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C S U R F 2 0 2 1

Colorado Springs Undergraduate Research Forum

USAFA Book of Abstracts

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Colorado Springs Undergraduate Research Forum

Letter from the USAFA Dean of the Faculty

Our state, country, and world have been through a lot in the past 12 months. While many events and activities understandably had to be canceled, one notable activity persevered amidst this great turmoil: our undergraduate education with research. Many of our academic and research activities looked different this year, but they had to continue uninterrupted. It is also fitting, that while the strains of a pandemic shed light on what is truly critical to our nation – like research – it is also research and science that are playing a critical role in returning our nation to normal.

Last year, we had to cancel the Colorado Springs Undergraduate Research Forum (CSURF) completely, and in its place we published an abstract book of the research that cadets had planned to present at the forum. This year we were delighted to host a virtual event on 24 April. While we would have preferred to share our research with you in-person, this event was one step closer to a normal Forum. And while our cadets were able to present their research virtually, we still see value in publishing this abstract book to share with all of our partners, colleagues, and friends who could not attend the virtual event.

This second annual CSURF abstract book contains summaries of 101 cadet projects representing 17 academic departments that were presented virtually during the 2020/2021 academic year. While these research projects are impressive, there is an even greater takeaway from this year's CSURF: each of this year's cadet presenters personally experienced the rigor of science, appreciation for empiricism, and the value of research...and they had these experiences in an austere, pandemic environment. These students will graduate and we will rely on them to lead our nation during future challenges. The skills they learned this year while conducting research will guide them.

We look forward to meeting again in person for next year's CSURF. Until then, I hope you find this abstract book informative and inspiring. From all of the faculty and staff at the United States Air Force Academy, we wish you health and safety.



A handwritten signature in blue ink, reading "Linell A. Letendre". The signature is stylized with a long horizontal flourish at the end.

LINELL A. LETENDRE
Brigadier General, USAF
Dean of the Faculty, United States Air Force Academy

The USAFA Office of Research Mission Statement

Execute today's research in order to develop leaders for tomorrow's battlespace.

The USAFA Office of Research exists to support researchers as they develop our nation's future leaders. The Office of Research does this by enhancing cadet education, providing DoD warfighter support, opportunities for faculty development, and partnership for technology transfer.

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**ENHANCING CADET EDUCATION
DEVELOPING FUTURE PROBLEM SOLVERS
PARTNERING FOR INNOVATION SOLUTIONS**

Department of Aeronautical Engineering

Quantifying Fundamental Detonation Parameters of Hydrocarbon Fuels and Nitrous Oxide

C2C Noah Pritchard and C2C Ryan Johnston

Faculty Mentor: Dr. Mitchell Hageman

Abstract:

A detonation is a combustion reaction preceded by a shock wave. The pressure increase caused by this shock wave has potential to reduce the compression work required in many modern engines. Potential near term applications include rocket engines and jet engine afterburners. Jet engine main combustors may also be replaced with detonation combustors if pressure fluctuation issues can be resolved. However, insufficient fundamental data about detonations exists and there are still many problems to work out before fielding the first practical detonation engines. The linear detonator at the U.S Air Force Academy (USAFA) has a 2.235cm x 2.235cm cross section with optical access. With this setup, detonation velocity was measured with ion probes, detonation pressure with a high speed pressure transducer, cell size with soot foils, and reactant/product concentrations using a modified FTIR. Data was collected for three hydrocarbon fuels. The pressure was found to be 20\% lower than pressures predicted by simulations for the same conditions. The source of this deficit is unknown. Detonation velocity was 2\%-3\% lower than the Chapman-Jouget velocity, which was expected due to the combustor size. Cell size for Ethane and Ethylene followed a U-shaped dependence on equivalence ratio, as expected. Fuel and oxidizer were correctly identified inside the combustor before combustion using infrared spectroscopy.

Department of Astronautical Engineering

Forced Relative Motion Using the Clohessy-Wiltshire Equations

C1C Brendan J. Hennessey Rose

Faculty Mentor: N/A

Abstract:

Natural relative motion trajectories for rendezvous and proximity operation (RPO) applications are well understood. Forced relative motion trajectories for RPO applications are much less developed. In this paper we present a novel method for the development and analysis of forced motion relative trajectories between two spacecraft, a target and a chaser. These trajectories are especially useful for real-world applications such as docking and servicing on orbit. This paper proposes a technique to discretize forced motion rendezvous trajectories in order to evaluate their efficiency. This method is based on Lambert Targeting in the natural relative motion space of the Clohessy-Wiltshire (CW) equations as well as the use of cubic splines to create smooth trajectories. The desired relative motion trajectory is discretized over time of flight and analyzed for required change in velocity or delta V. The method ultimately analyzes the feasibility of multiple trajectory types by comparing the required change in velocity to the actual capabilities of current spacecraft. In addition to calculating the required delta V, the tool can also output the required quaternion to point the thrust vector of the spacecraft in the direction of the required delta V. The technique is applied to several rendezvous trajectories in which a chaser spacecraft begins in a natural motion circumnavigation (NMC) of a target spacecraft.

Uninterrupted Earth-Mars Colony Communication Relay

C2C Benjamin Bayless

Faculty Mentor: Dr. Scott Dahlke

Abstract:

Every 13 months during Earth-Mars Solar conjunction or opposition, there are a number of days and even weeks when communication between Earth and Mars is hardly possible, and even impossible, given the current communications structure between the two planets. Outside these blackout periods, there are moments when objects on Mars' surface may not be reached due to a lack of line-of-sight (LOS), even with several Mars orbiters currently in place. This communications structure would be unacceptable for any long-duration manned mission to the Red Planet. However, this problem may be averted with a more robust relay. By leveraging special orbits, the Sun-Mars Lagrange points, and the current communications structure, this relay guarantees constant communications with any possible human activity on Mars' surface, no matter the orientations of the celestial bodies. We have shown this by simulating the concept's astrodynamics in Systems Tool Kit (STK), accounting for all relevant perturbations.



Mars Relay Network (MRN)

1. NASA's Mars Reconnaissance Orbiter (MRO) {Red}
2. NASA's Mars Atmospheric and Volatile Evolution (MAVEN) {Blue}
3. NASA's Mars Odyssey {White}
4. European Space Agency's (ESA) Mars Express {Yellow}
5. ESA's Trace Gas Orbiter (TGO) / ExoMars {Green}

Function

- To transmit/receive Signals between Earth and Mars Surface missions

Department of Biology

Expression of Tardigrade Damage Suppressor Protein in Escherichia Coli is Not Protective Against UV Radiation

C1C Camryn M. Olhausen and 2d Lt Jonathan Ford

Faculty Mentor: Dr. J. Jordan Steel

Abstract:

Tardigrades are microinvertebrates that are highly resistant to extreme environments. Tardigrades express a protein called Damage Suppressor Protein (DSUP) that helps protect them from high levels of radiation. The objective of this project was to investigate the protective properties of DSUP using Escherichia coli. The cDNA gene of DSUP was inserted into a pET28a expression plasmid and E. coli were transformed with the recombinant plasmid. Transformed E. coli were treated with UV light to evaluate their radiation resistance by comparing their survival rates to those of untransformed E. coli. A variety of exposure times and distance from the UV source were tested. There was no significant protective benefit for the E. coli expressing the DSUP protein as compared to the wildtype E. coli. A possible explanation for the lack of protection in E. coli could be the difference in genome packaging between prokaryotic and eukaryotic cells. Current work is being conducted to determine if purified DSUP has any genomic protective properties. If DSUP's radiation protection can be more fully understood, it could potentially be engineered for use in space or earth applications to extend the life of living and stability of non-living substances.



E. Coli



Tardigrade DSUP gene

Performance of Yeast at Various Elevation Gradients

C1C James J. Duffy

Faculty Mentor: Dr. Kellie Kuhn

Abstract:

Microbes do not follow the well-established biogeographical patterns exhibited by plants and animals. For example, microbial diversity does not decline with elevation. Species that range across steep elevational clines provide the opportunity for intense selective pressure on life history strategies. To examine how elevation influences life history in microbes, the growth and reproduction of the yeast *Saccharomyces cerevisiae* was measured in the lab under conditions that emulated low (sea level), middle (7000 ft), and high elevations (14000 ft). An altitude chamber was used to alter nitrogen

and oxygen concentrations. Temperature was regulated by water baths that corresponded to average annual temperatures, low (16°C), middle (21°C), and high (26°C). Cell number and size for *Saccharomyces cerevisiae* was measured every two hours for over 8-hours. Cell growth and proliferation was the highest at high elevations across all temperatures. Yeast propagated at sea level elevations had the lowest cell growth and proliferation compared to mid and high elevation conditions. Cold conditions inhibited cell growth and proliferation across all elevations. This contrasted with the expectation that performance would be higher in less extreme environments. Our results suggest that yeast was released from a limiting factor when grown under high elevation conditions.

Effect of COVID-19 Induced Anthropause on Wildlife Presence and Activity

C1C Mollie Bushelman, C1C Matthew Kop, and C2C Jacob Taylor

Faculty Mentor: Dr. Kellie M. Kuhn

Abstract:

The first case of COVID-19 was reported in December 2019. As the virus quickly spread all over the world global lockdowns greatly reduced human activity and gave scientist an opportunity to see how wildlife would respond. We examined how mammals on the United States Air Force Academy (USAFA) responded to the reduction of human presence and activity. We deployed 26 Browning Strike Force game cameras from Sep 2019-Jan 2021 to determine abundance and activity patterns of mammals. The data collected was separated into three temporal periods pre lockdown (Sep 2019-Mar 2020), lockdown (Mar 2020-Jul 2020), and post lockdown (Aug 2020-Jan 2021). For each trap site, we calculated species diversity, abundance, and activity patterns. We found that overall there was an increase in species diversity during the lockdown period. Among all groups, there was a significant increase in the abundance of carnivores during the lockdown. The results suggests that human presence and activity have a dramatic effect on when and how mammals use wildlands on the USAFA.

