the process-structure-property relationships that drive this technology.

Desalination using wave power. With climate change and people living in increasingly arid environments, there is a need for producing potable water without fossil fuel power. One proposed solution is to use mechanical energy from waves to pump seawater through reverse osmosis (RO) filtration membranes. Traditionally RO membranes have been used in constant pressure or flow rate applications, so this application represents a new operational paradigm. This project will work on aspects of understanding the application of RO to direct wave power including characterizing novel

performance measurement techniques and developing ML based tools to optimize maintenance activities and membrane life under these conditions.

Life-cycle assessment and carbon sequestration in materials. To mitigate global warming, there is a need to sequester carbon from the atmosphere. One efficient way to do so is by converting biomass to permanent infrastructure. This project will investigate and quantify the carbon that can be sequestered and the embodied energy or emissions that result from doing so for long-life civil infrastructure components.

Life-cycle assessment of recycled wind turbine blade materials. While the wind industry produces clean energy it also creates significant quantities of fiber reinforced polymer composite waste from the wind turbine blades at the end of their useful life on the turbine. In this project we will investigate, develop, and refine a framework for the life cycle assessment and the techno-economic case for different end of life approaches.

Computational high-throughput screening of high-entropy corrosion resistant alloys. Corrosion has a wide impact on society, causing catastrophically damage to structural engineered components. High-entropy alloys are emerging materials for superior corrosion performance. However, experimental design of those materials is time consuming and expensive. In this project, we will investigate proper thermodynamic and kinetic metrics to describe corrosion behaviors for alloys and based on the metrics we will use first-principles calculations or machine learning approaches to computational screen potential high-entropy alloy candidates for experimental validation.

Reliability based control of moveable structures using weather forecasts and local measurements. This project tackles the challenge of how to perform optimum design and control of a reconfigurable structure to minimize the design wind loads while maximizing the function. An example application is for a reconfigurable solar array that can be folded when wind speeds become too high. Using weather forecast and historical data we want to assess the reliability of both forecast based and direct measurement-based control of this structure for specific locations or regions to avoid exceeding wind speed limits with the panels deployed while simultaneously maximizing the energy generation. The goal is to develop analytics algorithms that allow for optimization of the structural properties and control decisions to achieve a target reliability for a given region.

Materials and material properties for reclaimed/recycled E-glass laminates. Pyrolysis is one potential method for recycling fiber reinforced polymer composites such as wind turbine blades results. This process uses heat and pressure in an atmosphere devoid of oxygen to decompose the resin leaving behind the clay solids and glass fiber. This fiber has been shown to have reduced mechanical properties and in addition the sizing has been removed. This project will explore building and testing composite materials made from this material to better assess the attainable secondary material applications and thus the value of the recycled fiber.

Determining newsworthiness of Twitter feeds using machine learning techniques. If you are on "Twitterdom" or Facebook or any other social media sites, you constantly receive news feeds either as status updates from your friends or companies that you follow. These continuous rolls of posts could be worth looking at either because they are informative, or they could be communicative news or events worth your time. How do you determine which of the posts is newsworthy? A better question could be: What is newsworthiness and what are factors that make some news (including twitter posts) make it to the newspaper or to the digital media (Television or radio etc)?

In this research, you shall be involved in firstly determining precisely what newsworthiness means and creating features/attributes of newsworthiness. Secondly, you will mine twitter data (posts) and annotate this data either as newsworthy or not newsworthy (you shall use the features that you determined earlier to make this annotation). You will then create a machine learning model that can be used to classify tweets as either newsworthy or not.