Precision genome editing in zebrafish

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CST
Biology

Unlike humans, zebrafish possess a remarkable regenerative capacity, including the ability to regenerate their hearts after severe injury. We are working to figure out which genes control this process and precisely how. To achieve this goal, we are using the CRISPR/Cas9 system to introduce precise changes into the zebrafish genome, including integration of sequences coding for epitope tags and loxP sites (see PMID: 30427827 and PMID: 27892520). We are looking for one or two students to join this effort. Sub-projects include screening for CRISPR/Cas9-induced genome editing events and analysis of generated mutant lines.

Location: Main; In-person essential
Student Majors Accepted: Biology, Biochemistry
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: N/A

More birds, cleaner parks? Field experiments of littered food consumption by urban birds

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Biology

Biological diversity sustains ecosystem services that make our cities healthy and comfortable places to live. The Integrative Ecology Lab (www.iecolab.org) is conducting experiments to determine how the abundance of birds in parks across Philadelphia contribute to the removal of littered food. Students will assist with conducting bird community surveys (visual and auditory identification of species) and setting up video equipment used to record birds as they consume littered food from feeding trays. Virtual tasks will include subsequent review of the recordings. This position is open to all CST students interested in gaining experience conducting research in field ecology.
Please note: To participate in the field components of this research, students will need to be willing and able to drive themselves to field sites across the Philadelphia and surrounding counties (Chester, Montgomery, etc.).

Location: Parks throughout Philadelphia County and the surrounding region; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: All Majors
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Applicants should be interested in spending time outside in summer weather

Lyme Disease Ecology

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Biology

The Integrative Ecology Lab (www.iecolab.org) is conducting surveys of wildlife across the Philadelphia region to better understand how community interactions impact Lyme disease dynamics. Students will assist with research by processing photos from motion Activated trail cameras to identify species involved in the transmission and control of Lyme disease. Pending university approval, students will also participate in in-person outdoor field work aimed at collecting ticks and trapping small mammals. This position is open to all students interested in gaining experience conducting research in ecology. To participate in the field component of the research, students will need to be able to travel to field sites across Philadelphia and the surrounding counties (Chester, Bucks, etc.).

Location: Field work will occur outdoors, at forested parks in Philadelphia and surrounding counties.; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: All Majors
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Applicants should be comfortable with and willing to spend time outdoors in summer weather. Travel to field sites may require use of a personal vehicle. Interest in animals is a plus for processing photos.

Combining Photons, Electrons and Nanoparticles for Plasmonic Sensing and Catalysis

Eric Borguet
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CST
Chemistry

Students will develop and use nanoscale plasmonic materials for rapid, high sensitivity detection of biological and chemical agents, as well as catalytic conversion. They will learn to use a variety of analytical techniques such as spectroscopy, Atomic Force Microscopy.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Chemistry, Physics
Class Preferences: Sophomore & Junior
Important Selection Criteria: Curiosity and persistence - Interest in research - Aptitude for careful laboratory research - - Undergraduate researchers in my group typically present at local, regional and even national conferences. Many have been co-authors on publications.

Laser Vibrational Spectroscopy and Dynamics of Molecular Species at Bio and Geochemical Interfaces

Eric Borguet
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CST
Chemistry

Research involves learning to use ultrafast lasers (we make some of the shortest infrared pulses in the world) to perform vibrational Sum Frequency Generation (SFG) a technique that provides sensitivity to single molecular layers. Students will investigate water, arguably the most important molecule on the planet at interfaces of biological and geochemical relevance. Students will learn about surface chemistry, biointerfaces, geochemistry and laser spectroscopy.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Chemistry, Physics
Class Preferences: Sophomore & Junior
Important Selection Criteria: Curiosity and persistence - Interest in research - Aptitude for careful laboratory research - - Undergraduate researchers in my group typically present at local, regional and even national conferences. Many have been co-authors on publications.

Animal-Landscape Interaction

Ilya Buynevich
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CST
Earth & Environmental Science

Zoogeomorphology - field observations of animal-landscape interactions (e.g., geological impact of reserving beaver populations in Philadelphia suburbs).

Some aspects may involve analysis of georadar (GPR) images of biogenic structures (large burrows).

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Geology, ES
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Geology or Environmental Science major, but other CST majors will be considered.

Pattern formation and out-of-equilibrium effects in biomolecular assemblies

Vincenzo Carnevale
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Chemistry

Constantly increasing evidence suggests that phase separation is one of the major mechanisms to generate patterns in all cellular compartments. The intriguing and peculiar aspect of living matter is its out-of-equilibrium nature caused by the steady action of enzymes and other molecular machines. In this context, emergent phenomena like motility-induced phase separations (observed for the first time in flock of birds, schools of fish and in bacterial communities) are a candidate mechanism to explain the origin of self-organization in the cytoplasm and in the plasma membrane as well. We are addressing these questions by studying the statistical mechanics of simple models based on collections of interacting diffusing agents with internal degrees of freedom subject to external time-dependent fields. During the project, the student will collaborate with a graduate students and a postdoc on a daily basis to learn the fundamentals of some numerical techniques first and then carry out molecular dynamics and Monte Carlo simulation.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Physics, Chemistry
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Interest in computational research, physics, chemistry and biochemistry. Basic computational skills preferred but not required.

Auto-detection of geologic features through citizen science

Alexandra Davatzes
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CST
Earth & Environmental Science

I am looking for a student to work with me and a few graduate students on a project where we are developing a citizen science activity to annotate images for the purposes of machine learning.