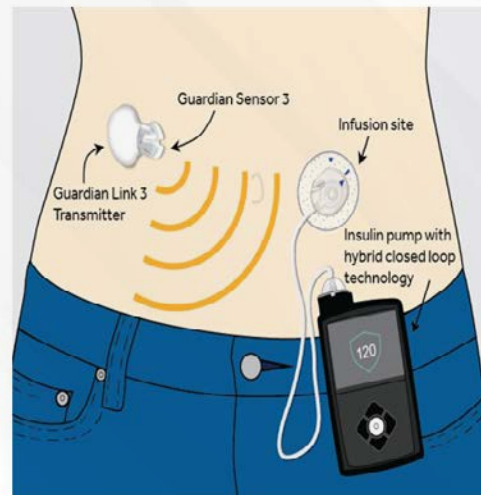
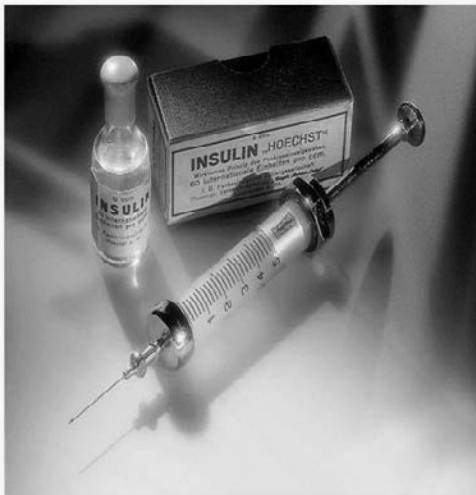
Exploring the Feasibility of Military Service for Individuals with Diabetes

C1C Tanner G. Johnson

Faculty Mentor: Lt Col Amy Carpenter

Abstract:

The purpose of this research is to explore the feasibility of military service for individuals with diabetes. Historically, a diagnosis of diabetes would extinguish any hope of a person joining the Armed Forces and would render most active duty members unfit for military service. Advancements in the efficacy of continuous glucose monitoring and management in current years may support the push for diabetic service in the military due to some of the impressive capabilities of the technology such as advanced warnings of impending high or low blood sugars and the ability to pre-determine blood sugar ranges that fit the user's lifestyle. In addition, a review of scholarly literature on diabetes prevalence and management in comparable populations with a "fit-to-fight" mission such as police, firefighters, civilian pilots, and other countries' Armed Forces will provide tested examples the U.S. Military could mirror for effective integration of diabetics amongst their ranks. Finally, evaluation of the performance of non-diabetic and controlled diabetic personnel in execution of similar tasks over extended periods of time could reveal currently unrealized benefits not previously explored.



Metabolic Inhibitors Reduce Alphavirus Infection in a Kidney Cell Culture Model

C1C Belle Toney and C1C Tynisha Spencer

Faculty Mentor: Dr. J. Jordan Steel

Abstract:

We hypothesized that metabolic inhibitor drugs could be re-purposed and used to treat and reduce alphavirus replication. To test our hypothesis, we infected BHK cells with a prototype alphavirus called Sindbis virus. A recombinant double subgenomic alphavirus that expresses green fluorescent protein during viral replication was used as a marker for viral infection. Alphaviruses are enveloped, positive-sense, single-stranded RNA viruses that infect humans and animals, causing a wide variety of disease. Current vaccines and treatment options are limited, and alphaviruses are serious emerging infectious diseases. Novel treatment options are critically needed to prevent the spread of these mosquito borne viral pathogens. Viruses are dependent on host cell metabolism and often elevate metabolic rates and pathways to ensure adequate energy and macromolecules to support high viral replication. It has

been shown with Dengue and other viruses that slowing down metabolism can successfully inhibit viral replication. We tested multiple compounds including a mitochondria and glycolysis inhibitors. Preliminary results indicate that treatment with metabolic inhibitors disrupts normal viral replication, but further research is needed to confirm the findings. Our initial results suggest the metabolic inhibitors in general can function as novel anti-viral drugs that could be used to treat serious alphavirus infection.

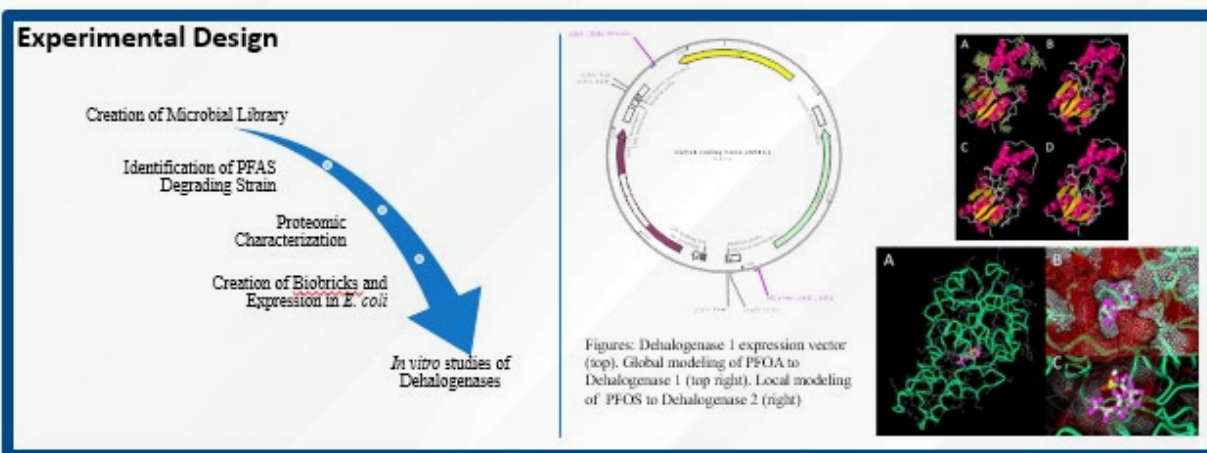
Biological Remediation of Perfluorinated Compounds

C1C Jackson D. Harris

Faculty Mentor: Dr. J. Jordan Steel

Abstract:

Remediation of man-made toxic compounds present in the environment is of significant interest due to the potential of utilizing existing biological solutions. Per- and Polyfluorinated alkyl substances (PFAS) are a broad class of synthetic compounds that have fluorine substituted for hydrogen in several or all locations. These compounds have unique chemical and physical properties that allow for uses in non-stick surfaces, fire-fighting efforts, and as slick coatings. However, recent concerns over the health effects of such compounds, specifically perfluorooctanoic acid and perfluorooctane sulfonic acid (PFOA, PFOS; PFOA/S), have led to increased attention and research by the global community into degradation methods. Soil samples from PFAS-contamination sites were cultured and screened for microbes with PFOA/S degradation potential, which lead to the identification of *Delftia acidovorans*, and two associated haloacid dehalogenases (DeHa1 & DeHa2). These enzymes have shown potential for enzymatic defluorination, a significant step in biological degradation and removal of PFOA/S from the environment.



Identifying Early Gene Expression Modulation as Markers for SARS-COV2 Infection

C1C Jonathan Soferr

Faculty Mentor: Dr. J. Jordan Steel

Abstract:

The SARS-CoV2 emergence in 2019 has caused health, safety, and socioeconomic issues around the world. Current testing prioritizes viral RNA detection, requiring specialized techniques, training, and time periods, resulting in significant testing limitations. Viral infection can cause changes in host gene expression, which vary from virus to virus. Recent research suggests SARS-CoV2 induced gene

expression modulations in infected human cells may be differentiated from expressions elicited by other acute respiratory illnesses. Our research compares SARS-CoV2 expression with those of other coronaviruses, Rhinoviruses, and Influenza to create a unique gene expression profile for this virus. This expression profile would be valuable for SARS-CoV2 testing, prevention, treatment, and vaccination research. Using previously collected COVID-19 surveillance-testing samples from cadets at the United States Air Force Academy, qRT-PCR will quantify the expression of 19 target genes. Despite vaccine developments, factors such as lengthy distribution estimates, evolution of untested and increasingly infectious strains, and anti-vaccine sentiment increase the need for safe and rapid testing research as people become less fearful of the consequences of infection. An expression profile that differentiates SARS-CoV2 from other acute respiratory infections would be extremely advantageous to detection and prevention efforts, as well as research efforts for treatment and vaccination.

Genetic Activity of L. Reuteri

C2C Cyril Yalung

Faculty Mentor: Dr. Katherine Bates

Abstract:

Lactobacillus reuteri is a bacterial species well known for functioning as a probiotic capable of inhibiting pathogenic microbial growth and shaping the bacterial environment in the host's gut. When exposed to glycerol or other bacteria *L. reuteri* produces the antimicrobial enzyme reuterin to combat potentially pathogenic bacteria such as *E. coli*. The objective of this research is to discover the optimal conditions in which *L. reuteri* is able to produce reuterin. It is expected that higher concentrations of glycerol and/or the presence of other bacteria will promote the expression of *pgd*, which codes for an enzyme required for reuterin production. Expression of *pgd* from *L. reuteri* grown in various conditions will be measured using qPCR. Understanding the reuterin production control mechanism may lead to more efficient probiotic usage, reduced antibiotic usage (which in turn will reduce stronger, anti-biotic resistant bacteria), and overall improved human health.

