2022 RI Summer Internship Program

Research Topics

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2022 RI Summer Internship Program

Research Project Topics

The mission of the RI Intern Program is

- *Cultivate and develop future research scientists and engineers in Command, Control, Communications, Computers, Intelligence (C4I) and Cyber Technologies*
- *Provide mentor-led projects to assist the mentor and empower the intern to discover, develop, and expand their professional talents*
- *Recruitment of talented and motivated students for summer internships and co-op positions*
- *Expand the Interns skillset through Enrichment Sessions, advocate graduating interns as potential hires, and facilitate a buddy system to stay connected with the interns*

How to Use This Document:

The projects on the following pages detail potential opportunities for internship at the AFRL Information Directorate for summer 2022. Please review the projects and preferred skills of each project, and feel free to email any questions to intern@griffissinstitute.org. Please reference the name of the project when asking questions.

When applying to the internship program, please select any and all projects that you would like to be considered for.

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2022 RI Summer Internship Program

Research Project Topics

Intelligence Systems Division (RIE)

Data Efficient Machine Learning

A trained classification model can be used to automatically sort items of interest, such as images or signals, into discrete categories or classes. Modern machine learning algorithms typically require a vast amount of labeled data with which to learn such a classification scheme. Unfortunately, this quantity of data is sometimes difficult to acquire. We are interested in techniques that help users efficiently label datasets to reduce the amount of labeled data required to achieve a useful classification model. Your work will focus on implementing state of the art techniques for data efficient machine learning, running simulation experiments, and helping develop the next generation of efficient labeling procedures. Other projects will be introduced over the summer with opportunities for additional involvement.

Skills Preferred Include: Familiarity or proficiency in some or all of the following: Python, R, Tensorflow, PyTorch, Numpy, Matplotlib, Jupyter. Additionally, a good understanding of statistics and some familiarity with presenting, report writing and critical thinking are desired.

Leveraging Publicly Available Information

The AFRL/RI Text Analysis group is seeking to leverage Publicly Available Information (PAI). PAI includes a multitude of digital unclassified sources such as news media, social media, blogs, and other sources. One task is to identify resources related to trust, for example the Media Bias Fact Check (MBFC), and use these resources for categorizing news. Second task is to explore how news stories with a clear perspective (example pro/anti science, pro/anti COVID vaccine and so on) are propagating online i.e. which users are reposting it, liking it (allows to form communities of users that are aligned to a particular viewpoint). Third task is to utilize topic modeling and network characteristics to differentiate communities aligned to a particular viewpoint (need to identify keywords as well as network characteristics of trustworthy individuals). Final task is to utilize the crowdsourcing power of these communities for labelling new articles (for example the articles that are liked by scholarly/scientific community and not by anti-science community may have a higher probability of being authentic).

Skills Preferred Include: The project will require knowledge of Python and being able to interface with databases such as MongoDB and ElasticSearch. It may be useful, but is not a requirement, to have some background in data mining, natural language processing, and network analysis.

Conversational AI

The AFRL/RI Conversational AI (CAI) Group is comprised of a combination of natural language processing engineers, data scientists, machine learning experts, and developers. The team jointly focuses on developing and delivering the next generation on CAI techniques to Air Force Operations. As a team, we focus on researching novel methods of building task-oriented CAI systems that can communicate with complex information sources, analytics, and micro services to provide users comprehensive and details answers. Traditionally, summer assignments vary from working on machine learning problems within CAI to developing micro services using one-to-multiple information sources. Some of the high-level research areas we are interested in are dialogue state tracking, natural language understanding, few shot entity linking, unstructured language representation learning, and natural language generation.

Skills Preferred Include: Advanced knowledge in multiple programming languages. Can be any combination of: Java, C++, R, Javascript, MATLAB, C#, and Python. Classwork in Artificial Intelligence (AI), Machine Learning (ML) technology, web apps and Convolutional Neural Nets (CNNs) also preferred.