Location: Main; Virtual or computational research
Student Majors Accepted: EES, CIS
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Students must have some geologic background, preferably completion of physical geology and Sedimentary Environments.

News Mining

Eduard Dragut
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CST
Computer and Information Sciences

The goal of this project is to create methods to mine social media data. Tasks include name entity recognition, crawling, authorship, fake news detection. Project Details:

https://cis.temple.edu/~edragut/Projects/MVSC/MVSC.html

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: All Majors
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Programming skills (java and/or python); Intro to probability and statistics

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Virtual Job Assistants for Individuals with Neurodevelopmental Disabilities

Eduard Dragut
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CST
Computer and Information Sciences

About 4% of children and young adults in the U.S. are diagnosed with neurodevelopmental disabilities. The objective of this project is to gain scientific understanding and to develop technology to support stronger participation of neurodiverse individuals in a future workforce. This project seeks to understand (a) what tasks are appropriate for what segment of the neurodiverse worker population; (b) what are the basic task analysis principles that enable job decomposition and chaining; and (c) what user interface design principles can minimize cognitive burden of workers. Project Details:
https://www.nsf.gov/awardsearch/showAward?AWD_ID=2026513&HistoricalAwards=false

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: All Majors
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Programming skills (java, python, and web)

Internet of Things (IoT) Security and Privacy

James Xiaojiang Du
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CST
Computer and Information Sciences

Internet of Things (IoT) is ubiquitous because of its broad applications and the advance in communication technologies. IoT devices interact with the environment directly and provide us with information for many aspects of our daily lives. IoT security and privacy become the most critical issue. In our research, we will study various security and privacy issues of IoT. Below is an example: Semantics-enabled Anomaly Detection in Smart Home Environments. With the large-scale deployment of the Internet of Things, smart home has become a reality to enable pervasive interactions among home electronic devices. However, anomalies (e.g., attacks, device failures or malfunction, human mistakes) occur in smart homes. Without timely detection, they may lead to severe consequences. Past researches mainly apply data mining to anomaly detection, but they suffer from a high false alarm rate in an appified home automation system. We thus propose semantics-aware data mining for anomaly detection to greatly mitigate the limitation and design a system that can comprehensively cover varieties of anomalies to help the user keep an eye on their home IoT systems.

Location: Main; Virtual or computational research
Student Majors Accepted: All Majors
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Good computer programming skills.

Developing Animations for Learning Chemistry

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Chemistry

The teaching tool Bio-Organic Reaction Animations (BioORA) has been developed to assist student learning. BioORA is available online and it covers topics that include enzyme chemistry, lipids, nucleic acids, and carbohydrates. The animations that are included in the program are based on 3D data from crystal structures found in the Protein Data Bank (PDB). This research project involves developing a conversion from PDB files or Maya files to 3D visualization using Unity3D and Oculus Rift Virtual Reality hardware. The ultimate goal would be to generate a new VR-based teaching tool for bio-organic chemistry. VR work would be in collaboration with Gillian Queisser.

Location: Main; Virtual or computational research
Student Majors Accepted: Chemistry, Biochemistry, CIS
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Organic chemistry and coding skills would both be helpful.

Climate change impacts on marine ecosystems

Amy Freestone
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CST
Biology

As climate change disrupts ecosystems worldwide, species will experience changing interactions. For this project, student researchers will help monitor the impact of increased temperature on herbivory rates and competitive interactions for two Pacific sea urchin species. A series of lab experiments with live animals will help quantify these expected changes. Experiments will be conducted during the fall semester on either Main Campus or at the Temple Ambler Field Station. The Field Station is located on the Ambler Campus and can be accessed from Main Campus via the inter-campus bus.

Location: Main; In-person essential
Student Majors Accepted: All majors
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: A background (coursework/experience) in ecology or related field is recommended, but not required

Temple Forest Observatory

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Biology

The Temple Ambler Field Station is collaborating with the Smithsonian Forest Global Earth Observatory (ForestGEO; https://www.forestgeo.si.edu/) to establish two forest research plots at the Field Station as a platform for inquiry-based education and long-term forest research. Students will develop skills in field data collection and more through hands-on training. These positions are open to all CST students who have an interest in gaining field experience in forest science and ecology. No previous research experience is required. The Field Station is located on the Temple Ambler Campus. Transportation from Main Campus is provided via the inter-campus bus during the academic year. Interns who work at the Field Station during the summer will need a person vehicle or other means of transportation.

Location: Ambler; In-person essential
Student Majors Accepted: All majors
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: A background (coursework/experience) in ecology or related field is recommended, but not required

X-ray Spectroscopy of Emergent Quantum Phenomena at Oxide Interfaces

Alexander Gray
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CST
Physics

Laboratory and synchrotron-based investigations of emergent electronic and magnetic phenomena at interfaces between strongly-correlated oxides.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Physics, Chemistry
Class Preferences: Juniors & Seniors
Important Selection Criteria: Interest in experimental condensed matter physics and/or materials science, familiarity with Matlab programming

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Building a tree of life with DNA data

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CST
Biology

This project involves working with DNA sequence data of diverse organisms, and software, to help build the tree of life and better understand evolutionary principles. It takes place in the Center for Biodiversity and mostly involves learning and using new computer tools and applications. The center is located in SERC.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Biology, but could be any major
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Strong academics