Genetic Engineering of Cyanobacteria with a GFP Trehalose Biosensor to Visualize Response to Desiccation

C1C Katarina M. Kowar

Faculty Mentors: Ms. Melanie L. M. Grogger and Dr. Donald V. Veverka

Abstract:

Concerns about climate change and desertification have increased research efforts in elucidating cellular mechanisms used by extremophilic microorganisms to survive in hostile environments. The objective of this research is to ascertain whether production of trehalose in certain cyanobacteria correlates with their ability to tolerate desiccation. Researchers have found that some cyanobacterial extremophiles, isolated from desert crusts, are able to survive desiccation by producing trehalose to stabilize cellular structure and protect genetic information. We are developing a genetically engineered biosensor to indicate real time trehalose production in cyanobacteria under desiccation conditions. Genetic engineering is being used to insert a biosensor, which activates green fluorescent protein (GFP) upon binding of trehalose, into cyanobacterial expression vectors. Protocols for producing electrocompetent cyanobacterial cells were developed for four different strains with successful transformation of a GFP-expressing plasmid in *Anabaena*. Understanding the mechanisms through which some extremophiles achieve stress tolerance could have profound implications in developing drought resistant crops and stabilizing soils affected by desertification.

Genetic Polymorphisms in Caffeine Metabolism and Action for USAF Aircrew

C1C Gabriel D. Fels

Faculty Mentor: Lt Col David Welge

Abstract:

Caffeine is the most consumed stimulant worldwide. It is popular for occupational use due to proven mental alertness and athletic benefits. United States Air Force (USAF) aircrew personnel are held to a high standard of performance in the execution of flying duties, and therefore are likely to consume caffeine. This study is a review of common genetic polymorphisms and other risk factors related to habitual caffeine use as applied to a USAF flying environment. Prior research has established a high degree of metabolic variability for caffeine in humans. Genes encoding enzymes in the cytochrome p450 metabolic pathway and the adenosine receptors acted on directly by caffeine are the main focus of this study. Specific genes identified to have polymorphisms of significance for multiple loci include CYP1A1/2 and the adenosine A2A receptor and its regulation. This allows recommendations to be made for optimal dosage and frequency of consumption for aircrew on a personalized basis. These recommendations serve to reduce the risk of negative effects associated with withdrawal and overdose while still allowing personnel to take advantage of caffeine's stimulant properties for performance enhancement. This will increase mission readiness and contribute to current fatigue modeling efforts.

Thermoregulation of High Elevation Tiger Salamanders

C1C Kerrilee Berger, C1C Sierra Crawford, and C2C Christopher Russell

Faculty Mentor: Dr. Kellie Kuhn

Abstract:

Water stress serves as a key limiting factor for high alpine terrestrial tiger salamanders, *Ambystoma tigrinum nebulosum*. Tiger salamanders are polymorphic, in which adult phenotypes are environmentally pressured by their natal ponds and will develop into terrestrial adults or fully aquatic gilled adults (paedomorphs) (Whiteman 2003). In years that snowmelt occurs early, terrestrial metamorphs are more likely to develop due to the abundance of resources in the ponds (Whiteman 2003). There is very little known about how these amphibians migrate between ponds without significant evaporative water loss and even less about how these organisms survive the harsh winters in the Colorado Rocky Mountains. This study was conducted within the Nature Conservancy Mexican Cut Nature Preserve located at 3,640 m and solely influenced by the harsh nature of the environment. To examine how thermoregulation affects the life history and habitat use of salamanders, we used plaster of paris models to determine water loss and temperature fluctuations in microhabitats over time. Models were placed under vegetation and in burrows. Results showed that models placed into burrows experienced a larger variations in water loss than the models placed under vegetation.



Exploring the Photophysical Properties of Sodium Naproxen as Predictors for the Sun Sensitivity Side Effect

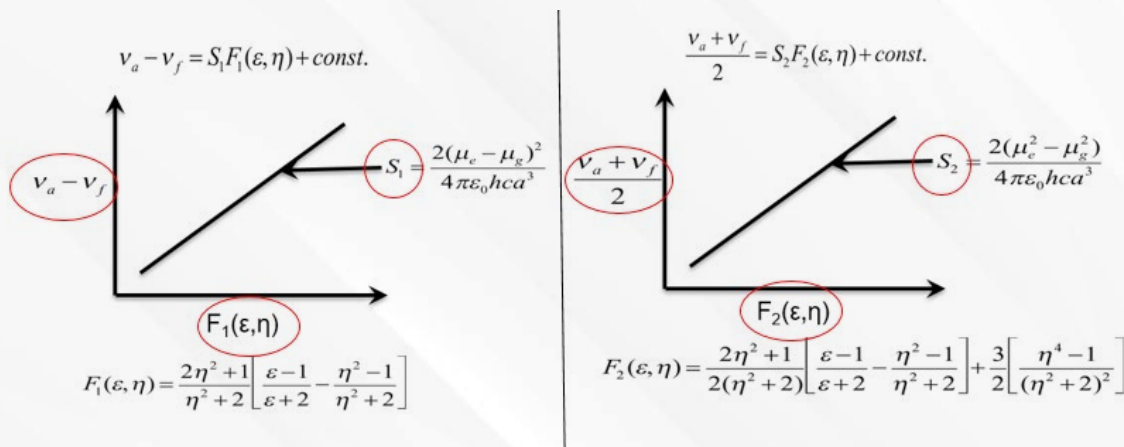
C1C Alex Prymek

Faculty Mentor: Dr. Andrea Giordano

Abstract:

There are a plethora of pharmaceuticals that cite sun sensitivity, a phototoxic effect, as a potential side effect. There are multiple pathways that elicit a phototoxic response in the body; however, the current FDA standards cite only the molar absorptivity and the lambda max as predicting factors, which leads to false positives and negatives. By using absorption and emission spectroscopy, the solvatochromic shift method was used to determine the change in dipole moment upon excitation of sodium naproxen. By gathering data on the photophysical properties of multiple pharmaceuticals, potential trends could lead to a model being developed that would allow for a more accurate prediction of the sun sensitivity side effect.

Calculated with the use of Bakhshiev Plot and Kawski-Chamma-Viallet (KCV) Plot



Lewis Acid Iodization of Unactivated Alkyl Fluorides

C2C Jensen J Zerban

Faculty Mentor: Dr. Todd A. Davis

Abstract:

Fluorinated organic compounds play a remarkable role within the pharmaceutical, material, medical and agricultural sciences. This widespread utilization has led to a high demand for fluorinated organic molecules in both the chemical and pharmaceutical industries. Fluorinated organic compounds contain organic chemistry's strongest bond, the carbon-fluorine bond, with a bond dissociation energy of 439 KJ/mol. Because of this high bond strength, methods to cleave a carbon-fluorine bond are limited. Our group has recently focused on the activation and cleavage of carbon-fluorine bonds using Lewis Acid activation of fluorine. This talk will focus on our recent efforts utilizing metal iodides to transform unactivated alkyl fluorides to alkyl iodides in high yield. Reaction optimization, substrate scope, and potential applications will be discussed in detail.

Department of Civil and Environmental Engineering

Column-Supported Embankments: Load Displacement Compatibility Method vs Case Histories **C2C Luke Socolofsky** **Faculty Mentor: Col Joel Sloan**

Abstract:

Column supported embankments (CSE's) enable rapid embankment construction over soft soils for roadways or rail lines. The column elements in CSE's transfer the embankment load to more competent strata below the soft soils, thus eliminating the time typically required for consolidation of the soft soil layer(s). CSEs are more expensive than some traditional methods (e.g. preloading with pre-fabricated vertical drains), but the time savings often makes CSEs an attractive alternative for fast-track embankment projects. The load-displacement compatibility (LDC) design method enables modeling of CSE's through user-provided design inputs to ultimately calculate key performance parameters such as differential settlement at the base of the embankment and total settlement at the embankment surface. In addition, researchers at USAFA and Lafayette College have collaborated to update the LDC method with new features based on the current state-of-practice. This poster presentation will compare predictions from the LDC design method with experimental measurements from case histories and will draw conclusions about the accuracy of the method, including the accuracy of recent improvements to the method.

Field Demonstration of Colloidal Silica Concrete Pavement **C1C Kelby Bailey, C1C Clay Madson, and C1C Ryan McKnight** **Faculty Mentors: Lt Col Matt LeBlanc and Lt Col Adam Strecker**

Abstract:

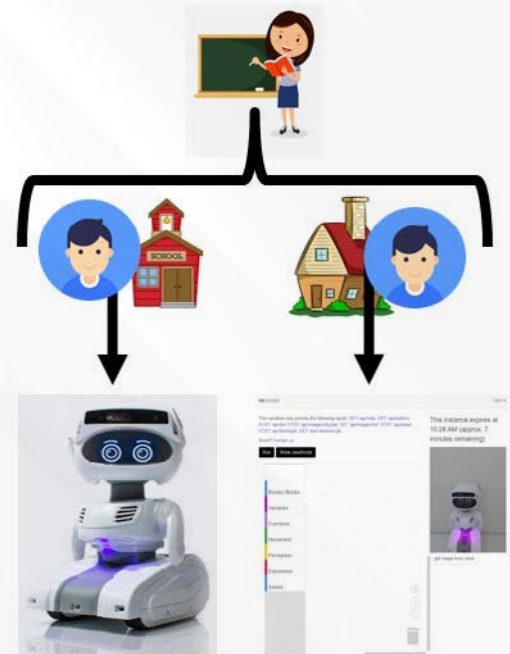
Upkeep of airfield pavements is of critical importance to Air Force civil engineers. Deteriorating airfield pavements create a severe risk to the Air Force's ability to execute aircraft missions safely and effectively. Due to the large dynamic loading on airfield pavements and the potential deterioration due to chemical and physical factors, both airfield pavement strength and durability are of utmost importance. A Colorado company, Intelligent Concrete, has developed a colloidal silica Portland cement concrete that can improve airfield pavement strength and durability. For this research project, cadets from the United States Air Force Academy have worked with Intelligent Concrete to test their colloidal silica concrete. The team created a mix design, performed required laboratory tests including compressive strength of cylinders, flexural strength, resistance to rapid freezing and thawing, and abrasion resistance. Additionally, cadets assisted in placing multiple concrete slabs at the United States Air Force Academy's Field Engineering and Readiness Laboratory (FERL) site. These concrete slabs will include strain gauges and serve as a field demonstration of the colloidal silica concrete pavement. The FERL site will allow a controlled traffic environment that can include normal automobile traffic as well as heavy construction equipment traffic. Data will be collected on the field demonstration pads to show if the desired increase in strength and durability is achieved. The field demonstration pads were placed in September 2020 and will be monitored through June and potentially into the fall of 2021. The desired outcome is to demonstrate to the Air Force the viability of a colloidal silica concrete pavement with adequate strength and improved durability that can be used on airfields.

