Undergraduate Research Experience 2019

Faculty & Research Projects

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COLLEGE OF ENGINEERING AND COMPUTER SCIENCE

CIVIL AND ENVIRONMENTAL ENGINEERING

1. Dr. Pratanu Ghosh

Research Interests: My research focusses on sustainability and durability of concrete structures using advanced experimental and numerical technologies. My research directs several innovative cutting edge non-destructive testing technology on concrete samples to evaluate different strength and durability problems in concrete structures. Currently, my students are involved to investigate the beneficial effect of Zeolite based high performance concrete (HPC) mixtures for future implementation in reinforced concrete bridges and pavements. They always enjoy hands-on experience in laboratory environment and they are also involved with different statistical analysis to determine service life of bridge decks and pavements. Earlier, my research students obtained TRB Eisenhower Fellowship, 2nd Prize in CSUF research competition. Every year, my undergraduate research students took part in CSUF student research competition, ECS Student Research showcase and presented their research in Southern California Undergraduate Student Conference (SCCUR).

Projects Available for URE19:
1. Investigate service life modeling of bridge slabs and pavements using life 365 software. Corrosion is one of major problems that deteriorate reinforced concrete over time. Students can compute corrosion initiation time and corrosion propagation time using diffusion coefficients of various sustainable cementitious materials and finally compute service life of bridges and pavements.

2. Investigate Surface Electrical Resistivity and Shrinkage of concrete samples using non-destructive testing techniques. More testing is needed for different high performance concrete mixtures for future implementation in reinforced concrete bridges and pavements.

Desired preparation for this lab: Students need to know basic statistical analysis and Excel and some basic lab training to conduct experiments. Our lab technician can help to provide adequate training to use the equipment.

2. Dr. Sudarshan Kurwadkar

Research Interests: The fate of emerging contaminants particularly pharmaceuticals and personal care products, endocrine disrupting compounds, hormones and neonicotinoid insecticides. My research work involves use of High Performance Liquid Chromatography and wet chemistry.

Projects Available for URE19:
1: Persistence of sulfonamide antimicrobials in engineered wastewater treatment system. In this project student will study the stability of selected sulfonamide antimicrobials in different stages of wastewater treatment system. Engineered wastewater treatment systems have become a sink for emerging micro- pollutants and their occurrence in environment could perturb ecology. This is a critical area of research that has tremendous human health and ecological consequences.
2: Evaluation of photostability of antimicrobial in surface water under simulated radiation source. This exploratory research is a proof of concept to see alternate disinfectants could not only kill the pathogen but also remove low levels of pharmaceuticals and other bio-active compounds. Wastewater with low levels of micro-pollutants will be exposed to UV radiation source to investigate their photostability.
3. Field scale mapping of neonicotinoid insecticides in intensive agriculture operations. This project involves sampling and detection of neonicotinoid insecticides at field scale. This research project involves"

Desired preparation for this lab: Students should have an interest in the field.

3. Dr. Yu Bai

Research Interests: Dr. Bai's research interests include neuromorphic computing, FPGA design, nano-scale computing system with novel silicon and post-silicon devices, and low power digital and mixed-signal CMOS circuit design.

Projects Available for URE19:

1. Real Time Object Detection using Artificial Intelligent

Recent research show that ours brains make vision easily. We can easily tell difference with a lion and a jaguar, read a sign, or recognize a friend face. However, these tasks are actually hard to solve with a computer. In the last few years, machine learning has made tremendous progress on addressing these difficulties. In this project, students will explore a kind of model called a deep convolutional neural network that can achieve reasonable performance on visual recognition tasks.

2. Self-driving Lego Robot using Artificial Intelligent

Recently, self-driving has been attained significant interest. In order to build a self-driving car, it requires numerous sensing equipment. For example, a standard project funded by DARPA had five different laser sensors. Therefore, current computation framework is not efficient to large scale self-driving car. In this project, students will use recent artificial intelligent techniques to construct the robot.

3. Hardware Accelerated Deep Neural Network

During recent years, researchers throughout academia and industry have been advancing the theory, operation, and applications of neuromorphic computing systems. Recent interest in neuromorphic computing systems stems from its superior and rapidly advancing performance at tasks such as image recognition, learning of complex intelligent behaviors, and large-scale information retrieval problems such as intelligent web search. However, to attain the benefits of neuromorphic computing, high computational and energy-consumption demands of the underlying processing, interconnect, and memory devices on which software-based neuromorphic computing executes has become an intense focus of government, industry, and academic research. In this project, students will focus on innovative hardware implementations to attain throughput goals within area, security, and energy constraints for orders of magnitude improvements.