Phantom Arrow Wargaming

The AFRL/RI Phantom Arrow group is comprised of computer scientists, and active duty members. This group is an all-volunteer group dedicated to enhancing RI's ability to conceptualize, build, integrate and deliver realistic and useful applications of technology to warfighters through wargaming. To meet this goal, the Phantom Arrow group is working on a digital wargame in the Unity Game Engine. The current effort is to digitize the commercially available wargame Persian Incursion, with the goal of modularizing its well-developed ruleset to elevate the wargame to a near-peer wargame in future iterations. Typical summer efforts have been primarily development focused and building upon the work previously completed in an agile software development style.

Skills Preferred Include: Proficiency in Unity Game Engine, C#, Git, 3D Modeling, Software Engineering, Networking, and Computer Science background

Battle Damage Assessment Algorithms

The AFRL/RI Battle Damage Assessment (BDA) and Critical Infrastructure (CI) Group is focused on modeling, simulation and analysis of resilient Power Grids Networks and developing algorithms for Battle Damage Assessment that could be associated with CI. Summer research topics include but are not limited to:

- Modeling resilient power grids, critical nodes analysis, collateral damage analysis, and optimal mitigation analysis.
- Image recognition, damage quantification, using incomplete, sparse data.

Skills Preferred Include: development of Machine Learning/Artificial Intelligence approaches to algorithm development; mathematical model; electrical power engineering; communication networks

Information Exploitation and Operations (RIG)

Internet of Things Living Lab

AFRL/RI is in the process of setting up an Internet of Things (IoT) Living Lab (IoTLL), which will be located in the Innovare Advancement Center (IAC). The IoTLL will be a device and infrastructure test ecosystem that will provide security, interoperability, resilience, and data governance opportunities for AFRL/RI and other entities with IoT interest. Typical summer topics may include software and data analysis, integration of multiple sensors, programming, testing of smart devices within Griffiss Park. Topics may also include machine learning and artificial intelligence research.

Skills Preferred Include: The ability to program in Java and/or Python. A basic understanding of wireless communication, all types of IoT sensors (i.e. cameras, weather stations) and a good understanding of how to access sensors contained in a smart phone are also desired.

Audio Processing & Signal Analysis

The AFRL/RI Audio & Acoustic Group is comprised of a unique combination of engineers, mathematicians, and software engineers. This combination of individuals allows them to tackle a wide spectrum of topics from basic research such as channel estimation, acoustic detection and tracking, acoustic identification (ID), language ID and dialect ID. To the challenging aspects of real-time implementation, GUI design, and concepts of operations. Typical summer topics may include software analysis, database development, programming, and signal detection and identification. State of the art techniques such as deep neural networks and other machine learning algorithms are used to pursue solutions for real-time and offline problems.

Skills Preferred Include: Proficiency in Matlab, Phython, signal processing background, knowledge of acoustic and audio principles, and acoustic wave transmission.

ELINT Signal Processing & Data Science

The AFRL/RIGC ELINT programs include onsite/in-house signal generation, capture, and processing capabilities. Anticipated internship activities include signal processing and data science applications. Specific tasking/topics involves radar waveform definition, generation, and collection, as well as feature extraction, clustering, and tagging.

*Skills Preferred Include***:** proficiency in Matlab, Linux, and signal processing exposure.

Machine Learning Interpretability and Explainability

The AFRL/RI RIGC Branch is comprised of a mathematicians, physicists, DSP engineers, software engineers, and intelligence operators. This combination of individuals allows them to tackle a wide spectrum of topics from basic research to the challenging aspects of real-time implementation of the results of research efforts. Typical summer topics may include software analysis, database development, programming, machine learning in IOT type systems and sensor data signal detection and processing. The branch interest range over topics linked to increasingly sophisticated techniques in signal detection, characterization, tracking, and classification, all with the goal of signatures via array processing. State of the art techniques such as deep neural networks and other machine learning algorithms are used to pursue solutions for increasing signal exploitation to enable warfighters with significant situational awareness and knowledge. Key to successful development and use of ML techniques is robust knowledge of ML and insights into the inner workings of these systems.