Department of Computer Sciences

Misty II Robots and Blockly Programming for STEAM Outreach **C1C Caden Kulp, C1C Caleb Richardson, and C1C Matthew Hageman** **Faculty Mentor: Dr. Steve Hadfield**

Abstract:

The Misty Robotics' Blockly programming language drag-and-drop interface affords inexperienced programmers the opportunity to execute code directly on the Misty II robot, a portable yet highly interactive humanoid robot. The U. S. Air Force Academy's Humanoid Robotics capstone team has enhanced the pre-existing Blockly codebase to make Blockly a more powerful and flexible tool for K-12 Science, Technology, Engineering, Art, and Mathematics (STEAM) outreach. These improvements include a level feature to adjust command sophistication based on user skill level and experience, a consistent color scheme for block types, pop-up tooltips to aid the programmer, comprehensive commenting of the codebase, and a new block to access Misty's text-to-speech capability. The capstone team also collaborated with rerobots.net who offers a remote robot programming environment. The result of this collaboration is a new STEAM Outreach capability that provides K-12 students the ability to program Misty II robots using Blockly without needing a robot of their own. This solution facilitates a hands-on programming experience for students to cultivate a broader interest in robotics, programming, and related STEAM subjects in a cost-effective and scalable manner.



Internet of Things on a College Campus

C1C Rodney Belcher, C1C Caelan Brown, C1C Anthony Gomez, C1C Nathan Lervold, C1C Martin Ramirez, and C1C Cullen Wojewodka
Faculty Mentors: Lt Col Adrian De Freitas and Lt Col David Merritt

Abstract:

In 1991, Mark Weiser wrote "The Computer for the 21st Century" where he predicted that ubiquitous computing would be the most important technology of the 21st century, on par with revolutionary technologies such as writing. It would change the world to the point that nobody would notice the computer's presence, much like people simply read and write without thinking of the technology. The ubiquitous computer would be everywhere and be so cheap that people would discard it like they do sticky notes. While computers have certainly gotten cheaper, their ubiquity does not compare to Mark Weiser's vision, even though we are twenty percent through the 21st century. Because of this, our work looks to bring Mark Weiser's vision closer to reality by incorporating technology and sensors into daily life on a college campus. We prototyped Weiser's vision on a college campus by implementing an

Instructor Tracker and an Occupancy Tracker; both of which can communicate with a website and database designed by us. The Instructor Tracker can be used by students who want to see which instructors are currently in their office, or to see if they are in their classroom by logging onto the website which displays the information they are looking for. The Occupancy Tracker can be used by faculty members who want to see how many people are in a room to monitor congestion for COVID by logging onto the website which displays the current number of people. This IoT framework, along with our implementation allowing the number of sensors to be quickly scaled up, could become common usage in the future in every college campus and bring us a step closer to Mark Weiser's vision thanks to the inexpensive hardware components used such as Raspberry Pi devices, Tile Bluetooth Trackers and sensors to include optical, audio, laser, Bluetooth and camera sensors.

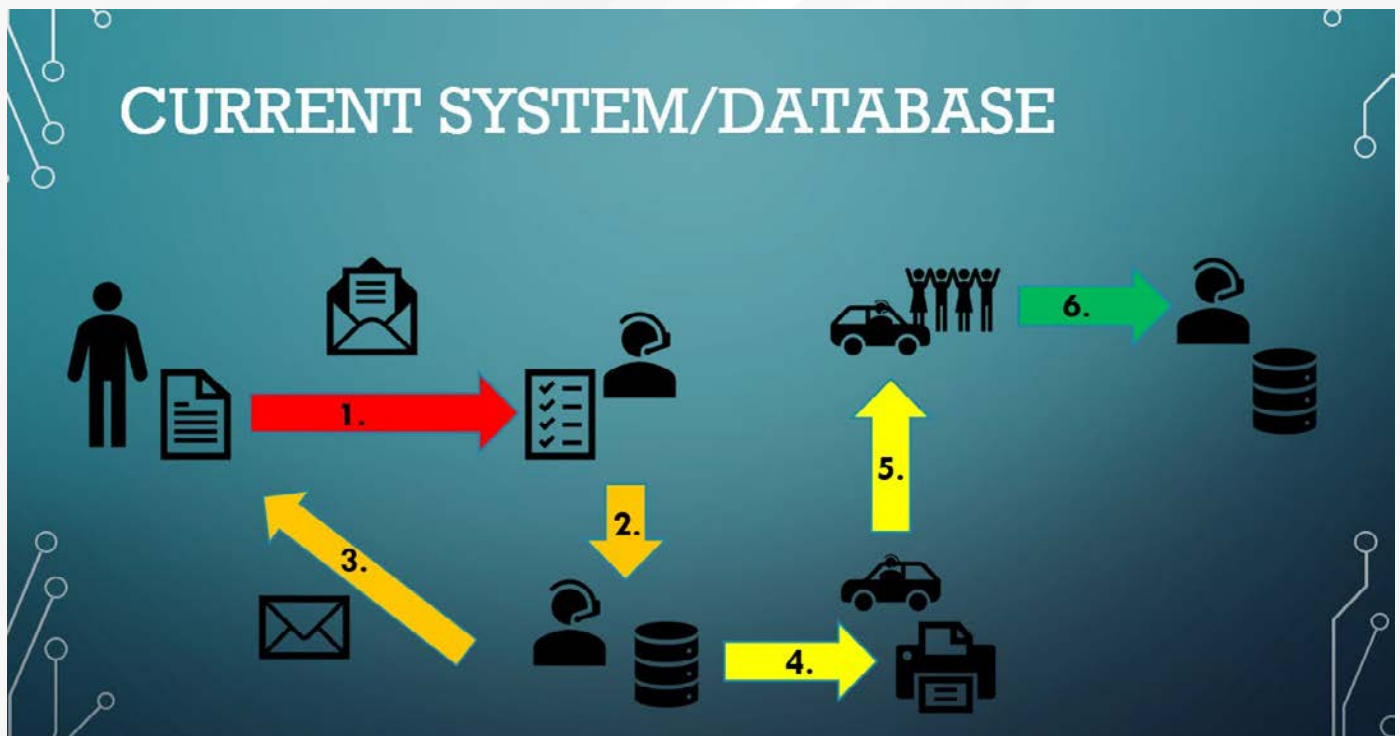
Ground Transportation Scheduling

C1C Jodi Dalton, C1C Hunter Manter, C1C Alexander Pak

Faculty Mentor: Dr. Kelly Huges

Abstract:

Cadets from the Department of Computer and Cyber Sciences at the United States Air Force Academy developed a secure web-based platform for the Ground Transportation Department at the United States Air Force Academy. The previous Microsoft Access based database was inefficient, outdated, and prone to crashing. By implementing a solution using Wordpress and MySQL services in the Microsoft Azure cloud environment, the process for requesting vehicle and driver services was fully automated from its formerly paper based request process. Wordpress, php scripts, and a MySQL database allow for application integration as well as preparation for future implementation of CAC authentication. This web-based solution can be accessed anywhere on any smart device attached to the Internet. By eliminating the human factor and automating the request process, the Ground Transportation Department will reduce the total number of missed trips and errors made per year.



Development of Combat Drone Swarm Algorithms

**C1C Addison Brown, C1C Josiah Goosen, C1C Manny Riolo, C1C Luke Ruan,
C1C Michael Shumate, C1C Jesse Sidhu, and C1C David Thacker**

Faculty Mentors: Maj James I Maher

Abstract:

This combat swarm project developed and tested combat drone swarm algorithms, implementing randomized simulations of prevalent combat swarm algorithms in literature, while developing novel algorithms through team competition. A drone simulation platform allowed customizable parameters including environmental obstacles and swarm size. The platform is able to simulate various drone types through adjustable class attributes including speed, weaponry, and sensor capabilities. Two teams worked to develop competing combat swarming algorithms, evaluated by average success rate in the drone simulation platform. Results of these simulations were documented using video, screenshots, and flight path records during the simulation. These artifacts were used to analyze and improve current state-of-the-art algorithms and to refine and improve drone and swarm behavior. Overall, the group was able to develop useful and effective combat swarming algorithms using this process.

UXO Tracking via Augmented Reality

**C1C Cristian Hanciuc, C1C Zach Lorch, C1C Devarsh Modh, C1C Jonathan Nash,
C1C Calvin Smith, and C1C Lance White**

Faculty Mentors: Lt Col Adrian de Freitas and Lt Col David Merritt

Abstract:

A serious threat that faces ground forces is safely detecting Unexploded Ordnances (UXOs) for disarmament. We believe the current method can be improved by highlighting said ordnances using augmented reality. In this project, we investigated how Microsoft Hololens can be used to visualize UXOs, and found that its LIDAR tracking for digital object anchoring was insufficient for operating as desired in outdoor settings. To address this problem, a mobile Global Positioning System (GPS) and database was used in conjunction with the Hololens to achieve digital object reliability and accuracy down to the meter. Utilizing handsfree interactive displays such as this help to showcase the usefulness of Augmented Reality and sensor fusion for improving a soldier's situational awareness. Our work also provides a framework for development in similar commercial applications and/or environments.

