Undergraduate Apprenticeships Opportunities

Arizona

Arizona State University (Tempe):

Subject area: Material Science

Project 1: Thermomechanical testing in different environments. The apprentice will conduct quasi-static tests at different temperatures, load levels, and length scales to understand damage evolution and material degradation. The apprentice will use a load frame with a high-temperature environmental chamber to characterize the ceramic matrix composite (CMC) thermomechanical response. Further, the apprentice will use a micro load frame, located inside an environmental SEM (ESEM), to capture real-time changes in the D - 3 material at the microscale. The information will be used to validate the damage evolution laws that are used in the high-fidelity multiphysics model.

Project 2: Experimental micrograph generation of CMC microstructures. The apprentice will learn how to prepare for and use a range of microscopy techniques, including confocal laser microscopy (CLM), and environmental scanning electron microscopy (ESEM), and take images of as-received specimens and those oxidized to different levels. Results from the characterization studies will be used in the systematic investigation of microstructural and architectural features, pre-existing flaws, and associated variability.

Project 3: The apprentice will do thermogravimetric analysis (TGA) tests on ceramic matrix composite(CMC) specimens to investigate temporal mass evolution due to oxidation over a broad range of temperatures. The test data will help identify the critical mechanisms responsible for oxidative degradation at intermediate “pesting” temperatures and oxidative crack sealing at high temperatures.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

California

California Institute of Technology (Pasadena)

Subject area: Material Science

Project 1: The apprentice research will focus on designing irregular materials inspired by the peel of citrus fruits. The apprentices will be invited to study slices of the citrus fruit peel to characterize their microscopic structure. After studying and understanding the material structure of the peel, the apprentice will create computational tools to design synthetic materials that mimic the structural properties of natural fruits. The apprentices will analyze the network-like cellular architectures of the

natural materials and study their response to fracture. After identifying the structural motifs protecting the fruit, the apprentices will reproduce the same motifs in 3D printable models that will be tested under quasistatic compression and tension. To test the energy absorption of the materials, the students will conduct dynamic testing by using a drop tower. During these tests, they will also use a digital camera to gather images of the fracture process and will use digital image correlation techniques and image processing packages to analyze the deformation of the samples.

Project 2: The apprentice research will focus on the study of irregular metamaterials consisting of interlocking hierarchical structures formed by periodically linking prime knots (as in an arrangement of linked granular elements, or chainmail). Such structures exhibit different properties based on the direction and magnitude of forces applied because of the dynamic rearrangement of the linked elements (in this case, knots). The apprentices will test the relation of mechanical properties to the knot geometry and will characterize and quantify the role of disorder in these systems that lead to optimal energy absorption performance.

Project 3: The apprentice research will aim at modeling and characterizing the role of interfaces on strength, energy dissipation, and damping in disordered interpenetrating two-phase metamaterials. One phase will consist of a continuous shell with programmed degrees of long-range order, with the other phase filling the remaining sample volume. The apprentice will design and additively manufacture (in polymer and/or metal) samples with different degrees of disorder, tuned via the shell topology, and interfacial strength, tuned by accurately controlling the offset of the two phases during the printing process (in the case of metal printing, the phases can be compositionally identical but can be printed to develop different microstructures). The apprentice will also characterize the samples via quasi-static compression and dynamic mechanical analysis, to measure strength, energy absorption, and damping. The overarching goal will be to quantify the optimal degree of topological disorder and interfacial strength on the most desirable compromises among these mechanical properties.

Site open: **Dec 4, 2023**
Site close: **Feb 29, 2024**

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Undergraduate Apprenticeships Opportunities

University of California (Los Angeles)

Subject area: Electrical Engineering

Apprentices will engage in the design, fabrication, and characterization of the test structures. Throughout the summer, apprentices will be doing the following research: the fabrication of each generation, the devices will be characterized and necessary modifications (e.g. surface treatment, post-dielectric deposition annealing, etc) will be applied to improve the performance of the next generation of devices.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

University of California Santa Barbara

Subject area: Physics

Project 1: Flexible optical potentials for quantum simulation. The precision and control that can be obtained in experiments on degenerate quantum gasses have advanced to the point where cold atoms can be used to study many-body quantum phenomena relevant to other systems, most notably condensed matter. This field, often called “quantum simulation,” is especially well-suited to undergraduate involvement both because of the field’s fundamentally interdisciplinary nature and because the diverse experimental techniques lend themselves to modularity. The Weld group’s research in this field and in the area of quantum dynamics is based on three main experimental platforms: two large Bose condensate experiments based around lithium and strontium, and an optical-tweezer experiment using ultracold potassium. The undergraduate apprentice on this project will work with one or more of these degenerate quantum gas experiments. The apprentices' contributions will focus on the generation and control of optical potentials to enable new forms of dynamical quantum simulation. Specific project details will depend on the intern’s interests and background. The optical, electronic, and software infrastructure that the intern will create will enable the generation and optimization of shaped optical potentials for use in experiments exploring the response of quantum systems to nonadiabatic variations of the potential.

Project 2: Nanofabrication of anyon interferometers. Quasiparticles arising from specific even-denominator fractional quantum Hall states are proposed to exhibit non-Abelian statistics and have the potential to be utilized as robust topological qubits, capable of performing protected quantum gate operations through braiding. This project aims to investigate graphene-based quantum Hall mesoscopic devices, including Fabry-P´erot interferometers, single electron transistors, quantum dots, and quantum Hall charge pump devices, with the overarching objective of probing and manipulating non-Abelian anyons within fractional quantum Hall states. However, integrating various nano-scale mesoscopic structures into all-Van-der-Waals heterostructures that probe both bulk and edge of these quantum Hall states without introducing additional disorder presents an experimental

challenge, necessitating precise and ultra-clean fabrication techniques. The involvement of the undergraduate researcher focuses on exfoliating the appropriate material and assembling the all-van der Waals stacks with the dry-transfer technique. During the stack assembly, the undergraduate researcher will also perform gate-defining lithography through anodic oxidation, by an atomic force microscope, which allows nano-scale structures to be pre-patterned and integrated into the device in a minimally invasive fashion, reducing the amount of disorder introduced to the system.