4. High Performance Computing using Non-Volatile Memory (NVM)

In the past several years, the use of Non-Volatile Memory (NVM) has proven to be having a potential in solving critical challenges that exist in modern computer memory systems such as storage density, latency, and power. Currently, NVM is generated from simple analytic models and characteristics, which hinders the ability for the NVM controller to extract any visible data for real device usage. To remedy this problem, an FPGA based controller is proposed to help characterize the models from NVM that can be applied to real devices. In this project, students are using FPGA-based NVM platform for accelerating various applications such as machine learning, control system, and image processing system.

Desired preparation for this lab: No additional preparation is required. I will take the responsibility to ensure that the students have sufficient background during the summer research activities to fully benefit from their participation in the projects.

4. Dr. Rakesh Mahto

Research Interests: My research interests include ASCI design, low power design, reconfigurable FPGA design, photovoltaics, renewable energy and mixed signal design and testing.

Project Available for URE19:
Currently, I am working on creating reconfigurable solar cells. This kind of solar cells can be used for powering micro-autonomous drones and CubeSat. You will get chance to understand the working of solar cells and learn programing of Arduino or Raspberry Pi boards.

Desired preparation for this lab: Some courses related to C and C++ programming should be sufficient.

5. Dr. Christopher Ryu

Research Interests: Artificial intelligence and machine learning.

Projects Available for URE19:
Robot navigation.
This project is about a problem of "robot navigation" using the robot operating system (ROS) for autonomous cars. The necessary background for this project includes python or C/C++ programming, basic understanding of physics (motion), basic math (trigonometry), and Linux operating system.

Additional project available in song composition and voice modeling. Background needed: music theory and python.

Desired preparation for this lab: C++ or Python programming and data structures.

6. Dr. Yun Tian

Research Interests: cloud computing, cloud security, big data, distributed computing, parallel and high performance computing, and computer science education

Projects Available for URE19:
1: Cloud Computing Storage Security. The rise of huge datasets, dubbed "Big Data", have pushed the need for introducing innovative ways to provide large-scale data processing using cloud and distributed computing systems. Two popular frameworks exist today: Apache Hadoop, which uses the MapReduce paradigm, and Apache Spark, which uses the Resilient Distributed Datasets for in-memory processing. This project focuses on proposing some solutions to store data securely and at the same time process data fast by using these two frameworks.

2: Location-based services. The increase in location-based services (LBS) in recent years has raised the prominence of spatial keyword (SK) queries. As the majority of current modes of transportation require travel along roads, the use of network distances in SK queries is potentially more desirable than Euclidean distances. This project aims to propose a novel indexing method, in a distributed framework, to simultaneously return query results of all relevant points-of-interest.

3: Text Mining. Most of the data we have today is text based and difficult to analyze because of its structure and size. Text mining help many organizations to obtain valuable information from large text-based content that can provide intelligent decision making. We will study and propose a solution on text mining application to calculate the aspect rating of hotel reviews using Map Reduce.

4: Cloud Computing Network Security. Software-Defined Networking introduces centralized control logic, and separated data plane from control plane which makes it easy for network engineers to monitor traffic and diagnose threats, insert and change security policies. Customized integration will become easy. However, it also creates security challenges which didn't exist before. In this project, we will analyze the effect of denial-of-service (DOS) attack on controller plane and propose a solution to mitigate DOS attack on SDN controller.

Desired preparation for this lab: No additional preparation is required.

7. Dr. Sagil James

Research Interests: My research areas include advanced manufacturing, smart manufacturing and clean-energy manufacturing. I am working on several projects in these areas. The focus of the projects is to study and develop technologies needed to reduce the time and cost required to translate design innovations into commercial processes and products.

Projects Available for URE19 include:
1. Improving quality of printed parts in Binder Jet 3D printing process
2. Investigation of ultraprecision laser cutting process for composites and ceramics
3. Study of vibration-assisted 3D printing processes
4. Study of radio frequency energy harvesting for IoT devices
5. Design, fabrication, and analysis of low-cost smart solar powered energy harvesting micro air vehicles using 3D printing

Desired preparation for this lab: No additional preparation is required.