Network Security Based on Cyber Intel

**C1C Cameron Conrad, C1C Scott Culbreth, C1C Jed Cutter, C1C Charles Goss,
C1C Andrew Lemke, C1C Alec McGahee, C1C Saideep Reddy, C1C Brynn Sulte,
C1C Richard Worthy**

Faculty Mentors: Dr. Steven P. Fulton

Abstract:

With the emerging market of automated cyber security, this project seeks to make threat intelligence and responses readily available to groups, organizations, and individuals while also exploring its applicability to computer security based on immunology. Using open source threat intelligence in a standardized format, this project explores and combines open source platforms such as Anomali, Staxx,

Cabby, Walkoff, Cortex, and MISIP as possible solutions to fully automating a cyber playbook. By exploring these different avenues with a focus on open source solutions, we are able to select which solution makes our automating process most efficient while also keeping the cost low to produce automated cyber security widely available to the public.

Zero-Shot Malicious Network Traffic Detection

C1C Samuel J. Butler, C1C Christopher M. Collins, and C1C Addison R. Whitney

Faculty Mentor: Dr. Kelly L. Hughes

Abstract:

While detecting malicious network traffic is not a new area of focus, applying Zero-Shot learning concepts to this problem is an emerging field. Zero-Shot learning models are Artificial Intelligence (AI) models, which have the ability to identify classes it has not seen in the training phase. Currently, there are models that are able to identify known malicious activity, but these models fail when they encounter unique payloads, even when similar attack methodologies are used. Zero-Shot learning attempts to answer this problem by focusing on the methodologies themselves. This project attempts to develop an AI model using Zero-Shot concepts in order to detect unknown malicious payloads, by identifying attack methodologies in real-time. In addition, this project will focus on enabling key stakeholders to dynamically update the model.

Multi Mission Autonomous Ground Agent

C1C Thomas McCurdy, C1C Michael Baldinger, C1C Ethan Isaacson

Faculty Mentor: Dr. Chad Mello

Abstract:

Cadets and Faculty in the Department of Computer and Cyber Sciences at the United States Air Force Academy trained several fully autonomous rovers using machine learning to create an A.I. capable of discovering and exploring new locations within large buildings such as offices, classrooms, and hallways. The rovers were fit with several onboard neural networks capable of identifying objects (such as people, chairs, and desks) in order to facilitate a real-time object avoidance/interaction system. The technology stack includes Intel RealSense depth-sensing cameras (D455 and D435i), Aion Robotics' R1 ArduPilot (PX4) rovers, as well as a custom rover built using the Warden Robot Chassis kit, Jetson Xavier NX systems flashed with Ubuntu, Python 3.7, DroneKit, PyMavLink, and Mission Planner. Training data was collected by manually driving the rovers around and within offices and hallways throughout Fairchild Hall using an integrated RC system while recording video and telemetry information simultaneously. To properly capture various lighting conditions as well as foreign objects such as people walking by, data was collected during mornings, afternoons, and evenings. This data was then used to train a neural network (via behavioral cloning) capable of navigating brand new environments (i.e. never before encountered by the rovers) and was used in tandem with other neural networks focused on object recognition tasks. Future missions that will be researched include implementing search and rescue, reconnaissance, and sentinel functionalities.

Virtual Reality Flight Debrief

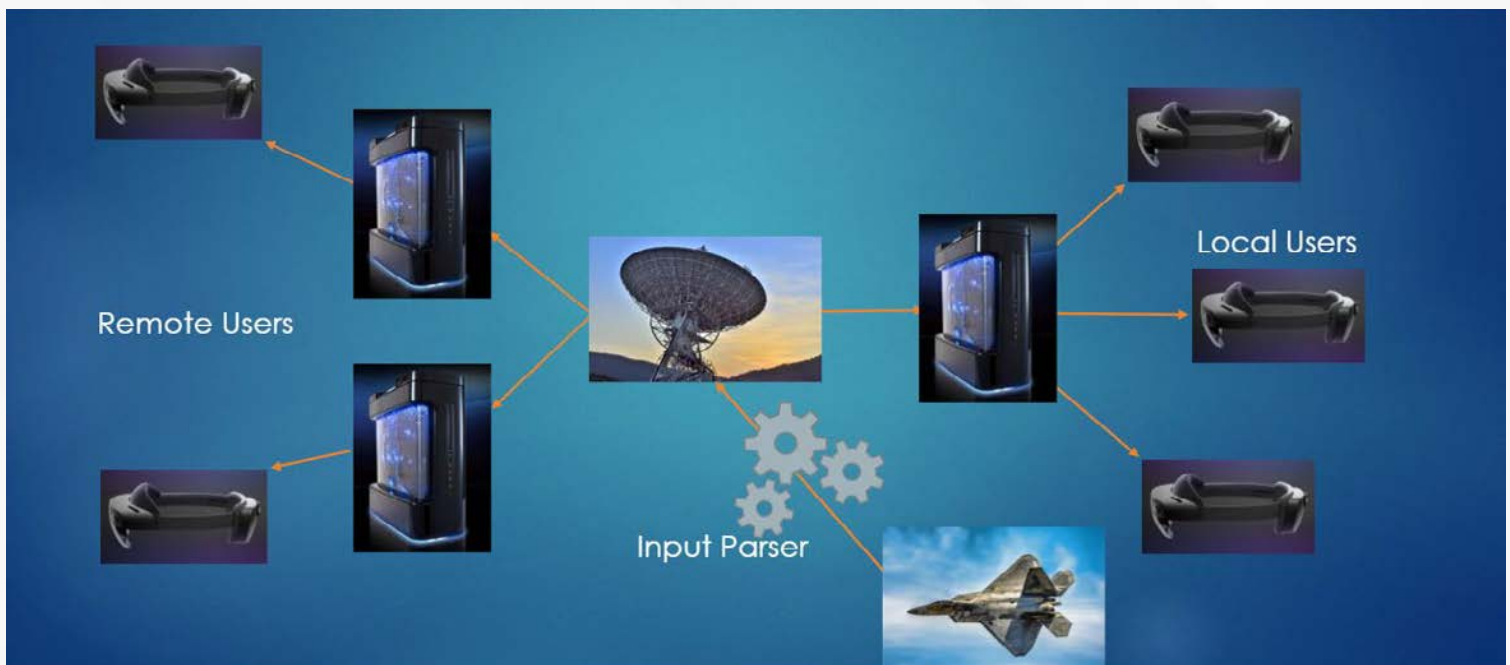
C1C Hannah Compton, C1C Theodore Drewes, C1C Adda Lantigua, C1C Alexis Shirley

Faculty Mentor: Lt Col Paul Graham

Abstract:

Currently, flight training debriefs use a crude "planes on sticks" method for instructors to describe the flight to the student. This approach does not consider geographical features and is limited by the instructor's memory of the flight and ability to physically demonstrate what occurred. Working off a current Virtual Reality (VR) Unity project, this project implements a Client-Server infrastructure that gives instructors more precision during debriefing sessions. Building the architecture from the ground up allows us to focus on data security and provides flexibility within the framework for additional features beyond flight data. Added features include the ability to debrief more than one student at a time on the same flight, added synchronization between group members, and the removal of geographical distance barriers to flight debriefing. This project's ultimate goal is to increase the effectiveness of flight debriefing by utilizing modern VR and communications technology.

SYSTEM ARCHITECTURE DESIGN



Ensemble Learning against Adversarial Machine Learning

C3C Brandon Kim

Faculty Mentor: Capt Caleb Ziegler and Dr. John Ciezki

Industry Mentor: Dr. Claire Thiem (AFRL)

Abstract:

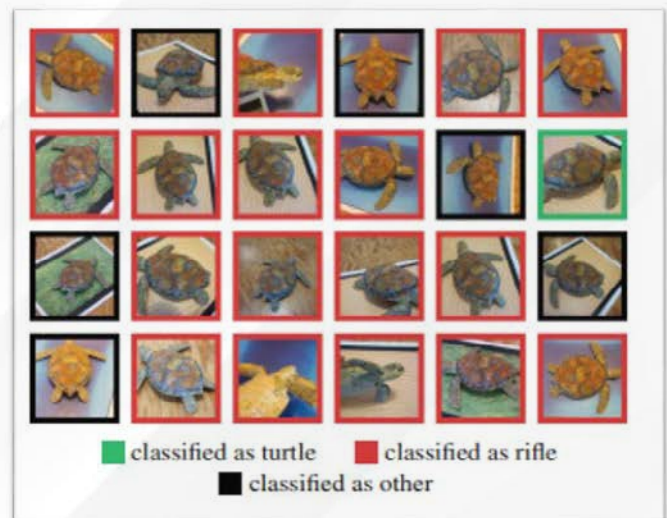
This study sought to recognize and address the increasing threat within the scope of adversarial machine learning using emerging ensemble learning models. Reviewing the work of Homayoun et al., a specific ensemble learning design presented itself as a competitive machine learning model against adversarial attacks (2020). The experimentation and analysis was outlined but not conducted in this report. The evaluation of this system would have involved the use of a performance metric observed by Elmenreich et al. that assesses the transferability and overall generalization ability of studied model between its training and testing phases (2019). Regression analysis would have investigated the correlation between the classification accuracy in testing and the training efficiency of the model. This study concluded with the validity of the test model and recommended future application of ensemble learning models in United States Department of Defense (DoD) cybersecurity strategies and the United States Air Force (USAF) Skyborg initiative.