Skills Preferred Include: Proficiency higher level programming languages (e.g. Matlab, Python, etc.), signal processing knowledge, knowledge of sensor and sensor data principles, and interest in machine learning.

Software Defined Radio and Machine Learning for Exploitation

The AFRL/RI SIGINT (Signal Intelligence) Group would like to transform the traditional methods for encoding, modulating, transmitting, receiving, exploiting, demodulating and decoding the information carried by man-made signals. We are looking for smart, low complexity, efficient, real-time, reliable and multifunctional transceivers and techniques that take advantage of novel signal processing and machine learning methods. We are also interested in extending methods beyond their conventional usages. Typical summer projects include classification, detection, estimation, classification, coding, and other areas of telecommunications applied to hostile and complex environments. The projects are designed to promote brainstorming and allow the student to implement guided solutions or propose and develop their own depending on technical merits.

Skills Preferred Include: Knowledge of software defined radios, high performance computers, programming languages such as Matlab, Python, Keras, and other available open source tools would assist the student in both research and development.

Small Unmanned Aircraft Systems (C-sUAS)

The AFRL/RI C-sUAS team is comprised of a unique combination of program managers, cybersecurity specialists, hardware/software engineers, UAS flight testing operators, and UAS Traffic Management (UTM) subject matter experts. This combination of individuals allows them to tackle a wide spectrum of topics including:

- basic and applied research such as Commercial Off-the-shelf (COTS)

- small Unmanned Aircraft System (sUAS)
- Command and Control (C2) link exploitation
- sUAS detection/tracking/identification and defeat capability development
- UTM capability development for ensuring the safe operation of UAS within the National Airspace System (NAS)
- and the application of Artificial Intelligence (AI) and Human-Machine Teaming (HMT) to speed up decision making to assist C-sUAS and UTM Operators in executing their missions.

  Typical summer topics may include C2 protocol analysis, C-sUAS capability development, AI/ML/HMT programming and algorithm development, and UTM capability development. Systems include the Ninja and Paladin C-sUAS systems, and the Collaborative Low-altitude UAS Integration Effort (CLUE) UAS Service Supplier (USS) and other UTM capabilities under development. Skillsets include:

Skills Preferred Include: Proficiency in AI/ML algorithm development, protocol analysis, C-sUAS and UTM knowledge, cybersecurity, software/hardware engineering, and an understanding of the Android Tactical Assault Kit (ATAK).

Resilient and Secure Computing on Untrusted Clouds (RESCU Clouds)

The AFRL/RI Resilient & Secure Computing on Untrusted Clouds (RESCU Clouds) program keeps close collaboration ties with highly skilled students, professors, engineers, and researchers from academia and industry to conduct different basic and applied research projects. The peculiar diversity of talents working with and cooperating under RESCU Clouds investigate, design, and implement novel methodologies to securely and efficiently outsource data and distribute computations across heterogeneous hostile computing environments and untrusted Cloud Service Providers (CSPs). The research topics of interest focus on zero trust security and include, but are not limited to, (1) decentralized identity and access control mechanisms and protocols, including those that support anonymity. (2) Novel application of existing cryptographic primitives and protocols to zero-trust computing paradigms. (3) Design cross-cloud, CSP-independent, privacy-aware protocols and frameworks that operate in the presence of emerging zero-trust security mechanisms. (4) Enable secure and transparent migration of application and data across heterogeneous CSPs, and facilitate multi-objective optimization in the security-mission trade space. (5) End-to-end data protection, concurrency and consistency for multi-user multi-cloud environments.

Skills Preferred Include: Proficiency in one or more programming languages. Knowledge of one or more of the following topics: Machine Learning (ML), data analytics, cryptography, cloud computing, and blockchain.