8. Dr. Nina Robson

Research Interests: This cross-disciplinary project is a collaboration between faculty in Biochemistry (Dr. Madeline Rasche) and Mechanical Engineering (Dr. Nina Robson). The research explores ways to develop models for predicting protein motion and/or constructing bio nano-robots using DNA by applying engineering mechanism kinematics and design principles towards solving complex biological problems. Possible applications of the research are in the areas of medical drug design and delivery.

COLLEGE OF NATURAL SCIENCES AND MATHEMATICS

BIOLOGICAL SCIENCE

25. Dr. Kristy Forsgren

Research interests: My lab focuses on the reproductive physiology and anatomy of internally fertilizing (viviparous) marine fishes. We are interested in describing the connection of the testes to the genital papilla to better understand sperm transfer from the male into the female reproductive system. We are also working on assessing seasonal sperm development and the function of the paired flask organs of the anal fin of five surfperch species.

Projects Available for URE19: The work described above is what is available for a student to work on over summer (i.e., surfperch reproductive anatomy). These projects require field work (i.e., collecting fish), which involve long days and sometimes odd times of day (e.g., 3:00am or 6:00pm beach seins). Lab-based work on campus is also required and may include fish handling and dissection, histology, photography, microscopy, and analysis using image J. Students will have an opportunity to work with graduate and undergraduate students previously established in the laboratory.

Desired preparation for this lab: No preparation/skills required. We will provide on-the-job training for a dedicated and enthusiastic student!

26. Dr. Bill Hoese

Research interests: Work in my lab focuses on the ecology and behavior of the non-native pin-tailed whydah. It is a common pet, but has escaped and established a breeding population in southern California. The pin-tailed whydah is an African finch that is an obligate brood parasite and lays its eggs in the nests of other birds. Brood parasites negatively impact the ability of their hosts to raise their own young. We don't really know at this point which species are serving as hosts for the pin-tailed whydah.

Projects Available for URE19: We have an ongoing study investigating the singing behavior of pin-tailed whydahs. The pin-tailed whydah belongs to a group of brood parasites that mimic the songs of their hosts. We will be recording and analyzing song to gain insights into the local hosts of the pin-tailed whydah.

Desired preparation for this lab: Students must be interested in spending extended periods of time working outdoors and should be prepared for hot, dry conditions.

9. Dr. Alison Miyamoto

Research Interests: We are interested in how proteins on the surface of mammalian cells communicate with each other and with their environment. Specifically, we are studying: 1) the mechanism of Notch signaling (Notch is conserved in all animals, required for proper development of the embryo, and defects in Notch signaling are associated with birth defects and cancer), and 2) how MAGP2, a protein of the extracellular matrix (ex. cartilage, bone), affects the activity of at least two different signaling pathways. We are also involved in a collaborative project tracking the localization of a RNA splicing factor, PTBP1, that is important to neural cell maturation.

Projects Available for URE19:
1) For the Notch project, we want to generate a human cell line that expresses a Notch1 receptor fused to Green Fluorescent Protein (GFP) that fluoresces green in live cells. These cells could be used in live cell imaging assays for Notch receptor cell signaling. 2) For the MAGP2 and PTBP1 projects, we have ongoing antibody-based assays (keywords: immunofluorescence, microscopy) to track their signaling/localization in mammalian cells.

Desired preparation for this lab: We will train students in all required techniques.

10. Dr. Nilay Patel

Research Interests: Niclosamide is an FDA-approved drug that is being considered as an adjuvant chemotherapeutic agent for cancer treatment. Our collaborators have synthesized compounds similar to niclosamide and our goal is to characterize how these compounds reduce cell proliferation. We have used microarray technology to identify which genes are differentially regulated by these compounds and we plan to evaluate role of these genes using cellular and molecular biology techniques such as quantitative PCR, immunocytochemistry, overexpression, knock-down along with drug treatments, and CyQuant cell proliferation assay.

Desired preparation for this lab: No additional preparation requested.

11. Dr. Melanie Sacco

Research Interests: We are interested in how viruses successfully infect some plants, while other plants are able to defend themselves with immune responses. We use different plus- and minus-sense RNA viruses for our research questions, and study interactions primarily in plants of the tobacco genus *Nicotiana*. Various projects in the lab investigate the activities of virus proteins in promoting infection or immune receptors that recognize those proteins through molecular biological and biochemical approaches, including mutation of clones for expression in tobacco to observe what kinds of effects the mutations have on protein function.