Turtle or Rifle?

- High misclassification rates
- Adversarial examples often successful
- What if “rifles” were classified as “turtles”?

Object	Adversarial	Misclassified	Correct
Turtle	82%	16%	2%
Baseball	59%	31%	10%

Table 3. Quantitative analysis of the two adversarial objects, over 100 photos of each object over a wide distribution of viewpoints. Both objects are classified as the adversarial target class in the majority of viewpoints.



Athalve, A., Engstrom, L., Ilyas, A., and Kwok, K., “Synthesizing Robust Adversarial Examples,” Proceedings of the 2018 International Conference of Machine Learning, Stockholm, Sweden (Jul 2018).

Hyperdimensional Computing Applied to Supervised and Reinforcement Learning

C3C Ashay Stephen

Faculty Mentors: Lt Col Rebecca Breiding, Capt Steven Beyer, and Capt Caleb Ziegler

Abstract:

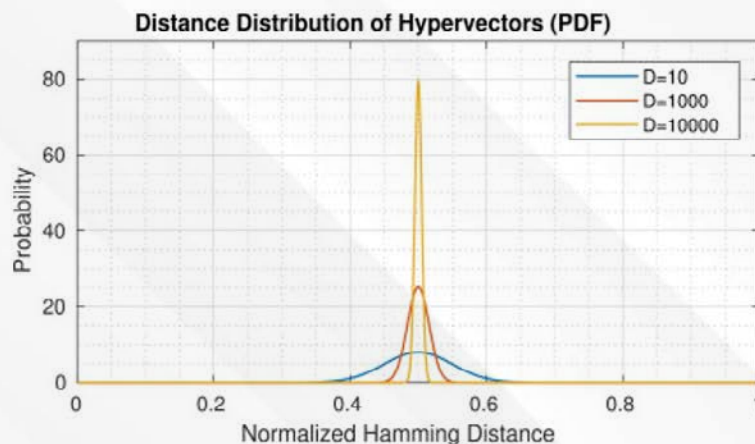
Traditional machine learning techniques involve the use of Artificial Neural Networks, utilizing a variety of weights and biases in order to make calculations and produce a range of solutions in the form of probabilities. Although this system of machine learning can produce great results, it is usually

impractical to use with hardware systems which have strict size, weight, and power (SWaP) limitations. Such constraints therefore require a new, computationally inexpensive, method of machine learning in order to allow them to be used in new ways. Hyper-Dimensional Computing (HDC) is such a method, which utilizes unique binary vectors in order to represent pieces of information and build associations among them. The following HDC research explores to what extent these associations can be made, their resistance to noise, and the most effective encoding schemes to store the maximum amount of information. These experiments were done in the contexts of supervised learning and reinforcement learning with the purpose of assessing the flexibility of HDC in different situations. The results from the coded simulations reveal that supervised learning schemes could stay above 80% accuracy at noise levels up to 88%, with negligible difference between encoding methods. The reinforcement learning experiments revealed that the simulation could correctly adapt to new rewards and punishments, and even correctly select for traits not explicitly included in its base code. Because of the simplicity of the code, and its compatibility with binary architectures, it is apparent that HDC could be effectively used with SWaP-limited systems.

AFRL

HDC: The Basics

- Two random HBV's are likely to be near orthogonal
 - 50% of bits would be different



Department of Economics and Geosciences

Countering China's Belt and Road Initiative

C2C Austin Moore

Faculty Mentor: Dr. Paul Bezerra

Abstract:

The Biden Administration will soon prepare its first National Security Strategy (NSS) outlining its view of threats to U.S. security and measures to counter each. This NSS must address China's Belt and Road Initiative (BRI). At face-value, the BRI is an ambitious economic development campaign to meet much of the world's insatiable infrastructure needs. However, further scrutiny suggests the BRI is part of a grand strategy to subvert the U.S.-led liberal world order whereby China gains political influence and acquires strategic assets to advance its economic and military position through vague or one-sided infrastructure loans. As such, the BRI poses a major threat to U.S. national interests in a favorable world order, and the Biden Administration must develop a comprehensive strategy to counter China's finance-fueled rise. This article explains what the BRI is, Beijing's motivations behind it, and builds on expert assessments to recommend U.S. courses of action towards China.

Land and Sea Corridors of the Belt and Road Initiative

--- Silk Road Economic Belt --- 21st Century Maritime Silk Road



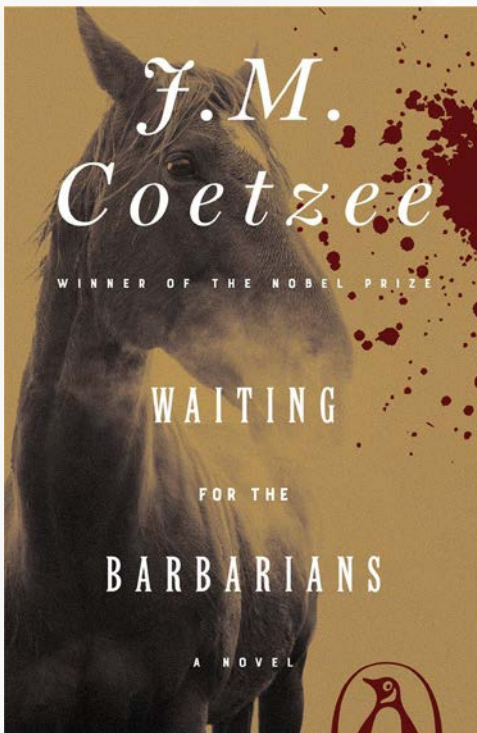
Waiting on the World to Change

C3C Robert J. Kersten

Faculty Mentor: Col Kathleen Harrington

Abstract:

Political divide based on hierarchies has been in the public spotlight as of late. This essay uses the current political climate to examine J. M. Coetzee's *Waiting for the Barbarians* as a literary explanation for the effects of power and anonymity on a middle and lower class. The explanation for Coetzee's motives derives from a literary review of the text with specific consideration of the power dynamic. Coetzee's creative example of an empire shows how power and positional authority fortify the maltreatment of minority populations. These individuals are further exploited by removing any sense of identity. The essay finishes by exploring Coetzee's use of sexual orientation to further describe the dangers of power seeking individuals. The essay found that J. M. Coetzee's *Waiting for the Barbarians* was critical of power and shed light on the importance of identity.



Waiting on the World to Change

*A contemporary analysis of J.M. Coetzee's
Waiting for the Barbarians*

Department of Foreign Languages

An analysis of the Existentialism in the novel Nada and La llamada of Carmen Laforet

C3C Andrew Hootman

Faculty Mentor: Dr. Ismenia Sales de Souza

Abstract:

The Spanish Civil War (1936–1939) proved to be a critical turning point in the nation's history and having an immense impact on the Spanish people. Post-civil war Spain saw much of the population in a distraught state because of the destructive aftermath and the establishment of the dictatorship of Francisco Franco. The Franco's regime caused radical changes in the nation and its people way of life. It took a massive toll on Spaniards and Carmen Laforet, a prominent twentieth century writer who emerged during this chaotic period, shows it in various literary works. Laforet uses the main protagonist, Andrea to portray the emotional and psychological condition of Spaniards during this point in the nation's history and integrates existentialism philosophy throughout the story to amplify the nation's situation. This essay analyzes how the author uses the novel Nada, and the short story La llamada, to illustrate Spain and the Spaniards, after the Civil War.



United States Satellite Network Vulnerabilities and Adversary Capabilities

C1C Karim Ahmed

Faculty Mentor: Dr. Ismenia Sales de Souza

Abstract:

The United States has been in the superpower position since the fall of the Soviet Union, yet adversaries have been engaging their capabilities to relive the U.S. of that role. In order to combat the next battle, the U.S created the Space Force, with a mission to maintain, protect, and expand the U.S. fleet of advanced military satellites that form the backbone of U.S. global military operations. This mission establishes a new front for security and global communications, yet it is not absolute. The focus will be on U.S. satellite vulnerabilities and adversary capabilities. While the satellite system is the U.S. new tool for maintaining the superpower status, the flaws in the system are what will allow the adversaries to engage and win the conflict. Satellites like all technological advances rely on a system that uses a computer based function, which is vulnerable to a malicious attack. A malicious cyber-attack is one of the few ways that the Space satellite network can fall. Another way is for another satellite to shoot it down, or set debris on a collision course with it. Recently, China tested one of its missiles and shot one of its satellite's down from orbit and that capability allows for the questioning of future motives, on the reason for the experiment. This topic is important due to level of diversion, which satellite systems play in our daily lives. Satellites enable the broadcast of television signals, or Wi-Fi. Satellites enable long distance communications between countries, as well as military forces. The fear is due to "the human factor; either someone engaging in an activity (witting or unwitting) on behalf of a cyber-threat actor. Alternatively, the omission of action (intentional or unintentional) such as patching, misconfiguration of systems; these entire factors can allow a gap to form which can be exploited by a threat actor. On a previous launch, the human factor which changed the calculations of spacecraft sources, the human factor led to the collision of these systems, due to a misinterpretation of units, between miles and kilometers. Currently, a new breed of satellites, which is much smaller in nature, yet called the parasitic satellite, due to its ability of traveling to orbit, without the need for a new rocket. These small satellites have the ability to halt and destroy every satellite they come in proximity of. As well as the robbery of information from the satellite system, which can be both a vulnerability and threat.