Project 3: Rotation-controlled transition metal chalcogenide heterostructures. Twisted homobilayers of the transition metal dichalcogenides (TMDs) MoTe2 and WSe2 have been proposed to host integer and fractional quantum anomalous hall states of matter. Transport measurements of a well-designed Van derWaals heterostructure containing the aforementioned materials could demonstrate sharp and clear quantum hall physics that potentially includes fractional excitations such as non-Abelian anyons even at zero magnetic fields, opening the door to further probing of these phases using quantum mesoscopic devices. Making contact with and defining a conducting region with ultra-clean edges and low twist angle disorder presents an experimental challenge along with the encapsulation of air-sensitive TMDs in an effective manner. The involvement of the undergraduate apprentice focuses on exfoliating materials (graphite, hexagonal boron nitride, and the TMD) as well as designing and assembling the Van derWaals heterostructure using the dry-transfer technique. Fine alignment of layers into a usable stacking geometry as well as gate definition using lithography via Atomic Force Microscopy constitute the design process where feedback with a personal mentor as well as independent problem-solving and innovation are key components of the undergraduate's success.

Project 4: Optimizing photoconductive switches for on-chip THz spectroscopy On-chip spectroscopy in the Terahertz domain is useful for the measurement of quantum phenomena in 2D materials. Terahertz spectroscopy's specific energy and time scale allow for experiments measuring superconductivity, strongly correlated phenomena and non-equilibrium dynamics in quantum materials. The addition of a specially designed chip allows these same measurements to be performed below the Rayleigh diffraction limit, particularly helpful for studying Van derWaals heterostructures and 2D materials such as graphene in ultra-cold environments. In this project, the difficulty lies in creating high-quality chips for the measurement of samples. The involvement of the undergraduate apprentice focuses on, but is not limited to the construction of complex optical arrays to generate and measure on-chip terahertz waves, dealing with analog and digital electronics for automated measurements and fabrication of custom parts necessary for measurements. By experimenting with different chip geometries and photo-conductive switches, the undergraduate researcher helps optimize the capabilities of on-chip spectroscopy.

Project 5: Precise monitoring and control of Feshbach fields. Tunable interatomic interactions are a key tool for quantum simulation experiments with ultracold atoms. Magnetically tuned resonances

between bound and unbound two-atom states offer the most straightforward way to control interactions, and our group commonly uses such ”Feshbach tuning” to create strong variable interactions or eliminate them. Currently, we are pushing up against the limits of our magnetic field control hardware: noise in the control electronics and power supplies is limiting the precision with which we can achieve the desired interaction strength. In the case of non-interacting samples such noise can even create attractive interactions which destroy the atomic sample in a so-called “Bose-nova.” The undergraduate apprentice on this project will design, develop, and deploy a system for monitoring and precisely controlling the magnetic fields applied to ultracold lithium atoms in our lab, to reach a hundredfold increase in precision.

Site open: Dec 4, 2023
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U.S. Army Combat Capabilities Development Command Army Research Laboratory - ARL West (Playa Vista, CA)

ARL regional sites create strong, enduring S&T partnerships–working together to solve the Army’s current and future challenges. ARL regional sites leverage regional expertise and facilities to accelerate the operationalizing of science for transformational overmatch.

Technical Focus Areas: Human Information Interaction, Contextual Analytics, Hybrid Human Interfaces, Integrated Analysis and Assessment, Joint Human-Agent Decision Making, Cybersecurity, Embedded Processing, Intelligent Systems

Rolling Application

U.S. Army Combat Capabilities Development Command-ARL West (Playa Vista) Cross-Reality (XR) Research and Development

In this project, you will support the design and development of AR/VR/XR applications that align with the objectives of ARL’s Military Information Sciences. Responsibilities include, design and implementing applications using Unity for XR devices, with a strong emphasis on optimizing performance and maintaining high-quality standards. Integrate the latest XR technologies and research findings into the research and development process to create novel and impactful applications. Conduct experiments and user studies to gather feedback and insights, iterating on designs to improve user experience and overall project success. Collaborate closely with multi-disciplinary teams, including researchers, designers, and data scientists, to analyze data, draw

meaningful conclusions, and present findings. You will be selected based on the following qualifications: Excellent problem-solving skills and the ability to think creatively to overcome technical challenges. Outstanding communication and collaboration skills to work effectively in a research-driven team environment. Experience in developing AR/VR/XR and applications for various XR devices. Experience in conducting user studies, usability testing, and data analysis to inform design decisions and research outcomes.

Rolling Application

Colorado

Colorado State University (Ft. Collins)

Project 1: Flexible optical potentials for quantum simulation. The precision and control that can be obtained in experiments on degenerate quantum gasses have advanced to the point where cold atoms can be used to study many-body quantum phenomena relevant to other systems, most notably condensed matter. This field, often called “quantum simulation,” is especially well-suited to undergraduate involvement both because of the field’s fundamentally interdisciplinary nature and because the diverse experimental techniques lend themselves to modularity. The Weld group’s research in this field and in the area of quantum dynamics is based on three main experimental platforms: two large Bose condensate experiments based around lithium and strontium, and an optical-tweezer experiment using ultracold potassium. The undergraduate apprentice on this project will work with one or more of these degenerate quantum gas experiments. The apprentice’s contributions will focus on generating and controlling optical potentials to enable new forms of dynamical quantum simulation. Specific project details will depend on the apprentice’s interests and background. The optical, electronic, and software infrastructure that the intern will create will enable the generation and optimization of shaped optical potentials for use in experiments exploring the response of quantum systems to nonadiabatic variations of the potential.

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into all-Van-der-Waals heterostructures that probe both bulk and edge of these quantum Hall states without introducing additional disorder presents an experimental challenge, necessitating precise and ultra-clean fabrication techniques. The involvement of the undergraduate apprentice will focus on exfoliating the appropriate material and assembling the all-van der Waals stacks with the dry-transfer technique. During the stack assembly, the apprentice will also perform gate-defining lithography through anodic oxidation, by an atomic force microscope, which allows nano-scale structures to be pre-patterned and integrated into the device in a minimally invasive fashion, reducing the amount of disorder introduced to the system.