Conserving the biodiversity of Haiti

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CST
Biology

This project involves helping efforts in Temple's Center for Biodiversity to learn more about the biodiversity of Haiti, and to protect it. The multi-faceted team efforts include discovery of new species, mainly through DNA sequencing of samples collected in Haiti, ecological and evolutionary studies, and educational and outreach components. The center is located in SERC.
Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Biology, but could be any major
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Strong academics

Spotted Lanternfly Invasion Meltdown

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CST
Biology

Temple University's iEcoLab (https://www.iecolab.org/) has several projects on stopping the destructive spread of spotted lanternfly. Projects include biological control, species traits, ecology, data science, computer coding, machine learning. Students will work within a dynamic group of undergraduates, graduate students and postdocs focusing on spotted lanternfly ecological and computational research.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Biology, CIS, ES, Physics, Engineering, GUS
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: We have projects available for a range of skill sets. We have projects that are focused on ecology and projects that are focused on computer coding.

Universal Patterns of Biodiversity

Matthew Helmus
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CST
Biology

Temple University's iEcoLab (https://www.iecolab.org/) has several projects on understanding global patterns of biodiversity and how humans are causing extinctions through pollution, deforestation and climate change. Projects include species traits, ecology, data science, computer coding, machine learning. Students will work within a dynamic group of undergraduates, graduate students and postdocs focusing on biodiversity and its conservation for future generations.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Biology, CIS, ES, Physics, Math, Engineering, GUS
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: We have projects available for a range of skill sets. We have projects that are focused on ecology and projects that are focused on computer coding.

Evolution and the Human Genome

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CST
Biology

Student's will work on questions about human evolutionary history using data from the human genome, as well as data from great ape and archaic humans (e.g. Neanderthal).

Location: Main; Virtual or computational research
Student Majors Accepted: All majors
Class Preferences: Freshmen, Sophomores & Juniors
Important Selection Criteria: Some knowledge of genetics and of evolution. Some coding experience.

Evolutionary Genomics

Jody Hey
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CST
Biology

Students will work with the genomes of multiple species to address questions about natural selection and adaptation.

Location: Main; Virtual or computational research
Student Majors Accepted: All majors
Class Preferences: Freshmen, Sophomores & Juniors
Important Selection Criteria: Some knowledge of genetics and of evolution. Some coding experience.

Population Genetics

Jody Hey
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CST
Biology

Students will help develop mathematical and statistical models of evolutionary processes and apply them to population genomic data sets.

Location: Main; Virtual or computational research
Student Majors Accepted: All majors
Class Preferences: Freshmen, Sophomores & Juniors
Important Selection Criteria: Some knowledge of genetics and of evolution. Some coding experience.

Visualizing Superconducting Qubits De-coherence Sources down to Atomic Scale

Maria Iavarone
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CST
Physics

The scanning tunneling microscope enables spatially resolved mapping of the electron density of states with unprecedented atomic resolution. Those states are relevant for a number of fundamental phenomena observed in condensed matter, from the simple electron conduction to more complex behavior such as superconductivity. In this project we use low temperature scanning tunneling microscopy and spectroscopy to study materials used for superconducting qubits with the goal to understand and mitigate the sources of de-coherence. Undergraduate students will be involved in measurements and data analysis.

Location: Main; In-person essential
Student Majors Accepted: Physics
Class Preferences: Sophomores & Juniors
Important Selection Criteria: Interest in research- Â- Work ethic and attention to details- Â- Highly motivated to learn.

Development of Igor Pro Based Data Analysis Program for large data set of Scanning Tunneling Microscopy and Spectroscopy

Maria Iavarone
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CST
Physics

The scanning tunneling microscope (STM) enables spatially resolved mapping of the electron density of states with unprecedented atomic resolution. Those states are relevant for a number of macroscopic properties of materials. Data acquisition of topographic and spectroscopic data leads to large, detailed data set. While data analysis techniques exist for many of the measurement performed there is a need of developing a custom user friendly program that includes the different types of data analysis usually performed in our group. Several programs have been developed in our lab over the years in Mathlab. Igor Pro offer the user many different tools for data visualization and analysis. In this project the student will adapt and combine different custom programs in Mathlab in one Igor Pro based program to analyze STM data.

Location: Main; Virtual or computational research
Student Majors Accepted: CIS, Math, Physics
Class Preferences: Sophomores & Juniors
Important Selection Criteria: Strong programming skills, interest or experience in image processing, data science.

The neurogenomics of incipient speciation in Drosophila

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CST
Biology

Behavioral isolation is thought to be among the first stages in forming new species. Among known populations of Drosophila melanogaster, female fruit flies from Zimbabwe display a unique preference to mate with males of their own population and discriminate against foreigners, including those from neighboring Zambia and global populations such as those from North Carolina. This Zimbabwean population presents one of the few naturally occurring examples of incipient speciation, presenting an excellent model to study behavioral isolation at its earliest stage. By combining high-throughput genomics and available phenomics data from the lab, we hope to gain a detailed understanding of both the neurogenes and evolutionary processes involved in population divergence and early species formation. The student will be expected to develop and build behavioral assays in the laboratory with fruit flies.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Biology, CIS, Physics, Mathematics
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: We will be generating large amounts of digital data. Some coding will be required.

Personalized medicine and evolutionary link between DNA and disease

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CST
Biology

We all have many DNA differences from others. Which of these personal differences cause disease? We use computers to study disease variation in humans and compare it to differences humans show with other species. We also build predictive methods and tools.