The Analisis of the Concept of Ubi sunt in the poem "Coplas por la muerte del maestro de Santiago don Rodrigo Manrique" por Jorge Manrique

C2C Eric Miller

Faculty Mentor: Dr. Ismenia Sales de Souza

Abstract:

Ubi sunt is a literary resource used often by writers of Latin-American literature. It was a widely used concept in medieval literature. In the poem, Coplas por la muerte del maestro de Santiago don Rodrigo Manrique, the writer, Jorge Manrique addresses a specific question: Where are those who came before us? Jorge Manrique, uses Ubi sunt to make references regarding important figures in the development of Spain history and culture. The writer uses Ubi sunt to emphasize the melancholy and elegiac tone of the poem. Therefore, this paper analyzes how the writer uses Ubi sunt in the poem regarding to Spain, the Roman and Christian contexts in the medieval and actual periods. Finally, this paper examines how Ubi sunt exemplifies the common changes in point of views on individual moral and religious values in the medieval period and afterwards.

A Comparative Analysis between the Biblical Version and the Auto de los Reyes Magos.

C1C Jamie Moul

Faculty Mentor: Dr. Ismenia Sales de Souza

Abstract:

The Auto de los Reyes Magos marks the beginning of the Spanish medieval theater. Throughout the centuries, Spanish literature has been heavily influenced by religion. For this reason, it will be interesting in comparing and contrasting this work with the biblical version to see what the differences are found in the two works. Unlike the Bible, The Auto de los Reyes Magos gives each of the Three Kings an in depth personality and with each personality a motivator. Therefore, the purpose of this paper is to make comparative analyses in between the two versions. In addition, to show the meaning and symbolism behind the story of the Three Kings.

A Comparative Analysis between Cantos de vida y esperanza por Ruben Dario and Veinte poemas de amor y una canción de Pablo Neruda.

C2C Nathaniel Kolligs

Faculty Mentor: Dr. Ismenia Sales de Souza

Abstract:

Many studies have been conducted on the literary work of Ruben Dario, the father of Modernism and a well-known author for his contributions to Latin American literature. Certainly, the vast number of research already conducted on his literary work has contributed substantially to the academic community. However, it is lacking a comparative analysis between Ruben Dario and Pablo Neruda. Therefore, the purpose of this paper is to make a comparative analyses between Cantos de vida y esperanza por Ruben Dario and Veinte poemas de amor y una canción de Pablo Neruda.

A Study of the Economic Collaboration between United States and Brazil in relation to Venezuelans Refugees in Brazil.

C1C Todd Campo

Faculty Mentor: Maj Julio Noschang

Abstract:

In January 2020, the United States announced the Economic Integration of Vulnerable Nationals from Venezuela in Brazil Program. According to the United Nations High Commissioner for Refugees, Brazil is hosting over 264,000 displaced Venezuelans. United States AID (USAID) reports that the US provided over \$32 million dollars to Brazil in the 2020 Fiscal Year as funding for the Venezuela regional response in Brazil. As the two largest economies in the Western hemisphere and the largest influences in each of their respective regions, cooperation between the United States and Brazil can have significant economic effects. By studying the agreements, joint ventures, and trade between the United States and Brazil, this research hopes to answer how the cooperation between the United States and Brazil to help Venezuelan refugees has influenced the economic relations between the two countries.

A Comparative Analysis of the Concept of Materialism in the United States and Spain.

C3C Aidan Boyle

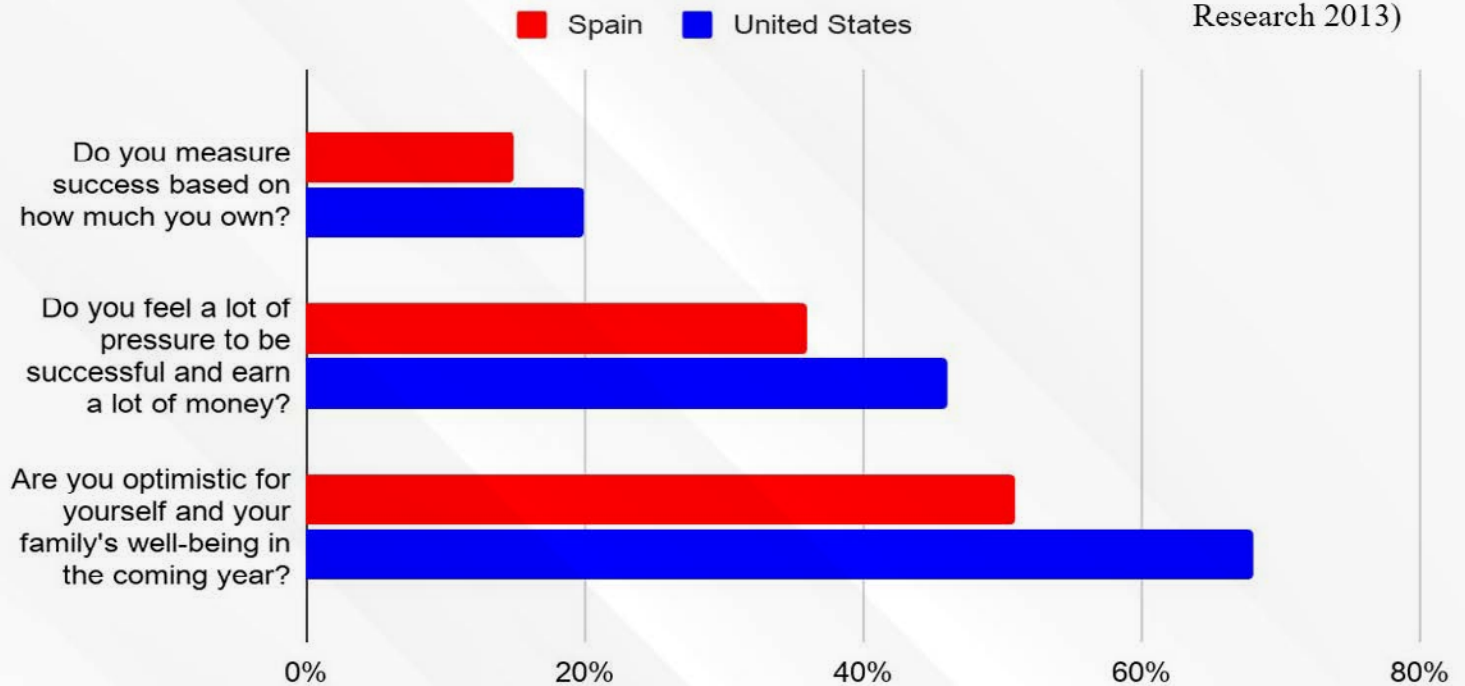
Faculty Mentor: Dr. Ismenia Sales de Souza

Abstract:

In the United States, one sometimes get the sense that everything seems to revolve around money. There are thousands of advertisements, shopping malls everywhere, and small and large business firms. In addition, a huge online shopping in which it is taking over the traditional Malls and Shopping Centers. In the United States, there is the concept that "more is better." This trend eludes to the idea of materialism, which is essentially the relentless pursuit of the "good life" through consumption. In the literary works of the Spanish poets Jorge Manrique, Garcilaso de la Vega, and Fray Luis de León, it is clear that these famous writers placed little importance on material wealth. Instead, they emphasize cultural values and traditions, religion traditions, the family institution, and well-being and health. Nevertheless, Spain's rapid modernization and re-establishment as a world power begs the question of whether this fact still holds true today. In this essay, I will investigate and compare three basic aspects of Spain and American societies: the pursue in acquiring material things, family institution, and religion traditions. Finally, I will analyze how each segment of society will affect each country's materialistic tendencies.

Attitudes about Wealth and Status

Source: (Ipsos
Global Market
Research 2013)



Silence in the Early Hours of 16 April 1746: The Glorious Revolution's Effect on Scotland and the Aftermath of the Jacobite Rebellions

C3C Abigail Asplund

Faculty Mentor: Dr. Meredith Scott

Abstract:

Many believe that the Battle of Culloden, on 16 April 1746, ended traditional Highlander life in Scotland. However, the Jacobites had been fighting for the restoration of their king since 1689. The Glorious Revolution of 1688 actually led to the Highlander's ultimate demise, as it kick-started the uprisings in Scotland that angered the British monarchy and Parliament. This presentation argues that Battle of Culloden was merely a tipping point of a long process, essentially wiping out the once-proud Jacobite Army. The British Parliament passed multiple acts after the events of 1688 that hindered the Scottish people and prevented a Catholic lineage from ascending the throne, a rule still governing the English monarchy today. The flight of Catholic King James VII/II and assumption of the English throne by William of Orange and Mary, Protestant daughter of James VII/II, resulted in a cascading slope of disparities for the Scottish Highlanders. Parliament halted many Scottish traditions for a seven-year span, including the playing of bagpipes and wearing of traditional Highland garb. Following the end of the 1745–1746 Jacobite uprising, later known as the "Forty-Five," Parliament went on to pass the "Disarming Act" and "Heritable Jurisdiction Act" in its attempt to prevent future uprisings in the Highlands. Despite ongoing attempts to restore the House of Stuart and a Catholic lineage to the throne, the Scottish Highlanders would never be successful.

Which event prompted restrictions on traditional Highlander life?



The Battle of Culloden in 1746



Glorious Revolution of 1688

East Timor: A Study in Human Rights Abused and Geopolitical Implications

C2C Lily Selvaggi

Faculty Mentor: Dr. Scott

Abstract:

In Plato's *The Republic*, Socrates debates the nature of justice within humanity. Is the government merely a reflection of the strong who impose their will on the weak? Does deference for the law arise from deferment and punishment or can humans behave justly in and of themselves? For the island of East Timor, the nature of justice can be seen through the actions and inactions of three intertwined agents: faithful grassroots movements, an encroaching Indonesia, and impassive global powers.