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Twisted homobilayers of the transition metal dichalcogenides (TMDs) MoTe2 and WSe2 have been proposed to host integer and fractional quantum anomalous hall states of matter. Transport measurements of a well-designed Van derWaals heterostructure containing the aforementioned materials could demonstrate sharp and clear quantum hall physics that potentially includes fractional excitations such as non-Abelian anyons even at zero magnetic fields, opening the door to further probing of these phases using quantum mesoscopic devices. Making contact with and defining a conducting region with ultra-clean edges and low twist angle disorder presents an experimental challenge along with the encapsulation of air-sensitive TMDs in an effective manner. The involvement of the undergraduate apprentice will focus on exfoliating materials (graphite, hexagonal boron nitride and the TMD), designing and assembling the Van derWaals heterostructure using the dry-transfer technique. Fine alignment of layers into a usable stacking geometry as well as gate definition using lithography via Atomic Force Microscopy constitute the design process where feedback with a personal mentor as well as independent problem-solving and innovation are key components of the undergraduate's success.

Project 4: Optimizing photoconductive switches for on-chip THz spectroscopy On-chip spectroscopy in the Terahertz domain is useful for the measurement of quantum phenomena in 2D materials. Terahertz spectroscopy's specific energy and timescale allow for experiments measuring superconductivity, strongly correlated phenomena, and non-equilibrium dynamics in quantum materials. Adding a specially designed chip allows these same measurements to be performed below the Rayleigh diffraction limit, which is particularly helpful for studying Van derWaals heterostructures and 2D materials such as graphene in ultra-cold environments. In this project, the difficulty lies in creating high-quality chips for the measurement of samples. The involvement of the undergraduate apprentice will focus on, but is not limited to the construction of complex optical arrays to generate and measure on-chip terahertz waves, dealing with analog and digital electronics for automated measurements and fabrication of custom parts necessary for measurements. By experimenting with different chip geometries and photo-conductive switches, the undergraduate apprentice helps optimize the capabilities of on-chip spectroscopy.

Undergraduate Apprenticeships Opportunities

Site open: Dec 4, 2023
Site close: Feb 29, 2024

Connecticut

Yale University (New Haven)

Subject area: Material Science

The undergraduate apprentices will learn to use numerical simulations to model geological flows and have significant exposure to scientific programming, the Unix environment, and running large-scale simulations on high-performance computation clusters. Through the High School and Undergraduate Research Apprenticeship Program, the students will learn to use numerical simulations to model geological flows and have significant exposure to scientific programming, the Unix environment, and running large-scale simulations on high-performance computation clusters. Apprentices will also be trained to communicate their research to a broad range of audiences. The students will gain insight into STEM careers, graduate school applications, and DOD graduate fellowships. Apprentices will have the opportunity to be coauthors of a peer-reviewed publication and present their work at an internal summer research symposium and a scientific conference.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

Florida

Florida International University (Miami)

Subject area: Computer Science

The apprentice research will be focused on five overarching research projects, 1) robust deep learning systems against deep fakes, 2) extracting forensic event signatures using network science techniques, 3) big data digital forensics, 4) drone forensics with machine learning-based fingerprinting and blockchain security, 5) extracting digital signatures and information through the development of new or improved digital forensic tools. Our large projects will be broken down into small task segments to provide a full research experience for each of the apprentices. This is dependent upon the overall research project status when students arrive. Each of these subprojects

will be directly related to “real world” research in which the principal investigators and key personnel are engaged but tempered to provide a suitable and full research experience.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

University of Central Florida (Orlando)

Subject area: Biochemistry

Apprentices will research nitramine degradation with relevance to bioremediation of explosive soil contaminants. The apprentices will gain experience in high-throughput screening of genetic variants, bioinformatics, oral scientific communication, experimental design, and reading scientific literature. Apprentices will be expected to participate in weekly lab meetings to present their data and relevant literature.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

University of Miami School of Medicine (Coral Gables)

Subject area: Molecular Biology

Project 1: Analysis of inducible T-SCs. The apprentice will be involved in screening the strain collection for the formation of inducible T-SCs by BN-PAGE upon growth in pBpa-containing media and cross-linking. Moreover, once identified TSCs, we will characterize their respiratory properties by high-resolution respirometry. To analyze SC function independently of their assembly and without introducing steric constraints, we aim to generate inducible T-SCs by crosslinking naturally occurring SCs. For this purpose, we will apply the non-canonical amino acids (ncAA)-mediated photo-crosslinking strategy. Briefly, the approach involves the incorporation of a photoreactive ncAA at a defined position of the target protein and UV-mediated protein-protein crosslinking. We have already generated in the lab yeast strains expressing an array of mutant forms of the CIII subunit Cor1, which mediates the interaction between CIII and CIV in SCs. The strains also express an engineered tRNA and aminoacyl tRNA synthetase pair, which will recognize amber codons and mediate the incorporation of the ncAA p-Benzoyl-Lphenylalanine (pBpa). The AEOP-UG Apprenticeship student will be involved in screening the strain collection for the formation of inducible T-SCs by BN-PAGE upon growth in pBpa containing media and cross-linking. Moreover, once identified TSCs, we will characterize their respiratory properties by high-resolution respirometry.

Project 2: The undergraduate apprentice will cross-link. Moreover, once identified TSCs, we will characterize their respiratory properties by high-resolution respirometry. Analysis of inducible T-SCs

To analyze SC function independently of their assembly and without introducing steric constraints, we aim to generate inducible T-SCs by crosslinking of naturally occurring SCs. For this purpose, we will apply the non-canonical amino acids (ncAA)-mediated photo-crosslinking strategy. Briefly, the approach involves the incorporation of a photoreactive ncAA at a defined position of the target protein and UV-mediated protein-protein crosslinking. We have already generated in the lab yeast strains expressing an array of mutant forms of the CIII subunit Cor1, which mediates the interaction between CIII and CIV in SCs. The strains also express an engineered tRNA and aminoacyl tRNA synthetase pair, which will recognize amber codons and mediate the incorporation of the ncAA p-Benzoyl-Lphenylalanine (pBpa).