Information Systems (RIS)

Generalizing Adversarial Machine Learning to Non-Imagery Domains

Machine learning models, especially deep neural networks, have been shown to be vulnerable to multiple attacks, e.g., dataset poisoning, backdoor attacks, and adversarial examples, that apply near-imperceptible perturbations to training or test data but yield undesirable outcomes in the machine learning models. The majority of research in this area focuses on benchmark image classification datasets. In natural images, the cost associated with each perturbation is generally calculated by taking some measure of distance between the original and perturbed samples. In this context, an attack is successful if the attack fools a target model and its cost does not exceed a specified threshold. This project is interested in exploring adversarial machine learning techniques in domains where the cost associated with "perturbations" is more restrictive. Interns on this topic will help explore the effectiveness of the existing attack literature on problem domains with additional constraints. Results will be used to explore the generalizability of current adversarial machine learning methods. In the case of adversarial examples, perturbations are typically generated for a specific data sample, however recent work shows that some perturbations may be universal across images and architectures. A goal of this effort is to reconcile this universal approach with the standard individual approach as a method of increasing the generalizability and lowering the cost of generating adversarial attacks against machine learning models.

This effort will proceed by implementing various existing perturbation and adversarial attack methods, performing numerical experiments by applying the perturbation techniques to new datasets in non-imagery domains, and exploring the mathematics underlying generalizability of the perturbation and adversarial attack methods.

Skills Preferred Include: Proficiency in Python. Familiarity with a deep learning framework, e.g., Tensorflow and Pytorch. Familiarity with Machine Learning concepts.

Computing and Communications (RIT)

5G Enhanced Communication Capabilities

Emerging 5G communications and network technologies can be leveraged to enhance military communication capabilities. In particular, 5G-enabling technologies are envisioned to provide higher data rates, lower latency, lower power consumption, security enhancements and ubiquitous access including non-terrestrial links. The three major use case domains of 5G—enhanced mobile broadband (eMBB), ultra-reliable low latency communication (URLLC) and massive machine type communications (mMTC)—provide the opportunity to harness commercial technology for future AF use cases such as smart bases, self-driving vehicles, augmented and virtual reality technologies for training, dynamic spectrum management and sharing technologies to facilitate coexistence of commercial and military spectrum dependent systems (SDSs). The 5G research areas of interests for this topic include but not limited to:

- Dynamic spectrum management and sharing with unlicensed and shared bands
- Internet of Things (IoT)
- Waveform design for enhanced security and high mobility
- Small cell mission scenarios
- AI and ML enhanced/incorporated spectrum management, dynamic sensing and sharing
- Smart base/smart port use cases with small cell, V2X, low power and localization technologies
- Advanced physical layer techniques such as carrier aggregation, full-duplex and massive MIMO
- Beamforming and adaptive nulling for interference tolerance and spectrum sharing/co-existence
- Millimeter-wave and terahertz band communications
- The application of unmanned aerial vehicles (UAVs) and Non-Terrestrial Networks (NTN) in the next generation of wireless networks and beyond
- Leveraging the mobility and 3D positioning of UAVs to enable inherent communications at the physical layer, i.e., Physical Layer Security (PLS)
- Channel modeling of air-to-air and air-to-ground channels

Skills Preferred Include: This opportunity will support internship candidates who are in graduate school. Work tasks include the conducting of modeling, simulation and emulation work associated with various 5G-enabling technologies that can enable spectrum sharing.

Trusted Software

The AFRL/RI Trusted Software group is composed of computer scientists and engineers that tackle research challenges in the areas of scalable formal methods; model-based engineering and validation; compositional verification techniques for resilience; and automation for abstraction validation, and synthesis. These research topics support security, resilience, and reliability in modern software development processes (Agile, DevSecOps, etc). Typical summer topics may include: developing and testing of models, analysis, and software development/programing. State of the art techniques for machine learning and automation are used to pursue solutions for developing and verifying learning-enabled autonomous systems.

Skills Preferred Include: Proficiency in software development languages (C/C++, Java, etc), Mathematics and formal methods background (Theorem Proving, Satisfiability,…), and familiarity with model-based design and related tools (AADL, SysML,…), knowledge of AI/ML principles.

Robust and Secure Machine Learning/Deep Learning

Despite advances that have enabled deep learning classification methods to achieve human-level performance, significant research is still necessary to ensure trusted and robust operation. The presence of vulnerabilities which can be attacked by a variety of methods, i.e., adversarial machine learning, necessitates a multi-faceted approach to algorithms and methods that ensure adversarial robustness.