Projects Available for URE19: We are currently researching two immune receptors in the model plant *Nicotiana benthamiana*: the Rx protein from potato that recognizes the virus potato virus X and the Tm2-2 protein from tomato that recognizes tobacco mosaic virus and tomato mosaic virus. Previous work in our lab showed that there are potential phosphorylation sites at the amino-terminus of these proteins, and that members of the 14-3-3 protein family of phosphoprotein-binding proteins are important for Tm2-2 function. Two available projects for summer 2019 will test ten members of the tomato 14-3-3 protein family (called TFT1 to TFT10) and dominant mutants of selected TFTs with the two immune receptors Tm2-2 and Rx for an effect on immune signaling. Wild-type and mutant immune receptor proteins will also be used to investigate if any of the TFTs function by binding to their amino-termini when phosphorylated.

Desired preparation for this lab: Students should have an interest in molecular biology or biochemistry and we will conduct the required specialized training for the specific research projects.

12. Dr. Parvin Shahrestani

Research interests: We study the evolution and genetics of health-relevant traits, such as longevity and immune defense. Our lab uses a fruit fly model system.

Projects Available for URE19:
1. Understanding sex differences in immune defense against fungal infection. When flies are infected with fungal pathogens, female flies die faster than male flies. We want to understand what behavioral and genetic factors cause this sex difference in immune defense.

2. Understanding how reproduction affects immune defense. Female flies that are virgin have better immune defense compared to female flies that have previously mated. It's possible that females who have mated are allocating their resources to reproduction, at a cost to immune defense. But this has not been experimentally tested before. We want to understand why virgin females have better immune defense compared to mated females.

3. Understanding the relationship between immune defense and aging. Some studies have shown that the genes of the immune system are expressed at higher levels when fruit flies age. However, other studies have shown that older flies have worse immune defense compared to younger flies. We want to understand how aging and immune defense are related to each other. For this work, we will test for immune defense differences at different ages in the same fly population, and we will also compare immune defense differences between long-lived and short-lived fly populations.

4. Understanding the role of the gut microbes in immune defense. Previous studies have shown that the gut microbiome can affect many host characteristics, including longevity and immune defense. We will characterize, and manipulate, the gut microbiomes of long-lived and short-lived fly populations with and without fungal infection in order to understand the complex relationships among these characteristics.

Desired preparation for this lab: We will train students in all aspects of the experiments.

13. Dr. Danielle Zacherl

Research Interests: The Zacherl lab's research interests center around topics in marine ecology including larval behavior, settlement and recruitment dynamics, population connectivity, restoration ecology, and native-non-native species interactions.

Keywords: Marine Ecology, Marine Population Connectivity, Restoration Ecology, Marine Invertebrates.

Projects Available for URE19:
Population connectivity – We use statoliths, otoliths, and genetic markers to measure dispersal and connectivity over ecological and evolutionary timescales.

Restoration – We have been engaged in science-based restoration projects focussed on restoring the Olympia oyster, *Ostrea lurida*, in southern California since 2010.

Monitoring – We have been monitoring populations of Kellet's whelk since 1996, settlement dynamics and populations of oysters since 2005, and pinto and black abalone since 2013.

Desired preparation for this lab: An interest in marine ecology or restoration ecology.

14. Dr. Peter de Lijser

Research Interests: The project we are currently working on involves the structure and reactivity of radical and radical ions derived from oximes and oxime ethers. We have previously shown that radical ions can react with built-in nucleophiles such as aromatic rings. Most recently we have been investigating the use of alkynes as nucleophiles and have found a novel reactions that generates what we believe to be an isoindole-N-oxide. The initial product seems unstable and reacts to give an unknown product. Our focus for the summer will be on determining the structure of the initial product as well as its stability under different conditions. In addition, we plan to identify the unknown product to learn more about the reactivity of the isoindole-N-oxide. We collaborate on this project with Dr. Andrew Petit, who provides computational data to help us understand the possible products and pathways.

Desired preparation for this lab: Students should have an interest in chemistry. Completion of organic chemistry with lab is recommended.

15. Dr. Allyson Fry-Petit

Research interests: Research interests are in solid state inorganic chemistry, focused on the rational design of new materials through the use of data mining, synthesis, structural characterization and optical and vibrational probes.