Site open: Dec 4, 2023
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Illinois

U.S. Army Combat Capabilities Development Command Army Research Laboratory - ARL South (Chicago)

ARL regional sites create strong, enduring S&T partnerships–working together to solve the Army's current and future challenges. ARL regional sites leverage regional expertise and facilities to accelerate the operationalizing of science for transformational overmatch.

Technical Focus Areas: High Performance Computing, Impact Physics, Machine Learning / Data Analytics, Materials and Manufacturing, Power and Energy, Propulsion Science, Quantum Science

Rolling Application

U.S. Army Corps of Engineers Engineer Research and Development Center Construction Engineering Research Laboratory (Champaign)

Under the guidance of mentors, you will conduct research alongside staff and primary researchers. Through your participation in the AEOP program at ERDC laboratories, you will be introduced to a real-world laboratory environment as well as modern research technologies and techniques. This experience will inspire you to continue to pursue STEM disciplines as a career pursuit.

Research Areas Includes: military installation and contingency bases sustainability, enhancing

socio-cultural understanding in theater operations, improving civil work facilities and infrastructure, resilient facilities and infrastructure, smart sustainable materials, installation decision support and Urban and Stability Operations

Rolling Application

Louisiana

Tulane University (New Orleans)

Subject area: Material Science

The intrinsic properties of a material are those that uniquely identify it at equilibrium – one of the differences between gold and lead is how they interact with light. What happens to these properties when the systems are driven from equilibrium by a laser field? Apprentices will study how to control material properties through driving laser fields, an application of which is to make lead look like gold. This is achieved using a framework for controlling the observable properties of a general many-electron system known as tracking quantum control. One feature of tracking control is its tendency to produce complex, broadband laser control fields that represent a significant challenge to synthesize experimentally. In this project, we will investigate a potential method to overcome this difficulty by employing a system to generate the desired laser field itself via feedback control. A simple example of this would be an all-optical proportional controller. Generalizing this to a more generic proportional-integral-derivative feedback controller offers opportunities to extend the range of generatable fields, as well as a platform for achieving on-demand programmable optical properties of materials.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

Maryland

The University of the District of Columbia

Subject area: Mechanical Engineering

The Center of Excellence for Acoustic and Seismic Sensing of Urban Environments (CEASSUE) summer apprentices will study land-atmosphere interactions in dense urban environments, by studying the effects of these interactions on propagating acoustic/seismic signals. The urban environment can modify surface exchanges with the atmosphere on a larger scale and thus affect flow fields in the area. Recovering mean profiles of wind speed, standard deviation of the vertical velocity, and turbulence intensity from acoustic propagation measurements is a well-known

approach. However, the urban environment's complex reverberation, multipath, diffraction, and signature masking by building structures make this a very harsh environment for robust acoustic measurements. Therefore, coupling acoustic measurements with seismic sensing data, to identify building structure and near-surface ground properties, would enhance the accuracy of the recovered flow field parameters.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

University of Maryland (Baltimore)

Subject area: Immunology

Apprentices will do both theoretical and experimental components in basic concepts in Immunology relevant to Army research. Apprentices will learn how to understand the hypothesis and design experiments. and will eventually, will individually complete research on molecular and cellular experiments.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

University of Maryland (College Park)

Subject area: Physics

The apprentice will learn to engage in theoretical work on cold-atom quantum simulators. Projects might involve: simulating many-body localization in cold-atom systems, exploring topological phases using numerical techniques and investigating quantum phase transitions in cold atom systems.

Site open: Dec 4, 2023
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U.S. Army Combat Capabilities Development Command Army Research Laboratory - ARL Adelphi Laboratory Center (Adelphi)

DEVCOM ARL seeks to remain at the forefront of executing the highest-quality research possible, building leaders in the scientific community, setting a bold Army-relevant science agenda and pushing beyond existing boundaries in search of new ideas.

ARL fully integrates our internal and external foundational research efforts to shape future concepts with scientific research and knowledge, and deliver technology for modernization solutions to win in the future operating environment.

Rolling Application

U.S. Army Combat Capabilities Development Command Army Research Laboratory - ARL Aberdeen Proving Ground (Aberdeen Proving Ground)

The U.S. Army Combat Capabilities Development Command, known as DEVCOM, Army Research Laboratory is the Army's research laboratory strategically placed under the Army Futures Command. ARL is the Army's sole foundational research laboratory focused on cutting-edge scientific discovery, technological innovation, and transitioning capabilities for the future Army.

Rolling Application

U.S. Army Combat Capabilities Development Command Chemical Biological Center (Aberdeen Proving Ground (Edgewood Area)

The U.S. Army Combat Capabilities Development Command Chemical Biological Center (DEVCOM Chemical Biological Center) is the primary Department of Defense technical organization for non-medical chemical and biological defense.

DEVCOM Chemical Biological Center (CBC) has a unique role in technology development that cannot be duplicated by private industry or research universities. It fosters research, development, testing, and application of technologies for protecting warfighters, first responders and the nation from chemical and biological warfare agents. DEVCOM Chemical Biological Center is currently developing better ways to remotely detect these chemical and biological materials – before the warfighter or first responder ever enters the threat zone. DEVCOM Chemical Biological Center is also developing a new generation of technologies to counter everything from homemade explosives to biological aerosols to traditional and non-traditional chemical hazards.

Rolling Application

ARMY EDUCATIONAL OUTREACH PROGRAM
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Undergraduate Apprenticeships Opportunities

Walter Reed Army Institute of Research (Silver Spring)

WRAIR provides unique research capabilities and innovative medical solutions to a range of Force Health Protection and Readiness challenges currently facing U.S. Service Members, along with threats anticipated during future operations.

Through both times of peace and war, infectious diseases have killed, sickened, and disabled far more Service Members than bombs and bullets. WRAIR has created a model of vaccine and therapeutic development that is unique, nimble, and responsive to dynamically evolving infectious disease threats of military importance. WRAIR, with its unparalleled expertise, facilities, and international network, has developed many vaccines and drugs in use today by military and civilian medicine around the globe.