The AFRL/RI Robust and Secure Machine Learning team focuses on analyzing plausible adversarial attack methods in order to develop and evaluate mitigations and techniques for trusted, robust, and efficient ML. Topics of interest cover both the basic and applied research categories, and include algorithm implementation and evaluation, dataset curation and analysis, and vulnerability analysis. State of the art techniques using deep neural networks and emerging computing architectures for video, image, and radar signal processing are explored for detection and classification applications.

Skills Preferred Include: Python, machine learning libraries (e.g. TensorFlow, PyTorch, etc.), video/image processing, signal processing

Application-driven Structure in Optimization

Mathematical optimization deals with developing models of problems and methods for finding the best available solutions. For example, removing noise from an image or extracting moving objects from video can both be cast as optimization problems. Research in this area includes studying theoretical properties of models, developing algorithms for solving them, and characterizing these solutions. Models arising from applications are often inherently nonconvex or nonsmooth, but may also inherit useful structure from the application in question. This research focuses on identifying that useful structure within the problem which can be utilized to provide theoretical analysis and algorithmic convergence guarantees. Examples of this structure include sparsity, generalizations of convexity, and metric regularity. Some areas of interest are sparse optimization, image and signal processing, variational analysis, and mathematical foundations of machine learning.

Skills Preferred Include: This project minimally requires knowledge of calculus and linear algebra; some experience with algorithms, optimization, real analysis, or signal/image processing is helpful but not required.

Computer Architecture- Hardware Development

Position Description:

Researches, designs, and develops computer architectures with military grade cyber security. Works as part of a team to develop and implement a custom microprocessor and its support environment. Implements digital logic designs in a Hardware Description Language (VHDL), and simulates the design to demonstrate the desired functional and security features. Synthesizes the VHDL into a gate level netlist and creates the laid-out design suitable for generation of a mask set for wafer fabrication. Uses fundamental knowledge of computer engineering, digital logic design, and integrated circuit layout, to quickly master ever changing commercial Electronic Design Automation (EDA) software such as Cadence Innovus. Documents work in tech memos and reports, and provides briefings to the team and customers. Develops test benches and assembly or C programs for validation of circuit designs. As a member of a multi-disciplinary in-house team you will have the opportunity to work with leading researchers across academia and industry on cutting edge technologies.

Duties Include:

- Contribute as a design engineer developing next generation single and multi-core cyber hardened processors. This includes the complete process: design, simulate, test, process flow, manufacturing test, system implementation.
- Specify, design, and test RTL components. Work as part of a small team gaining experience in many areas of processor design.
- Work closely with government scientists and engineers to explore, identify, and apply new emerging research from academia and industry to Air Force application.
- Identify, understand, and analyze state-of-the-art research methods in the context of real-world data, operational constraints and environments, and Air Force problems.
- Work with government scientists and engineers to design, develop and prototype new tools for data collection and analysis tailored to Air Force applications.
- Design and conduct experiments at the Air Force laboratories to develop curated data sets for Air Force applications, including hands-on work with electronics, experimental computers and laboratory measurement equipment.

Skills Preferred Include:

- Basic understanding of Digital combinational and sequential logic design using VHDL/ Verilog
- Basic understanding of computer/processor architectures
- Modelsim simulator, Cadence Genus, Cadence Innovus layout software, Mentor Calibre design rule checker
- FPGA programming and use for emulation of custom circuits
- GNU software development environment, compilers, assemblers, linkers, operating systems

- C/C++/Assembly programming
- FPGA programming and use for emulation of custom circuits

Software Integrated Development Environment for Computer Architectures

Position Description:

Researches, designs, and develops software integrated development environment for computer architectures with military grade cyber security. Works as part of a team to develop and implement microcode, compilers, assemblers and linkers for custom military microprocessors and its support environment. Create firmware in unison with hardware design team in order to develop and test new embedded processor features. Develop low level interface drivers for open communication protocols like RGMII, SPI, I2C, SATA, etc. Documents work in tech memos and reports, and provides briefings to the team and customers. Develops test benches and assembly or C programs for validation of circuit designs. Plans, initiates, and conducts research and development programs to exploit new technology in the area of computer science and systems to support Air Force command, control, communications, and intelligence missions. As a member of a multi-disciplinary in-house team you will have the opportunity to work with leading researchers across academia and industry on cutting edge technologies.