Location: Main; Virtual or computational research
Student Majors Accepted: All Majors
Class Preferences: Freshmen & Sophomores
Important Selection Criteria: Interest in the field and interest in discovering patterns and solving problems.

Software development and Bioinformatics

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CST
Biology

We develop software (including smartphone apps) for analyzing biological data in the fields of Genomics, Evolution, and Medicine.

Location: Main; Virtual or computational research
Student Majors Accepted: All Majors
Class Preferences: Freshmen, Sophomores & Juniors
Important Selection Criteria: Knowledge of computer programming and/or app development.

Deep Neural Networks and Their Applications in Computer Vision

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Computer and Information Sciences

One of the most innovative and transformative technologies of our time is deep learning, a form of machine learning that uses neural networks containing many hidden layers, which are called deep neural networks (DNNs). Recent success has led to breakthroughs in applications in particular in computer vision. In this project, we will focus in applying DNNs to various computer vision tasks.

Location: Main; Virtual or computational research
Student Majors Accepted: Computer Science, Math, Chemistry, Biology
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Linear Algebra; Programming skills in Python; Knowledge of PyTorch and Matlab are a big plus.

Comparative Genomics to Characterize Lineage-Specific Biology

David Liberles
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CST
Biology

Computational pipelines to analyze genomic data from different species towards an understanding of the changes in gene content that correspond to changes in organismal phenotype will be generated and run. Species groups we are currently analyzing include spiders, fish, and plants.

Location: Main; Virtual or computational research
Student Majors Accepted: Biology, Chemistry, Physics, Mathematics, Computer Science
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Students with experience in programming, strength in mathematics, and an understanding of and interest in phylogenetics and evolutionary biology are desired.

Detector Simulations with Grown-Up Software

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Physics

Capble students can do important work in support of the HUNTER sterile neutrino experiment. after being taught to use standard physics analysis and simulation packages (ROOT, GEANT, SIMION, COMSOL). See project website at https://www.cst.temple.edu/phys/hunter/. Students must have experience writing computer programs in a language like BASIC, python, c, c++, etc. Travel to the experiment site in Los Angeles after May 15 is also a possibility. Other opportunities exist for in-person lab work on digital pulse processing with Arduino nanocomputers and low level counting work with the High Purity Germanium gamma ray detector located in SERC basement.

Location: Main; Virtual or computational research
Student Majors Accepted: All Majors
Class Preferences: Sophomores & Juniors
Important Selection Criteria: Must be interested in nuclear/particle physics and technology. Must have at least some coding experience in a procedural computer language. Must be able to make a definite time commitment of minimum 5 hours per week.

Modeling photophysical and photochemical properties of molecules

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CST
Chemistry

Computational chemistry is applied to study the fate of molecules after absorption of light. Theoretical methods based on both quantum mechanics and classical mechanics are used to model the excited states of molecules and their reactivity, leading to our understanding of photophysics and photochemistry of chemical and biologically relevant systems. We focus on a variety of applications: (i) photostability of DNA subject to radiation, (ii) development of fluorescent probes used in biomolecular detection; (iii) absorption and fluorescent spectra of organic chromophores; (iv) formation and stability of prebiotic molecules; (v) modeling and interpreting pump probe spectroscopies of gas phase molecules. Motivated undergraduate students can make contributions to any of these topics.

Location: Main; Virtual or computational research
Student Majors Accepted: Chemistry, Biochemistry, Physics, CIS
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Interest in physical chemistry, math, computational science

Unraveling the mechanisms of neuronal plasticity

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CST
Biology

Students will use molecular biology and genetic approaches to investigate how different molecules regulate the excitability of individual neurons. Techniques in the lab will include PCR, subcloning, tissue culture, immunolabeling, and confocal imaging.

Location: Main; In-person essential
Student Majors Accepted: Neuroscience, Biology, Biochemistry
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: A basic understanding of molecular biology and genetics is encouraged. A desire to learn new techniques and think critically as well as attention to detail. Work with mouse models, so should be willing and able to work with animals.

Secure Over-The-Air Software Updates in the Internet of Things

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Computer and Information Sciences

Driven by the rapid escalation of its utilization, as well as ramping commercialization, Internet of Things(IoT) devices increasingly face security threats. Apart from denial of service, privacy, and safety concerns, compromised devices can be used as enablers for committing a variety of crimes and e-crimes. One of the major mitigation plans to defend against these malicious activities, securing IoT devices involves software update or patching. But the resource constrained nature if IoT makes quick, efficient software updates very hard. IoT devices do not have enough memory, bandwidth and computational power to securely receive software updates from verified directory. We want to design a secure, efficient, applicable software update mechanism suitable for heterogeneous IoT devices. Moreover, our plan to create a proof of concept IoT testbed. In the testbed we want to emulate real life scenarios to test our proposed design by deploying different network attacks.