Rolling Application

U.S. Army Combat Capabilities Development Command-Aberdeen Proving Grounds, MD- Bi-Directional Adaptation

This project aims to revolutionize communication between Soldiers and systems, going beyond traditional methods. By focusing on real-time multimodal interactions, it will explore innovative solutions for team-level trust calibration, cohesive team dynamics, dynamic information presentation, and optimizing human-system performance in real-time. This will involve researching and developing technologies that enable Soldiers to communicate with systems as naturally and efficiently as they do with fellow humans, utilizing speech, gestures, and other forms of body language. Army Research DirectorateCompetency: Human In Complex Systems

Rolling Application

U.S. Army Combat Capabilities Development Command-Aberdeen Proving Grounds Composites with Tunable Thermal Properties

Controlling heat flow in composite materials is of fundamental interest. In this project, the student will design, fabricate and test fiber-reinforced composite materials (e.g., carbon fiber with a polymer matrix) and explore methods of significantly changing the material's thermal properties (i.e., thermal diffusivity, thermal conductivity, thermal contact resistances). Students majoring in engineering, chemistry, physics or materials science are ideal for this project.

Rolling Application

ARMY EDUCATIONAL OUTREACH PROGRAM
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Undergraduate Apprenticeships Opportunities

U.S. Army Combat Capabilities Development Command - Adelphi Laboratory Center- Data Scientist/Machine Learning for Recommender

This opportunity is focused on information management research and development using the latest machine learning techniques. As a Data Scientist/Machine Learning Researcher, your primary responsibility will be to support the design and development of ML applications that align with the objectives of ARL's Military Information Sciences. You will work with multi-disciplinary teams across the country to develop the ML algorithm to advance Army's future capabilities.

You will be selected based on the following qualifications: • Excellent problem-solving skills and the ability to think creatively to overcome technical challenges. • Outstanding communication and collaboration skills to work effectively in a research-driven team environment. • Experience in developing AR/VR/XR and applications for various XR devices. • Experience in conducting user studies, usability testing, and data analysis to inform design decisions and research outcomes.

Rolling Application

U.S. Army Combat Capabilities Development Command-Aberdeen Proving Grounds Estimating and Predicting Human Behavior

Focusing on the variability of human behavior within complex systems, this project will develop techniques to sense, interpret, and predict change in human states such as stress, fatigue, and intent. By understanding these human elements, the project aims to adapt technologies more effectively and infer the operational environment contexts, thus enabling intelligent systems to better comprehend and collaborate with their human counterparts.

Rolling Application

U.S. Army Combat Capabilities Development Command-Aberdeen Proving Grounds - GNC Research with the Julia Programming Language

The Julia programming language aims to solve the "two-language" problem by being as easy to write as python and as fast to run as C. However, it is not widely used in guidance navigation and controls (GNC) communities. Transitioning work in flight simulation, control theory, state estimation,

image-based navigation, reinforcement learning, and other areas goes far beyond syntax differences. We're looking for candidates with strong coding and problem-solving skills to help us figure out how to do GNC research with this new tool.

Rolling Application

U.S. Army Combat Capabilities Development Command - Adelphi Laboratory Center -Heterogeneous and Low Probability of Detection Wireless Networks

Summer apprentices are sought to support projects focusing on intelligent heterogeneous networks which have been shown to have the potential for enhancing the resilience and security of wireless communications networks by intelligently and adaptively exploiting multiple communications technologies operating at different parts of the electromagnetic spectrum (i.e., low-frequency RF to Optical). The interns will work closely with ARL researchers on a variety of research tasks including theory, analysis, and modeling, as well as experimental research.

Rolling Application

U.S. Army Combat Capabilities Development Command - Adelphi Laboratory Center- Human-AI Collaboration Experimentation

Apprentices will run human-subjects experiments to understand how to configure and plan human-AI collaboration for optimal performance and subjective outcomes.

Rolling Application

U.S. Army Combat Capabilities Development Command - Adelphi Laboratory Center- Human-Guided System Adaptation

This project addresses the rapid evolution of military and civilian AI technologies. It will develop methodologies allowing Soldiers to guide the adaptation of these technologies effectively. This includes creating interfaces and protocols for Soldiers to interact with and steer the development of intelligent systems, ensuring that these technologies remain relevant, useful, and upgradable in rapidly changing combat environments.

ARMY EDUCATIONAL OUTREACH PROGRAM
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Undergraduate Apprenticeships Opportunities

Rolling Application

U.S. Army Combat Capabilities Development Command-Aberdeen Proving Grounds - Human-System Teaming

This project seeks to understand and leverage dynamic interactions within human-system teams. It will develop principles for effective collaboration between Soldiers and intelligent systems, focusing on emergent team properties, variability in performance, shared situational understanding, and dynamic task allocation. Special emphasis will be on adapting to changing conditions, such as loss of capabilities, shifting goals, and adversarial interference.

Rolling Application

U.S. Army Combat Capabilities Development Command-Aberdeen Proving Grounds -Hybrid Human-Technology Intelligence

The focus here is on anti-disciplinary research to enhance human-system teams in multi-domain operations. This involves pioneering hybrid approaches that integrate human cognitive capabilities with advanced technology. The project will study the bottlenecks in human cognition, develop technological solutions to overcome these, and explore new methods to leverage human neural processing for creating or enhancing intelligence within human-system teams.

Rolling Application

U.S. Army Combat Capabilities Development Command-Aberdeen Proving Grounds- Injury Biomechanics

The position involves developing experimental procedures, analysis techniques, and advanced modeling approaches in a greater effort to measure, understand, or predict the biomechanics of biological tissue in high-rate impact scenarios. The work performed in this position will support a larger effort to improve computational human body models designed for simulating impact events by contributing to more biofidelic constituent materials and models and reproducing more realistic loading conditions.