Duties Include:

- Contribute as a software design engineer developing new trusted environments and applications for military grade processors.
- Specify, design, and test firmware and low level interface drivers. Work as part of a small team gaining experience in many areas of secure computing platform design.
- Work closely with government scientists and engineers to explore, identify, and apply new emerging research from academia and industry to Air Force application.
- Identify, understand, and analyze state-of-the-art research methods in the context of real-world data, operational constraints and environments, and Air Force problems.
- Work with government scientists and engineers to design, develop and prototype new tools for data collection and analysis tailored to Air Force applications.
- Design and conduct experiments at the Air Force laboratories to develop curated data sets for Air Force applications, including hands-on work with electronics, experimental computers and laboratory measurement equipment.

Skills Preferred Include:

- Proficient in C/C++, linux environment
- Basic understanding of computer/processor architectures
- Basic understanding of state machines and implementation
- Python, Assembly level programming experience
- Familiarity or desire to understand software defined radio and unmanned air systems

Neuromorphic Computing

The high-profile applications of machine learning(ML)/Artificial Intelligence (AI), while impressive, are not suitable for a) Size, Weight, and Power (SWaP) limited systems and b) systems without access to “the cloud” and high end computer resources via networking. Neuromorphic computing is one of the most promising approaches for low-power, unconnected ML. This computing can potentially operable down at the sensor level, and implements aspects of biological brains, e.g. trainable networks of neurons and synapses, in non-traditional, highly-parallelizable, reconfigurable hardware. As opposed to typical ML approaches today, our research aims for "the physics of the device" to perform the computations and for the reconfigurable hardware itself to be the ML algorithm. This research effort encompasses mathematical models, hardware characterization, hardware emulation, hybrid VLSI CMOS architecture designs, and algorithm development for neuromorphic computing processors. We are particularly interested in approaches that exploit the characteristic behavior of the physical hardware itself to perform computation, e.g. optics, memristors/ReRAM, metamaterials, nanowires.

Skills Preferred Include: Potential students for algorithm development should have skills in MATLAB and/or Python. Students interested in demo and hardware development should have skills in microcontrollers, C programming, and FPGAs/HDL. General familiarity with electronics and automation is a plus.

Hyperdimensional Computing (HDC)

Hyperdimensional computing (HDC) or Vector Symbolic Architectures (VSA) are potentially the mathematically rigorous engineering design rules sought by the machine learning (ML) community to stitch together disparate artificial neural network (ANN) frameworks. In HDC, information is represented by high dimensional vectors (1,000 – 10,000 elements long), which may be added (superimposed) or multiplied together to create sets or dictionary key-entry pairs, respectively. A similarity metric measures the correlation between any two vectors. These formalisms follow a connectionist approach: linking concepts together such as in sequences, graphs, and trees. This research topic considers the "edge computing" potential of these methods, e.g. sensors fusion for robot navigation, methods for computing with sparse hyperdimensional vectors, implementing a resonator network in hardware, and memristor crossbar implementations. Additional interest is in exploring the application of sheaves from topological geometry with respect to hyperdimensional vectors derived from sensor data.

Skills Preferred Include: Proficiency in either Matlab (preferred) or Python required as well as linear algebra. Experience with artificial neural networks (ANN) will be helpful but not essential, since HDC violates many ANN conventions and limitations.

Quantum Information Sciences: Quantum Algorithms

The Quantum Information Sciences branch (AFRL/RITQ) performs cutting-edge experimental and theoretical research in a wide range of topics at the frontiers of quantum computing and quantum networking. With a unique interdisciplinary team composed of physicists, engineers, mathematicians, technicians, and computer scientists, RITQ has numerous active research efforts in quantum algorithms and leading quantum technologies such as trapped-ion systems, integrated quantum photonics, and superconducting quantum devices. Below are the application spaces and skillsets desired for four different projects available to choose from broken out by active research efforts.