Project Available for URE19:
Students will be researching solid materials that possess negative thermal expansion, the expansion of materials upon cooling. Their project will include synthesizing new compounds and analyzing their atomic crystal structure via x-ray powder diffraction and infrared spectroscopy.

Desired preparation for this lab: Interest in biochemistry and/or chemistry

16. Dr. Michael Groves

Research interests: We work to understand how chemical reactions take place on surfaces and develop the tools necessary to quickly and accurately predict them. Our current projects include understanding formate production from CO2 over novel metal alloy surfaces as well as hydrogen peroxide synthesis over modified graphene structures. We are also using machine learning algorithms to develop automated, and intelligent global optimization search protocols for organic systems which are designed to increase the performance of the search for thermodynamically favorable structures. We intend to use them to search for novel modified graphene surfaces.

Project Available for URE19: Transitioning away from carbon-based fuels will be one of the major challenges facing humanity in the 21st century. During the transition, carbon neutral energy generation will useful in limiting the environmental impact of human activity while alternatives are developed. Formate is a fuel that can be synthesized from carbon dioxide and can be used to produce energy in a fuel cell. This URE19 project would focus on computationally predicting metallic alloy catalysts that most efficiently create formate from carbon dioxide. This project also involves working in tandem with experimentalist who will synthesize the predicted alloys to verify their properties.

Desired preparation for this lab: I will teach the students all the computer programming they need to work effectively in the lab.

17. Dr. Maria Linder

Research interests: Mammalian copper and iron metabolism, focusing on the structure, function and regulation of proteins associated with these elements. Current emphasis is on copper transport within the blood plasma (particularly a new small copper carrier we have discovered), mechanism of uptake by cells, and excretion of copper via the bile and urine, in conditions of copper overload (which naturally occurs in dogs) as well as in pregnancy and with estrogen intake/exposure. With iron we are studying the mechanism by which iron stored in a large protein, ferritin, is made available to cells and organs when needed. Studies use a broad variety of approaches from cell culture models, mutated mice and rats and tracer radioisotopes, to isolation, sequencing and characterization of proteins, as well as manipulation of mRNA/protein expression.

Project Available for URE19: Determining the identity and structure of small copper carriers in the blood plasma of humans and animals

Desired preparation for this lab: interest in biochemistry and/or chemistry

18. Dr. Marcos Ortega

Research interests: The Ortega lab is a biochemistry lab that focuses on viral assembly and replication. We week to study how proteins interact with each, and with viral DNA, to assemble a mature virus. The Ortega lab uses structural, kinetic, and biophysical studies.

Projects Available for URE19:

1. Large terminase expression, purification, and characterization.
In this project, students will express and purify a viral enzyme involved in viral replication. The protein will be screened for crystal formation and sent to a collaborator for further structural studies.

2. Small terminase expression, purification, and characterization.
In this project, students will express and purify a viral protein involved in binding viral DNA to initiate assembly. The protein will be used in structural studies and in DNA binding studies.

3. Capsid expression, purification, and characterization.
In this project, students will express and purify a viral protein that forms the head/capsid of the virus. The protein will be screened for crystal formation.

Desired preparation for this lab: Students should have completed general chemistry before entering the lab.

19. Dr. Stevan Pecic

Research interests: Inhibitors of sEH and FAAH - Our main research interests and assignments are focused on identification of novel inhibitors of enzymes involved in lipid metabolism and their evaluation as potential therapeutics. In particular, we are interested in two enzymes, soluble epoxide hydrolase (sEH) and fatty acid amide hydrolase (FAAH). Through traditional medicinal chemistry techniques, including in silico drug design, organic synthesis, structure-activity relationship (SAR) studies and in vitro biological evaluations, our goal is directed toward elucidation of the pharmacology and biochemistry of lipid metabolism and pathophysiology of related diseases.

Development of DNA-based aptamer biosensors - We are using optimized procedure (SELEX) that directly yields DNA-aptameric sensors for small molecules in so-called structure-switching format. We are in particular interested in small molecules such as steroids and drugs that regulate pain and inflammation. Aptamers generated via SELEX hold promise for diverse biomedical applications, such as drug development, bioimaging, drug discovery, disease diagnosis, hazard detection, food inspection, etc.