Rolling Application

ARMY EDUCATIONAL OUTREACH PROGRAM
usaeop.com

Undergraduate Apprenticeships Opportunities

U.S. Army Combat Capabilities Development Command-Aberdeen Proving Grounds- Machine Learning for Security and Security for Machine Learning

Machine Learning has become an integral part of many domains (e.g., image analysis, networking protocols, network security, etc.), resulting in increased integration of ML into cyber defense tools. One way in which adversaries have responded is by perturbing inputs to cause misclassification to achieve their objective. This type of attack is known as adversarial machine learning (AML). Cybersecurity-related defenses to AML should strive to defend against unseen attacks and not require constant updating based on newly discovered attacks. Increasingly, supervised learning relies on a significant amount of labeled data to perform supervised learning. To avoid the requirements of a significant amount of labeled data, it is necessary to innovate self-supervised methodologies in a resource-constrained domain for network communications in the cyber domain. In the network/communications domain, machine learning-based classifiers are generally trained within a closed environment. Specifically, datasets used for training and evaluation are static and do not vary. Conversely, network environments are dynamic over time. Adversaries' attacks become more sophisticated and change in response to defenders' actions, requiring a defender to retrain a classifier to reflect the new attacks in the intended environment for deployment. This research seeks to address key research questions, such as: • How do we design ML for cyber classifiers using a limited amount of data in a resource-constrained environment? • How do we innovate network communication classifiers that are adversarial resilient?"

Rolling Application

U.S. Army Combat Capabilities Development Command - Adelphi Laboratory Center - Meta-optics for photonic integrated circuits

The U.S. Army Combat Capabilities Development Command Army Research Laboratory serves as the fundamental research facility for the U.S. Army. During this summer project, student researchers will gain the chance to engage in numerical modeling and experimental characterization of nanometer-scale structures for applications in photonic integrated circuits.

Rolling Application

U.S. Army Combat Capabilities Development Command-Aberdeen Proving Grounds

The project is focused on growth, synthesis, metrology and functional (optical, electrical, magnetic, electromagnetic) property characterization of semiconductor and metal quantum dots, nanotubes, and two-dimensional (2D) nanomaterials. Metrology tools involve electron microscopies, surface probe microscopies, X-ray crystallography and a suite of spectroscopic techniques including Raman, UV-Visible. Specific properties of interest are electrical and thermal transport, magneto-optical effects, linear and non-linear optical (NLO) effects, strong light-matter interaction, plasmonic and polaritonic effects. The interns work with senior researchers and learn nanomaterials synthesis and characterization techniques, physics of nano and quantum materials and develop device concepts and assembly for applications in photonics, electronics, and magnetics.

Rolling Application

Massachusetts

Harvard University (Cambridge)

Subject area: Computer Science

The goal of this research program is the development of a suite of software tools that will allow for the solution of quantum Hamiltonians using a neural network approach that exploits the symmetries of a problem, and to develop the tools to characterize and visualize the solutions and extract relevant physical observables. This means that we have an interwoven set of tasks:

1. Classification of periodic supercells and symmetry reduction for each distinct lattice type
2. Development and optimization of code for exact numerical solution
3. Neural network model development and training
4. Analysis of physical observables

Site open: Dec 4, 2023
Site close: Feb 29, 2024

Massachusetts Institute of Technology (Cambridge)

Subject area: Biochemistry

Apprentices will learn to express a redox-active electron-transfer protein that responds to specific environmental stresses, including redox fluctuations. They will use ΔcymA *S. oneidensis* initially with the cymA complemented under the control of a native two-component sensor that responds to the target environmental stressor. With confocal microscopy combined with electrochemistry, we can observe variations in the respiration and redox state of cells with single-cell resolution.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

U.S. Army Combat Capabilities Development Command Army Research Laboratory - ARL Northeast (Boston)

ARL regional sites create strong, enduring S&T partnerships–working together to solve the Army's current and future challenges. ARL regional sites leverage regional expertise and facilities to accelerate the operationalizing of science for transformational overmatch.

Technical Focus Areas: Materials & Manufacturing Sciences, Artificial Intelligence & Intelligent Systems, Cyber & Secured Comms at the Tactical Edge

Rolling Application

Nevada

University of Nevada (Reno)

Subject area: Genetics

Project 1 - Structure-function analysis of the gene harboring the mutation leading to the PinS+ phenotype. The goal of the apprentice research project will be to understand how the protein encoded by the gene leads to the phenotype. We will obtain a chromosomal deletion of the gene and introduce a copy of the gene on a plasmid. The plasmid-borne copy will be used for mutagenesis. If the gene has been extensively studied before, mutations and deletions will be introduced based on already available information. If the gene is novel, mutations and deletions will be introduced based on sequence analysis and structure predictions. Another possible approach is random PCR-based mutagenesis followed by the selection of mutations leading to the PinS+ phenotype, or eliminating it. I have considerable experience in making deletion constructs, introducing site-directed mutations, and creating libraries by random mutagenesis in yeast.

Project 2 - Analysis of the effect of other components of the [PUB1/SUP35] microtubule-associated complex on its assembly. The goal of the apprentice research project will be to test how inactivation or overexpression of these proteins affects the assembly of the complex (fluorescent microscopy and anti- Tub1 pull-downs), as well as its ability to maintain microtubule cytoskeleton. For the inactivation analysis we can disrupt the genes encoding the most interesting components, or to use the whole genome disruption collection available in the lab. For the overexpression analysis, genes will be cloned and expressed from the plasmids under the control of inducible promoters (CUP1 or GAL1).

New Jersey

U.S. Army Combat Capabilities Development Command Armaments Center U.S. Army Combat Capabilities Development Command Armaments Center (Picatinny)

Apprentices will get world-class leadership in engineering, science excellence, quality and innovation, and we are relied upon to objectively evaluate armament solutions so that we know our true progress and how it relates to our adversaries.

Rolling Application

New Mexico

U.S. Army Combat Capabilities Development Command (DEVCOM) Analysis Center (White Sands)

The U.S. Army Combat Capabilities Development Command Army Research Laboratory (DEVCOM-ARL), as an integral part of the Army Futures Command, is the U.S Army's foundational research laboratory that has the mission of operationalizing science. The DEVCOM-ARL mission essential task of foundational research has the objective to conduct research and reconnaissance to inform future Army science, technology, and engineering and invest in areas that ensure overmatch.

Rolling Application

New York

Cornell University (Ithaca)

Subject area: Material Science

Project 1: Atomic layer deposition of high K dielectrics on AlGaN and MOSCAP characterization. In this project apprentices will deposit high K dielectrics (e.g. HfO2) by ALD and characterize and optimize the resultant films by making and testing simple capacitors. The apprentice will learn ALD, simple lithography, metal deposition, and C-V measurements.