Location: Main; Virtual or computational research
Student Majors Accepted: Computer Science, Information Science and Technology, Math, Physics, EES
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: basic programming skills in C++ or Python needed

A Course Design, Materials and Analysis (CDMA) Observatory To Study Engagement and Alignment for CS Education

Jamie Payton
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Computer and Information Sciences

Computer Science instructors frequently face the need to refine courses and degree programs to address emerging topics; and in making such course decisions, they often rely on recommendations from colleagues, or simply draw from their own experiences. Many lack awareness of international curriculum guidelines, nor do they possess the training in pedagogy or exposure to evidence-based strategies for increasing engagement and improved learning outcomes A desired transformation is a change in the mindset of instructors to think of course design in a more holistic sense by using a data driven approach, rather than as a self-contained, linear sequence of topics. Our goal is to encourage instructors to create, share, assess, and use computing education materials that are engaging and incorporate modern pedagogies, and aligned with community-defined standards.
Students will help to design and create a National Course Design, Materials, and Analysis (CDMA) Observatory. The CDMA observatory will let CS educators explore course designs, materials and assessment through sharing, vetting, searching and analyses. The observatory will contain learning materials mapped to international curriculum guidelines. In this three year project, we will focus on introductory CS courses (i.e., freshmen, sophomore level CS). The observatory will include tools for contribution, search, comparison, and analysis capabilities across multiple dimensions.

Location: Main; Virtual or computational research
Student Majors Accepted: Computer Science, Information Science & Technology, Education
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: students need either a) basic programming skills in Java, C++, or Python or b) coursework from the College of Education

Computer Science Education Research

Jamie Payton
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CST
Computer and Information Sciences

In this project, you will assist with conducting research in the field of K-12 computer science education. This includes but is not limited to conducting a review of the literature, contributing to research papers for publication, conducting a quantitative analysis on survey data, etc.

Location: Main; Virtual or computational research
Student Majors Accepted: Computer Science, Data Analytics
Class Preferences: Juniors & Seniors
Important Selection Criteria: N/A

Developing Secure Service-Oriented Protocols for the Internet of Things

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Computer and Information Sciences

The wide-scale use of the Internet of Things (IoT) is propelling a paradigm shift in next-generation computing and communication technologies, particularly with respect to human-machine interaction. New applications of wearables and sensors, home assistant systems, and smart appliances are increasingly connecting more IoT devices to the Internet. That leads to many exciting applications of IoT in financial services, infrastructure management, manufacturing industry, military domains, healthcare services , consumer applications, transportation systems and agriculture. UPnP is a very popular protocol that enables seamless communication between IoT devices. A huge number of devices use UPnP for the lack of protocols that maintain interoperability, language independence, and decentralization in service oriented pervasive networks. For example, in the last 2 years, 1500 companies manufactured 6900 different types of networking-enabled products owing to 81 millionIP addresses responding to UPnP discovery requests.

However, UPnP lacks security measures. The basic UPnPprotocol does not include any access control or data integrity mechanisms. The adversaries take advantage of this shortcoming and launch devastating Distributed Denial of Services(DDoS) attacks in recent days such as Mirai. Even this year a vulnerability named "CallStranger" is published which indicates millions of affected IoT devices. Using "CallStranger'' vulnerability an attacker can bypass network security which leads to information leaks, DDoS and many other attacks. We want to investigate the security measures of UPnP protocol to find out the vulnerabilities. Consequently, we want to develop security schemes that can mitigate the vulnerabilities of UPnP and protect the IoT devices from adversarial activities.

Location: Main; Virtual or computational research
Student Majors Accepted: Computer Science, Information Science, Data Science, Physics, EES
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: basic programming skills in C/C++ and Python

Understanding antibiotic resistance: Computational study of biofilm architectures

Gillian Queisser
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CST
Mathematics

Antibiotic resistance is one of the most relevant research topics in the health research sector. In this project biofilms, which are ubiquitous in the human body, will be studied computationally to understand the impact of the structural organization of biofilms on potential antibiotic resistance. This is a joint project with Dr. Buttaro (Department of Microbiology and Immunology, Temple University) who will provide microscopy data. This data will be used to develop computational workflows for spatio-temporal analysis. The proposed research lays the ground work for simulation-based studies of antibiotic flow through heterogeneous biofilms in order to quantify potential antibiotic resistance.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Math, CIS
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Java programming skills are a clear asset.

Virtual Reality-based Computation of Signaling in Neurons

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CST
Mathematics

Neuroscience has become a highly interdisciplinary research area. Combining expertise in mathematics, physics, computer science, and biology the function of brain cells can be studied in a highly systematic way. In this project Virtual Reality (VR) is integrated into a computational workflow that allows scientists from all areas to study the spatio-temporal activity of neurons and interact with and drive simulations in real time in VR. Undergraduate researchers will be part of an active team that develops visualization and interaction tools for VR using Unity3D. Another component of the project is the development and implementation of mathematical and computational methods. This allows researchers to identify their personal research interests within the project and take control of their subprojects.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: All Majors
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Familiarity with programing languages (e.g. C#, C++, Java, ...) and/or Unity3D is a clear asset.

Opportunities for co-location of solar energy (PV) with agriculture for cost reductions and carbon, water, and energy footprint mitigation

Sujith Ravi
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CST
Earth & Environmental Science

Solar energy installations are rapidly increasing, due to technological advances and policy support. Even though solar energy provides several benefits such as reduction of greenhouse gases, reclamation of degraded land, and improving the quality of life in developing countries, the deployment of large-scale renewable energy infrastructure may negatively impact land and water resources. A major challenge for the future is how to meet the ever-expanding energy demand with limited land and water resources, in the context of increasing demand for alternative uses such as agricultural and domestic consumption. This project will explore opportunities to co-locate solar infrastructures and agricultural crops to maximize the efficiency of land and water use. The undergraduate student will involve in data collection, data management, and visualization. Other duties may be assigned.