Desired preparation for this lab: interest in biochemistry and/or chemistry

20. Dr. Andrew Petit

Research interests: The Petit lab uses computational chemistry to answer fundamental questions about the mechanisms through which chemical reactions take place as well as photochemistry (i.e. what happens after molecules absorb light and become excited).

Projects Available for URE19:
1. Using Computational Chemistry to Discover Greener Routes to New Medicines. Many drugs contain complicated rings containing atoms other than carbon and hydrogen. In collaboration with Dr. de Lijser's research lab at CSUF, we are using computational chemistry to discover an approach to making these structures using light instead of other, less environmentally friendly, methods. This project will involve using computational chemistry to determine how changing the structure of the reactant affects its ability to undergo the reaction.

2. Photobases: Using Light to Transform a Weak Base Into a Strong Base A series of recent studies performed in the Dawlaty lab at USC have explored the properties of a small family of photobases – molecules that are normally weak bases but become strong bases after absorbing light and becoming electronically excited. We are using computational chemistry to greatly expand the family of known photobases and make predictions about how adding different functional groups affect their properties. Such compunds have potential applications as light-activated catalysts.

Desired preparation for this lab: This project will be a good fit for students who are planning to major in chemistry, biochemistry, or physics. It would be good if the student has completed either general chemistry or introductory physics. Experience with organic chemistry would be useful but not necessary. Experience with calculus and/or coding are helpful but not required.

21. Dr. Madeline Rasche

Research Interests: This cross-disciplinary project is a collaboration between faculty in Biochemistry (Dr. Madeline Rasche) and Mechanical Engineering (Dr. Nina Robson). The research explores ways to develop models for predicting protein motion and/or constructing bio nano-robots using DNA by applying engineering mechanism kinematics and design principles towards solving complex biological problems. Possible applications of the research are in the areas of medical drug design and delivery.

22. Dr. Joe Carlin

Research interests: Dr. Carlin's research is focused on coastal and shallow marine sedimentology over the recent geologic past (last ~3,000 years to the past several decades). The research primarily utilizes sediment cores to better understand the processes that have shaped coastal and marine environments over these times, and to better understand the connectivity between terrestrial (land) and ocean processes that come together at the coast and in the shallow ocean. By understanding how sediment deposits and coastal landforms have changed in the recent past, we can have a better sense of what to expect in the future as climate change, sea level rise, and human populations increasingly impact our oceans and coasts.

Projects Available for URE19:
1: This project will analyze sediment cores collected from offshore Monterey Bay California to investigate how the supply of sediment form the land to the ocean has changed throughout time. The project offers the opportunity to assess environmental changes on land in the ocean over a variety of time scales including the recent past (last ~ 150 years) and recent geologic past (~ 3,000 years).

2: This project will determine how an urban estuary (Upper Newport Bay, CA) has evolved over the past 100 years under the influence of humans, and how future climate change, in particular sea level rise, may impact the bay.

3. This project will analyze a sediment core from a small southern California estuary (Los Penasquitos Lagoon, CA) to reconstruct the environmental changes in the lagoon over the past ~2,500 years.

Desired preparation for this lab: No additional preparation required.

MATHEMATICS

23. Dr. Jessica Jaynes

Key Words: Statistical methods and applications; Experimental Design; Survey design known as Discrete Choice Experiments

Research interests: Her research projects include the development of a new class of designs that provide higher efficiency, more in-depth analyses, and require a shorter time to run. She has applications in the biomedical field such as Herpes Simplex Virus Type-1 and KB Oral Cancer, as well as lipid accumulation for algae growth. More recently her research has been focused on survey design in the area of snack accessibility to understand children's snack choices and parental influences. She works in collaboration with the Department of Public Health and has been actively collecting and analyzing data from local Orange County schools.

Desired preparation for this lab: This project would be best for a student who is interested in focusing on statistics and has had at least Calculus I.

24. Dr. Roberto Soto

Research interests: Currently my students and I focus on studying variations of the classic game Peg Solitaire. Peg Solitaire is a classic game played in many cultures consisting of a board with pegs and one hole placed anywhere on the board. The goal of the game is to reach an ending state with only one peg remaining on the board by removing all other pegs. To remove a peg requires "jumps" similar to how checkers is played. We have created many different versions of the game and study its "solvability", in other words, when is it possible to reach an ending state with one peg.

Desired preparation for this lab: Students should have completed 2 semesters of introductory, algebra-based physics.