The Quantum Algorithms team tackles understanding, characterization and exploration of commercially available quantum hardware systems. Application spaces of algorithm development include graph theory optimization and quantum machine learning.

Typical summer projects may include programming on a commercially available quantum hardware platform, quantum simulations, software analysis, and algorithmic development.

Skills Preferred Include: Mathematics or Physics background and familiarity with Python or a Quantum Language

Quantum Information Systems: Trapped Ion Systems

The Quantum Information Sciences branch (AFRL/RITQ) performs cutting-edge experimental and theoretical research in a wide range of topics at the frontiers of quantum computing and quantum networking. With a unique interdisciplinary team composed of physicists, engineers, mathematicians, technicians, and computer scientists, RITQ has numerous active research efforts in quantum algorithms and leading quantum technologies such as trapped-ion systems, integrated quantum photonics, and superconducting quantum devices. Below are the application spaces and skillsets desired for four different projects available to choose from broken out by active research efforts.

The trapped ion team focuses on implementing trapped ion systems using barium 133 and/or ytterbium 171. These isotopes have a combination of properties that make them perform particularly well as a qubit. Past summer projects contributed to the effort at a variety of levels and include a wide range of topics. Examples include: the investigation of a new material for optics mounting, the development of electrical and mechanical ion trap demonstrations, the construction of key pieces of control electronics, and the creation of new versions of existing lab tools at new wavelengths.

Skills Preferred Include: Physics or engineering background. Useful (but not required) skills include: experimental design and setup, electronic/circuit design and assembly, mechanical design/CAD, programming (for example python, matlab, or Mathematica).

Quantum Information Sciences: Integrated Quantum Photonics

The Quantum Information Sciences branch (AFRL/RITQ) performs cutting-edge experimental and theoretical research in a wide range of topics at the frontiers of quantum computing and quantum networking. With a unique interdisciplinary team composed of physicists, engineers, mathematicians, technicians, and computer scientists, RITQ has numerous active research efforts in quantum algorithms and leading quantum technologies such as trapped-ion systems, integrated quantum photonics, and superconducting quantum devices. Below are the application spaces and

skillsets desired for four different projects available to choose from broken out by active research efforts.

The Integrated Quantum Photonics team centers on both the theoretical and experimental aspects of photon-based qubits. The team develops the technology to generate, manipulate, measure, and quantify entangled photons. Typical summer projects include the production and quantification of entangled photons, programming to automate test equipment, integrated photonic device modeling, and theoretical models for quantum transduction.

Skills Preferred Include: Physics or engineering background, strong mathematics background, and a familiarity with python and c programming languages. Useful (but not required) skills include: experimental design and setup.

Quantum Information Sciences: Superconducting Quantum Devices

The Quantum Information Sciences branch (AFRL/RITQ) performs cutting-edge experimental and theoretical research in a wide range of topics at the frontiers of quantum computing and quantum networking. With a unique interdisciplinary team composed of physicists, engineers, mathematicians, technicians, and computer scientists, RITQ has numerous active research efforts in quantum algorithms and leading quantum technologies such as trapped-ion systems, integrated quantum photonics, and superconducting quantum devices. Below are the application spaces and skillsets desired for four different projects available to choose from broken out by active research efforts.

The superconducting team's research focuses on the investigation of new quantum devices, new qubit control and measurement techniques, and the exploration of fundamental physics relevant to quantum networking architectures, with an emphasis on hybrid superconducting systems – i.e. interfaces between superconducting quantum circuits and other leading quantum modalities, such as trapped-ions and quantum photonic circuitry. Typical summer projects may involve one or more of the following: numerical simulations; programming for data acquisition and data analysis applications; design and assembly of laboratory hardware, including mechanical, electronic, and cryogenic components; and participation in quantum measurements.

Skills Preferred Include: physics or engineering background; experimental design and setup; mechanical design/CAD; analog and digital circuit design; and python programming language.