Project 2: Atomic layer etching of TMN, AlGaN and AlBN with emphasis on etch selectivity - Precision etching of the nitride heterostructures will be critical to the fabrication of the “epi-Hi-K + epi-Metal Gate” AlN based devices. Atomic Layer Etching (ALE), where layers are removed one by one, should be well suited for this precision process. CNF houses one of the few dedicated ALE systems in university laboratories. Apprentices will develop and characterize etch processes for enewpitaxial metals (mostly transition metal nitrides (TMNs), AlGaN and AlBN films.

Project 3: Characterization of AlGaN/AlBN heterostructure interfaces. The proposed “epi-Hi-K + epi-Metal Gate” AlN-based devices require particularly flat and pristine interfaces. These films are grown within the Xing/Jena research group. Apprentices will use Atomic Force Microscopy (AFM), electron microscopy, and x-ray diffraction to characterize the base films.

Project 4: Characterization and Optimization of Ohmic Contacts to Nitride Semiconductors Project As the UWBG project proceeds to the fabrication of actual devices, reliable, high-performance ohmic contacts to the quantum well heterostructures will become an important issue. CNF has recently installed a load-locked Ultra-high vacuum electron beam evaporator specifically for clean metal contact applications. The system features a six-pocket electron gun, an ion beam, and sample heating, cooling, tilt, and rotation. For this project, the apprentice will optimize the ohmic contract process (materials, rates, thicknesses, cleaning, annealing temperatures ambient etc.) for contact quality and reproducibility. This will involve electron beam deposition, lithography, fabrication of transmission line structures, and electrical measurements.

Project 5: LPCVD Nitride Passivation of AlGaN/AlBN Devices Project Host: Phil Infante Post-doc Mentor: Jimy Encomendero CNF is retrofitting/upgrading an existing horizontal tube furnace (one of 21 in CNF) to enable low-pressure chemical vapor deposition (LPCVD) of Silicon Nitride on compound semiconductors. Previously, this was limited to silicon substrates. LPCVD nitride will be used as passivation of the UWBG HEMT devices. The apprentice will characterize and optimize the deposition process (time, temperature, flows) on AlGaN/ALBN HEMT structures. Techniques user will include

LPCVD, stress measurement, profilometry, ellipsometry, and breakdown measurements.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

Cornell University (Ithaca)
Subject area: Material Science
The apprentices will work collaboratively with the graduate research assistant to characterize the organization of confined fluids (e.g., water, hydrocarbon contaminants, water-hydrocarbon mixtures) using X-ray scattering measurements. Apprentices will work collaboratively to elucidate the crystallization of fluids in confinement, as discussed in a recent article on benzene crystallization. The anticipated scientific outcomes include the determination of the changes in freezing points as a function of pore size, fluid chemistry, water-hydrocarbon mixtures, and the crystallization behavior of confined fluids. During the first half of the 10-week summer experience, the apprentices will investigate the freezing behavior of single-component fluids. In the second half, the apprentices will build on this understanding and extend these studies to include two-component fluid mixtures.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

New York University (New York)
Subject area: Computer Science
Apprentices will research single qubits, the idea of this topic is to familiarize apprentices with key concepts of quantum mechanics and learn to transpose them in terms of circuits using Qiskit. After getting familiar with what a qubit is, the apprentice will learn how to represent it and how to control it using Qiskit, we move on to a larger system. Apprentices will then look into Quantum State Tomography, this is how one can determine the effect of a circuit on an arbitrary state. Fully characterizing the state of a quantum state requires performing a tomography of the state. Finally, apprentices will learn about the impact of noise on a qubit with the methods that can be used to characterize a qubit. In the second half of the summer program, we focus on experimental realizations of basic quantum tools.
Site open: Dec 4, 2023
Site close: Feb 29, 2024

New York University (New York)
Subject area: Biological Engineering

Apprentices will biosynthesize, develop, and characterize conductive helical assembled fibers (CHAFs). CHAF will be engineered computationally with optimal phenylalanine residues positioned in the interior. To CHAF, apprentices will first study protein structures through techniques such as circular dichroism (CD) spectroscopy and attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy. They will be visualized via transmission electron microscopy (TEM), scanning electron microscopy (SEM), and X-ray fiber diffraction studies. The lessons learned from this proposed research will have implications for the creation of bioinspired bioelectronic materials with applications in fuel cells, biocompatible and portable power sources, miniature sensors, and neural interfaces relevant to the Army and society as a whole for the military.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

U.S. Military Academy at West Point (West Point)

At West Point, apprentice research is organized and executed through centers and institutes. These centers and institutes, along with the Academic Research Division provide the infrastructure necessary to tackle the Army and nation's most challenging problems. Ongoing research is focused on solving current and future Army challenges using a diverse, interdisciplinary team of experts.

Rolling Application

North Carolina

North Carolina State University (Raleigh)

Subject area: Biology

Apprentices will work to complete a gut microbiome sequencing of the 480 samples. Apprentices would complete the following tasks: 1) dissection of the gut from each bumble bee, 2) DNA extraction and quantification, 3) 16S amplification and library preparation, 4) library quantification and pooling, and 5) sequence data analysis. Notably, libraries would be sent over to the NC State Genomics Sciences Laboratory for sequencing on an Illumina NextSeq 2000.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

North Carolina State University (Raleigh)

Subject area: Biology

Apprentices will determine potential reproductive trade-offs between drone reproductive potential and mating flight behavior. This research experience will therefore provide each undergraduate apprentice with valuable skills in recording behavioral data, collecting live specimens, insect dissection, cellular staining, and reproductive physiology.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

Ohio

Miami University (Oxford)

Subject area: Physics

Undergraduate apprentices will build a diode laser system capable of detecting nuclear spin in alkali atoms. The apprentices are provided the optical components, machined mounts, and required electronics for current-driving, temperature-stabilizing, and frequency-scanning the laser diode, and are asked to build the laser system from scratch. Manual-style written instructions are provided to them. In 2024 we will add another extremely useful device to the list - the Spatial Light Modulator (SLM), which enables real-time manipulation of the amplitude and phase of an electromagnetic wavefront, and is widely used in laser pulse shaping and microscopic laser surgery. The EOM, AOM, and SLM are invaluable tools in the burgeoning field of quantum information processing, and we have set aside 2 weeks to train the apprentice pair on them.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

Rhode Island

University of Rhode Island (Kingston)

Subject area: Chemistry

The overarching theme of this site is forensic investigations. Specifically, apprentices are using Isotope Ratio Mass Spectrometry (IRMS) to link residue from exploded ordnance to that from unexploded. Attribution is a large part of forensic investigations. Using forensics as the theme will allow us to introduce laboratory skills as well as enticing fieldwork.