Location: Main; In-person essential
Student Majors Accepted: Environmental Science, Geology
Class Preferences: Sophomores & Juniors
Important Selection Criteria: Experience in data analysis and data visualization (in R or Python) or interest in learning these skills.

Impacts of biochar application on soil hydrologic properties

Sujith Ravi
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CST
Earth & Environmental Science

Novel carbon sequestration strategies such as large-scale biochar application may provide sustainable pathways to increase the terrestrial storage of carbon in agricultural areas along with increasing crop production. Biochar has a long residence time in the soil and hence the environmental impacts of biochar addition needs to be investigated to identify the tradeoffs and synergies. This project will investigate the impacts of biochar application on soil hydrologic properties. The undergraduate student will assist in laboratory activities including soil sample preparation, measuring soil hydrologic properties, data management and visualization. Other duties may be assigned.

Location: Main; In-person essential
Student Majors Accepted: Environmental Science, Geology, Biology
Class Preferences: Sophomores & Juniors
Important Selection Criteria: Undergraduate course in Hydrology/soil science, interest in laboratory experiments.

Computing two-dimensional materials and their interaction with light

Adrienn Ruzsinszky
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CST
Physics

Two-dimensional materials have received tremendous interest in industrial applications as optical devices. These materials have largely different electronic and optical behavior compared to their bulk correspondents. To apply the state-of-the-art electronic structure methods for crystals with periodic boundary conditions, we need to remove the spurious long-range component of the Coulomb interaction that arises from repeating the supercells for the periodicity condition. To achieve this goal, there are various truncation schemes available. The project will involve an undergraduate researcher who will work with other group members in implementation and computation. Good computational skills and some background in fortran/python programming languages is required.

Location: Main; In-person essential
Student Majors Accepted: Physics, Computational Science
Class Preferences: Juniors & Seniors
Important Selection Criteria: determination, responsibility

Understanding the Impact of Vehicle Automation on Traffic Flow

Benjamin Seibold
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CST
Mathematics

The broader goal of this research is a better understanding the impact of vehicle automation on traffic flow and its impacts on health and safety. This specific project focuses on developing mathematical models, simulations, and small-scale virtual experimentation that can provide new insights into heterogeneous traffic flow in which a few vehicles are automated and the rest are human-driven. Two particularly important research directions are: (a) the development of better models for traffic waves, smart vehicle controllers that smooth traffic waves, and models that quality the energy impact and accident risk; and (b) the incorporation of models for traffic waves into 3D virtual reality simulators that can then be used for studies on human reactions to automated vehicles. No specific course or technical background is required; but the projects require a keen interest in mathematical models, simulations, data, programming, and hardware (all or some of the above). Students will work virtually or in the Center for Computational Mathematics and Modeling.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Mathematics, Computer Science, Physics
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Experience in numerical methods, data processing, and/or programming (particularly Unity) is very welcome.

Bat susceptibility to white-nose syndrome

Brent Sewall
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CST
Biology

White-nose syndrome is an emerging infectious disease of hibernating bats caused by an invasive fungal pathogen. Since its first detection in 2006, it has caused extensive mortality of bats during hibernation, and has spread across much of North America. In this project, we will seek to improve understanding of factors influencing both the impacts and spread of the disease, and means to conserve bat populations in light of this ongoing threat.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Biology, Environmental Science, Mathematics
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Coursework, training, or experience in ecology, conservation biology, animal behavior, statistics, Geographic Information Systems (GIS), epidemiology, or public health, and a strong motivation for research and interest in the topic

Spotted lanternfly studies at the Temple Ambler Field Station

Brent Sewall
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CST
Biology

The spotted lanternfly is an invasive insect that poses an emerging threat to native forest ecosystems. In this project, the student will work as part of a team, using field surveys, standardized field experiments, and laboratory work to understand the ecology of spotted lanternflies and the effects they have on tree species. Research will occur at the Temple Ambler Field Station during summer, and at both Temple Ambler Field Station and Main Campus during fall. The Field Station is located on the Temple Ambler Campus. Transportation from Main Campus to the Field Station is provided via the inter-campus bus during the academic year. Students who work at the Field Station during the summer will need a personal vehicle or other means of transportation. This project will continue during summer and fall, and while we will consider all applicants, we encourage applicants who are interested in joining the team for both summer and fall.

Location: Ambler; In-person essential
Student Majors Accepted: All majors
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Background (coursework/experience) in ecology or related field is recommended, but not required

Machine Learning Optimized Molecular Energy Surfaces

Jonathan Smith
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CST
Chemistry

Accurate molecular properties can now be computed using quantum mechanical computations for moderate sized molecular systems. In the case of reactive systems of astrophysical and atmospheric significance and their spectroscopy, molecular dynamics can extend these studies but requires many computationally expensive steps. These steps can be sped up by >10,000 fold by trained machine learning molecular potential energy surface models.

Location: Main; Virtual or computational research
Student Majors Accepted: Chemistry
Class Preferences: Juniors & Seniors
Important Selection Criteria: An aptitude in coding (or interest in learning) to automate and analyze computations.

Machine Learning Optimized Molecular Energy Surfaces

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Location: Main; Virtual or computational research
Student Majors Accepted: Chemistry
Class Preferences: Juniors & Seniors
Important Selection Criteria: An aptitude in coding (or interest in learning) to automate and analyze computations.

The Suppression of Bitter Taste

Gregory Smutzer
smutzerg@temple.edu
CST
Biology

Bitter taste is aversive to humans, and many oral medications exhibit a bitter taste. Bitter taste can be suppressed by the use of inhibitors, or by masking agents such as sucralose or sucrose. Another approach is to encapsulate bitter tasting compounds in lipid microspheres or in lipid matrices. In both cases, the release of a taste stimulus from lipids is delayed as these lipid supports erode in the oral cavity. Bitter taste suppression can be achieved by encapsulating bitter taste stimuli in lipids, and then placing these encapsulated stimuli in rapidly dissolving edible films that contain a variety of bitter taste masking agents. In this approach, masking agents are immediately released as films become hydrated by saliva, but before the erosion of encapsulated stimuli. This delivery method also minimizes choking hazards in both the young and the elderly. This novel approach is useful for increasing the palatability of oral medications, for delivering micronutrients to the oral cavity, and for enhancing the flavor of food.

Location: Main; In-person essential
Student Majors Accepted: Biology, Neuroscience, Biochemistry, Chemistry
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Willingness to be engaged in research, and ability to think critically.

Scene Analysis for Large Image Collections

Richard Souvenir
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CST
Computer and Information Sciences

The student will apply and adapt recent techniques from computer vision and machine learning to identify attributes from images of indoor scenes. This work is part of an ongoing project to (http://traffickcam.org/about) to combat human trafficking by identifying hotel room features from images.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Computer Science
Class Preferences: Sophomores & Juniors
Important Selection Criteria: Strong programming skills (preferably Python), interest or experience in image processing, data science, or machine learning.

Demography of a native wildflower population

Rachel Spigler
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CST
Biology

What causes population decline? We are conducting a series of studies in natural populations outside Philadelphia to answer this question for a native wildflower. Addressing this question requires following plants from seed to adults in the wild. The work involves censusing seedlings and adult plants in the field Jun-Aug. We are also conducting complementary experiments in the Plant Growth Facility on main campus.

Location: Main; In-person essential
Student Majors Accepted: Biology or EES
Class Preferences: Freshmen, Sophomores & Juniors
Important Selection Criteria: Enthusiasm! Attention to detail. Ability to work outside for long hours in hot weather.

Urban stormwater monitoring

Laura Toran
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CST
Earth & Environmental Science

We know urbanization increases stormwater runoff as we pave our cities. We further amplify stormwater runoff through human-induced climate change. My research team uses monitoring equipment to collect large data sets with unprecedented temporal and spatial resolution. Students are needed to maintain field equipment and analyze data; also expected to assist graduate students in collecting data. The work is storm dependent and is only expected to be half time.

Location: Main; In-person essential
Student Majors Accepted: Geology, Environmental Science
Class Preferences: Juniors & Seniors
Important Selection Criteria: Strong preference for students who have taken Groundwater Hydrology or Physical Hydrology. Need to enjoy using computers for data analysis. If COVID restrictions are in place, must provide your own transportation to field sites.

Bioinorganic Titanium Chemistry

Ann Valentine
tue39358@temple.edu
CST
Chemistry

The Valentine Lab is interested in hydrolysis-prone metal ions of biological relevance. The student will investigate possible ligand systems for stabilization of titanium(IV) in a water environment, will make and characterize new inorganic coordination compounds, and will evaluate their interactions with biomolecules.

Location: Main; In-person essential
Student Majors Accepted: Chemistry, Biochemistry
Class Preferences: Sophomores or Juniors
Important Selection Criteria: intelligence enthusiasm conscientiousness - will teach skills necessary

Molecular simulation of SARS-CoV-2 main protease dynamics

Vincent Voelz
voelz@temple.edu
CST
Chemistry

The Voelz lab uses large-scale molecular simulations to study the dynamics and function of biomolecules. The student will use scientific computing to help analyze a large dataset of simulation trajectories of the SARS-CoV-2 main protease complexed with potential inhibitors.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Chemistry, CS, Physics, Biology, Math
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Experience or enthusiasm for: coding in Python, high-performance computing, biomolecular structure and function.

Creating intelligent software systems

Slobodan Vucetic
vucetic@temple.edu
CST
Computer and Information Sciences

Depending on a student background and interests, the research can include activities ranging from software development, data collection and processing, data science, building and evaluating artificial intelligence tools, and design of human-computer interfaces. Students could work on one of several ongoing projects in the lab that aim to make a difference through applying intelligent software systems in real-world scenarios.

Location: Main; Virtual or computational research
Student Majors Accepted: Computer science, Data Science, IST, Sciences
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Curiosity, persistence, attention to detail, resourcefulness, willingness to learn. Good written and oral communication skills. Critical thinking. Strong programming background and/or strong mathematical and quantitative skills and/or familiarity with data science and machine learning.

Relational Policies: Towards a Strong Representation System for Managing Network Polices

Anduo Wang
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CST
Computer and Information Sciences

The goal of this proposal is to develop a strong representation system for network policies, as a means to facilitate network operators in defining, manipulating, and analyzing policies, \textit{precisely}. Our work will place policy management on a strong intellectual foundation, solving pressing network problems and opening the door to new applications. To accomplish this, we will advance the knowledge representation system originated in the theoretical database community: Rather than burying policies in the distributed protocol states or arbitrary SDN controller programs, we make policies first class citizen --- explicit data objects that can be accessed and manipulated via the SQL-like interface, leading to a policy management system for non-programmers, for people with little computer specialties.