Undergraduate Apprenticeships Opportunities

Site open: Dec 4, 2023
Site close: Feb 29, 2024

South Carolina

University of South Carolina (Columbia)

Subject area: Material Science

Apprentice will study the influence of architectural features {dimensions, boundaries, arrangement, and orientations of composite tows/layers} on quasi-static (QS) fracture of meso-architectured composites (MACs). To investigate fracture propagation and stress-redistribution mechanisms in MACs, the apprentice will 3D print MACs and perform a series of QS tensile experiments with DIC on several composite architectures using a single-edge notched tension specimen. The apprentice will analyze the experimental data to determine strength and toughness and establish scaling laws for toughness as a function of layer width for the various composite architectures.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

Tennessee

University of Memphis

Subject area: Material Science

Undergraduate apprentices will be studying the non-thermal dusty plasma described offers the ability to process materials in a highly reducing environment due to the presence of reactive free electrons. As a model materials processing application using non-thermal dusty plasma, the proposed project will focus on repeatedly injecting metal oxide particles of size ~0.5 – 10 μm into a gas discharge. The applied research component of this project will focus primarily on injecting (reducing) metal oxide (Al/Ti/Fe) particles into and verifying their gas-phase concentration using sampling into a TSI Optical Particle Sizer 3331 commercial instrument. The aerosolized particles will be collected from the gas phase and characterized using Scanning Electron Microscopy and Energy Dispersive X-ray Spectroscopy at the Integrated Microscopy Center (IMC) of The University of Memphis to ensure repeatability in the morphology and composition in aerosolization and particle injection into the

plasma. Within this scope, the ability to inject known concentrations of aerosol particles into plasma is of interest. The experimental efforts proposed depend on the introduction of grains of known size and number concentration into a well-defined RF plasma.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

Texas

University of Texas (Austin)

Subject area: Biology

Many animals and plants have symbiotic bacteria that live inside their cells, organs, or tissues. Apprentices will be studying interactions between insects and their endosymbionts to understand at a molecular and genetic level how these vital symbiotic associations evolve and operate.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

University of Texas (Austin)

Subject area: Biochemistry

The overarching project goals for the present proposal will be accomplished by developing stimuli selective photosystems and characterizing their reactivity and final material properties. (A) Comparison of two main types of radical photosystems and relevant light sources. (B) Design and synthesis of photosystem components and monomers for resin formulation. (C) Spectroscopic monitoring of photopolymerization kinetics to optimize the photosystem and target specific material properties.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

U.S. Army Combat Capabilities Development Command Army Research Laboratory - ARL South (South, Austin/San Antonio/College

Station)

ARL regional sites create strong, enduring S&T partnerships–working together to solve the Army's current and future challenges. ARL regional sites leverage regional expertise and facilities to accelerate the operationalizing of science for transformational overmatch.

Technical Focus Areas: AI/ML for Autonomy, Energy/Power, Cybersecurity, Bio, Materials & Manufacturing

Rolling application

Virginia

George Mason University (Fairfax)

Subject area: Computer Science

Apprentices will implement efficient and robust mmWave communication protocols that include robust beam sweeping and beam hopping schemes, Low-probability-of-intercept, and low-probability-of-detect communication schemes with active obfuscation on the mmWave signals. In the beam sweeping phase, Tx and Rx aim to find a set of best tx and rx beam patterns (sectors) at both sides to achieve a good tradeoff between high signalto- noise ratio (SNR) and spatial diversity. In the beam hopping phase, Tx and Rx will hop among different beam patterns in order to achieve a low probability of detection against Eve and a low probability of disruption against the jammer. Various online learning protocols will be implemented, including multi-armed bandit (MAB), Q-learning, safe reinforcement learning (RL), etc. These learning algorithms aim to deal with the uncertainty brought by the dynamics of the environment as well as the jamming behavior. The safe RL algorithm aims to meet a quality-of-service (QoS) performance (e.g., short-term BER or delay lower than a threshold) during the entire exploration and exploitation process. Different system parameter settings will be examined, including transmission power, distance between different parties and their relative positions, Tx/Rx patterns, learning and exploration rates, static and mobile scenarios, etc.

Site open: Dec 4, 2023
Site close: Feb 29, 2024

Washington

Washington State University (Pullman)

ARMY EDUCATIONAL OUTREACH PROGRAM
usaeop.com

Undergraduate Apprenticeships Opportunities

Subject area: Computer Science

Three main tasks will be performed by the undergraduate apprentices. The first task will be to explore the general potential of large language models (LLMs) for quality and diverse code vulnerability sample generation, under the assumption that specialized DL-based vulnerability analysis (e.g., detection, discovery, and repair of vulnerabilities) is still needed as it is superior to general-purpose LLMs for these common software security tasks. We will assess (1) the label accuracy of the generated datasets and (2) the diversity of these datasets in terms of code complexity and vulnerability category (CWE) coverage. The second task will be to examine the merits of LLM-based vulnerable sample generation for training data augmentation hence enhancing deep learning (DL) based software vulnerability analysis. We will assess (1) the usefulness of the generated datasets in enhancing those downstream tasks and (2) the strengths and limitations of each approach regarding when and why it works well or not. The third task will be to validate the assumption underlying the first task. In particular, we will directly apply the same general-purpose and coding-task-specific LLMs to the three downstream tasks—i.e., examining whether those LLMs can immediately deal with vulnerability detection, discovery, and patching in comparison to the respective training-data-augmented DL-based techniques.

Site open: Dec 4, 2023
Site close: Feb 29, 2024