Location: Main; Virtual or computational research
Student Majors Accepted: Computer Science, Mathematics
Class Preferences: Juniors & Seniors
Important Selection Criteria: Computer programming, interaction with Relational Databases

Artificial General Intelligence

Pei Wang
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CST
Computer and Information Sciences

NARS is a model of Artificial General Intelligence (AGI) developed in the framework of a reasoning system. The model has been implemented into computer systems, and is under testing in various domains. Undergraduate students can join our existing projects, as well as explore novel ways to test the system.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Computer and Information Sciences, Mathematics
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Strong interest in science, especially in human and machine intelligence and cognition; solid background in discrete mathematics and computer science; basic programming skills.

Development of Novel Hypervalent Iodine Halogenating Agents

Sarah Wengryniuk
Sarahw@temple.edu
CST
Chemistry

Students will work in a team format to design and synthesize a library of Novel halogen transfer reagents capable of incorporating bromine, chlorine or fluorine into organic molecules. The groups both serve both as versatile functional handles and to modulate the activity of bioactive small molecules. The targeted "PyIX" family of reagents are bench stable with versatile reactivity. Studies on the full scope of their reactivity will also be included.

Location: Main; In-person essential
Student Majors Accepted: Chemistry
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Should have taken orgo I, but not absolutely required

WiFi and mobile phone app

Jie Wu
jiewu@temple.edu
CST
Computer and Information Sciences

We focus on building a robust and accurate WiFi sensing platform for various applications, such as activity recognition and indoor localization. This project seeks to largely reduce the training cost of current WiFi sensing system with the help of transfer learning techniques. Specifically, we will study what is the minimal number of training instances needed to ensure good performance for a new environment. In addition, we will investigate what domain knowledge in exiting environment can be transferred to new environments.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: CIS, ECE
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Strong programming skills (perferred C and Matlab) and signal processing experience

Online Job Scheduling with Machine Learning Techniques

Jie Wu
jiewu@temple.edu
CST
Computer and Information Sciences

This project aims to develop an online job scheduler for cloud/edge computing clusters using machine learning or reinforcement learning techniques. Online job scheduler is used to determine the priority and the amount of resource allocated to each job in computing clusters, which is an important but challenging problem. An efficient scheduler could significantly reduce the average job finish time. In the project, we would like to apply machine learning or reinforcement learning techniques to solve the scheduling problem.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: CIS/IST, Math
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Programming experience in Python or Matlab; Basic knowledge of machine learning

Network Forensic

Jie Wu
jiewu@temple.edu
CST
Computer and Information Sciences

In the research project, we will investigate different programs and their compatibility for the arm-based processors. We will research network packet traceability issues using lightweight programs that may be portable to arm-based processors. This project is a great opportunity for an undergraduate student to learn more about current security trends and work with real devices. This project is funded by the Office of Naval Research and in partnership with TDI Technologies. So, the undergraduate student will get experience in industry-based research.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: CIS/IST, Math
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Basic IP/Network knowledge, linux shell/terminal, Programming languages (C/C++/JAVA/Python)

Datacenter and SDN

Jie Wu
jiewu@temple.edu
CST
Computer and Information Sciences

This research focuses on efficiently and innovatively leveraging SDN technology in a large-scale datacenter network. SDN is essentially a way of making a network programmable by decoupling control from the underlying hardware and assigning it instead to a software-based controller. With SDN, updating a policy or optimizing for resource allocation in a datacenter is a matter of programming the software, rather than buying a new appliance or wrangling with a proprietary physical interface. This project can have multiple interesting topics of SDN in datacenters, including traffic engineering, network updates, and resource allocation. Our computing cluster has already installed a testbed of a datacenter network, which is able to practically evaluate a lot of novel research in the rising field of datacenter and SDN.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: CIS
Class Preferences: Juniors & Seniors
Important Selection Criteria: Self-motivated; hard-working; Experienced in python; Basic knowledge of networking and algorithms is preferred but not required.

Blockchain and its applications

Jie Wu
jiewu@temple.edu
CST
Computer and Information Sciences

Blockchain technology has been widely adopted, ranging from cryptocurrency, financial services, Internet of Things (IoT) to public and social services, while still at an early stage of its development. Thus, lots of design details of this technology need be perfected. In this project, students may consider to modify existing consensus protocols to improve Blockchain transaction throughput or propose new transmission policy to decrease information propagation delay in Blockchain networks, both of which would improve the liveness of Blockchain.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: CS or Math
Class Preferences: Juniors & Seniors
Important Selection Criteria: Solid math background

Machine learning for solid-state materials

Qimin Yan
qiminyan@temple.edu
CST
Physics

The student will be involved in the development of novel machine learning frameworks that incorporate physical principles (such as symmetries) and beyond-atom material information (such as atomic orbitals) to achieve supreme performance. The machine learning models will be tested for solid-state inorganic crystals to make reliable and efficient predictions of material properties for materials discovery and design.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: CS, Physics, Chemistry
Class Preferences: Juniors & Seniors
Important Selection Criteria: Experience in Python and knowledge in machine learning.

Defects for quantum computing

Qimin Yan
qiminyan@temple.edu
CST
Physics

The student will be involved in the development of theoretical approaches to achieve a deeper understanding of the collective behavior of defects in two-dimensional materials as qubits for quantum computing.

Location: Main; Virtual to start, but could shift to in-person if the University approves
Student Majors Accepted: Physics, Chemistry
Class Preferences: Juniors & Seniors
Important Selection Criteria: Python, solid-state physics, or inorganic chemistry.