This paper will examine the Indonesian invasion and occupation of East Timor from 1974 to 1999, unveiling an asymmetrical power dynamic between the East and the West. In addition to analysis of newspapers, testimonies, and government documents, it examines the roles of Western powers. It highlights their selective concern for the East Timorese and contributions to President Suharto's destructive regime. This paper argues that Indonesia saw an independent East Timor as a threat to Suharto's totalitarian New Order and used Operation Komodo to destabilize the region. In return, global powers deferred to Indonesia under the guise of 'regional stability' and anti-communist ideology, overlooking grave abuses in human rights. This study of East Timor implies an obligation to critically consider the effects of self-interested strategic agendas and a global network of responsibility. It asks the larger question: where do geopolitical objectives end and where considerations of fundamental human rights begin?

Constructing China: Ethnic Minorities in Chinese Foreign and Domestic Policy

C1C Jackson Ayers

Faculty Mentor: Col Paul Gillespie and Dr. Sara Castro

Abstract:

In November of 2019, the New York Times released "the Xinjiang Papers", exposing the mass detention and cruelty towards the People's Republic of China's Turkic Muslim population. Similar aggression defines the relationship between the PRC and two of other largest autonomous regions: Inner Mongolia and Tibet. During the 1950s, however, the Chinese Communist Party (CCP) endeavored to build a national identity, *zhonghua minzu*, inclusive of ethnic minorities and distinct from its imperial roots. This project examines the domestic and geopolitical origins of early ethnic considerations in China. The Wilson Center and People's Daily digital archives provide most of the primary source material in this research. It departs from previous historiography by incorporating internal and external developments, not isolating either factor in its analysis. This synthesis reveals that stability with the Soviet Union and unstable imperial influences created the context for China's ethnic considerations and national identity construction during the 1950s. Significantly, the PRC's national identity and foreign relations during this period were inherently prescriptive. As opposed to describing the contemporaneous state of its frontier regions, *zhonghua minzu* imagined identities and relations with the Western world to come. The dissonance between this prescriptive identity and party control are still consequential to the PRC today.

The London Times and the Early British Labour Party

C3C Angelo Capriola

Faculty Mentor: Dr. Robert Wettemann

Abstract:

The early years of the British Labour Party represented a significant political evolution within the United Kingdom that caused reverberations throughout the democratic world. This research analyzes how the famous London newspaper The Times, reported on the burgeoning Labour Party between the formation of the Labour Representation Committee (the party's original name) and the party's remarkable successes in the 1906 United Kingdom general election. The report compares the inside developments of the early Labour Party, its centralization as a political party, expansion among British trade unions, and legitimization as the sole Parliamentary representative of British labor to The Times' evolving coverage of the party. Documenting The Times' reporting, the paper's view of the Labour Party shifts from a small and mostly insignificant group of labor activists to a legitimate Parliamentary party with substantial political capital. The Labour Party's significant successes in the 1906 election validated The Times' evolution in coverage and demonstrated the paper clearly accurately assessed the party's growing potential for electoral success. Ultimately, The Times' accurate assessment of the early Labour Party and its political potential indicates the paper correctly analyzed British politics of the time. This research uses primary source publications of The Times along with diverse narrative histories of the early Labour Party and its development.



Initial Neglect

... (text continues) ...

A Phantom Army

... (text continues) ...

The Election at Dewsbury

... (text continues) ...

The Same Old Socialists

... (text continues) ...

The Root of the Israeli-Palestinian Conflict

C2C Audrey Phillips

Faculty Mentor: Dr. Douglas Leonard

Abstract:

Like much of the Middle East, there is ongoing conflict between Israel and Palestine. These tensions are rooted in a number of issues, which this paper considers. Examining events between the late 1800's and the mid 1900's, it argues that the origins of continued violence in the Israeli-Palestinian region can be found in British inconsistency and a lack of responsibility amongst the powerful five of the United Nations. In addition, there was poor decision making when partitioning the territories. From a broader perspective, this paper examines the failures of the mandate system and the impacts on the Jewish identity. The arguments in this essay can also be applied to a wider understanding of conflict in the Middle East as a whole. This paper analyzes historical events through socio-economic tensions, relative perceptions of Israelis and Palestinians, and events that laid the groundwork for later conflict. An ethnographic lens helps clarify the cultural evolution of the Jewish population in both Israel and Europe. This essay relies upon three primary sources: the White Papers of 1912, the Balfour Declaration, and the Charter of the United Nations. Secondary sources in this essay include multiple perspectives regarding Jewish and Palestinian experiences, as well as such major political events as the Sykes-Picot conference.

The President vs. the Joint Chiefs of Staff: Nixon and Civil-Military Relations, 1953–1972

C1C Mark Schell

Faculty Mentor: Dr. Douglas Kennedy

Abstract:

Richard Nixon inherited a divisive and unpopular war upon election in 1968. The Joint Chiefs of Staff (JCS), his primary military advisors, were also legacies of the previous Johnson administration, which was notorious for manipulating the military to achieve short-term political gain. The Nixon administration and JCS would ideally work together to bring about a successful conclusion to the conflict, and it is true that Nixon entered the presidency eager to utilize his military advisors. However, he quickly became frustrated with their lack of imagination and boldness. Early events, such as the MENU bombings, EC-121 shootdown incident, and PRUNING KNIFE planning, marked the rise and fall of JCS influence. Subsequent milestones – the Cambodian incursion, Lam Son 719, the Easter Offensive, and Linebacker II – show the Nixon administration actively undermining the Joint Chiefs and shifting their responsibilities elsewhere. Although no structural changes limited the JCS's power, Nixon and members of his administration undercut and restricted the Joint Chiefs by withdrawing from the traditional national security apparatus, valuing loyalty over expertise, and discrediting the chain of command. These events are compellingly captured in the Foreign Relations of the United States archives, which include memorandums, telephone and conversation transcripts, and contingency proposals. Numerous autobiographies, including those of Richard Nixon, Henry Kissinger, and William Westmoreland, also help tell this story. Secondary sources, such as Dr. Jeffrey Kimball's *Nixon's Vietnam War* and Stephen Randolph's *Powerful and Brutal Weapons*, compliment primary sources and provide necessary context, especially considering the complexity of the time.

Art of a New Era: The Social and Cultural Impact of Tattoos on North America and Europe since the 1700s

C1C Hunter Matthew Myszka

Abstract:

Modern scholars have found evidence of tattoos on humans dating back to 1000 B.C.E. Numerous ancient civilizations practiced the art of tattooing and passed it down from generation to generation. The history of tattooing is especially prominent in the Philippines, Japan, New Zealand, and other Pacific Ocean countries. This led to a deep affinity for tattoos in these countries, in stark contrast to Europe. Although tattoos were practiced by Northern and Eastern European civilizations such as the early Norwegians, Slavs, and Germans, they never became as widespread as in East Asia and the Pacific. This changed with the journals of numerous European explorers, the most famous of which are the journals of Captain James Cook. Cook's journals in the Pacific brought back descriptions of the elaborate tattoos. The people of Europe quickly took up the practice, and within the next century, tattoos were becoming a common sight both in Europe and the newly created United States of America. Tattoos were popularized in the military, especially in the Royal and U.S. Navies. Regular citizens started to get tattoos, and a rapid boom occurred. With this boom came a counterculture that despised tattoos and tattoos themselves became a counter to the then modern norms of society. This cultural war transitioned to the tattoo culture today. Tattoos are visible across the media and society. Yet there is still a large aversion to the practice, but it has become a well-established industry leading to a greater acceptance for different expressions of art and culture.

Ancient Roots



Great Britain and Russia's Quandary with Institutes of Art and Public Art Consumption in the Late Nineteenth Century

C1C Maria G. Gasparovich

Faculty Mentor: Dr. John Jennings

Abstract:

The late nineteenth century provides historians the ability to observe early clashes between cultural diplomacy and class distinction through the production and consumption of art. These clashes both intentionally and unintentionally established national identities, depending on the varying degrees of exposure to outside cultures. Two emerging world powers, Great Britain and Russia, not only dealt with class problems in the domestic production and consumption of art, but also through their cultural diplomacy with each other. This interdisciplinary investigation considers the dynamic between Great Britain and Russia through several approaches. It examines the creation of art institutions and museums, consumption habits of the upper classes, the motivations of artists and art critiques, and the power of travel guides. In doing so, it analyzes evolving national identities. While the production and consumption of art in these two nations developed differently based on separate socioeconomic structures, their methods of creating art professionals and critic had much in common. The value of breaking down these cultural exchanges is vital, as they represent solidifying of national identities, the rise of the bourgeoisie class in Europe, and the emerging travel culture of the late 19th century. These factors created networks that ultimately helped governments control the narrative of national identity on the world stage.

Silent Saviors: American Glider Operations in Normandy, 6–13 June 1944

C1C Cole Resnik

Faculty Mentor: Dr. Bob Wettemann

Abstract:

Only twenty-four days after American boots hit French soil on June 6, the Allies captured the crucial port of Cherbourg. From there, they mounted a massive logistical operation that kept the Allied fighting force fueled until the end of the war. However, resupply leading up to Cherbourg proved difficult. On the beach, the amphibious supply missions in the days following D-Day underperformed, due to a variety of factors. Meanwhile, airborne infantry divisions inland struggled to push back German armored divisions attempting to reach the shore. With few supplies ashore and an operational airfield a week away, only gliders or airdrops could deliver the artillery pieces and ammunition so desperately craved by paratroopers in a mission to combat their armored foes. In the end, gliders proved the most effective in doing just that. Historians devote much attention to the gliders landing with the paratroopers on D-Day, but this paper redirects that attention toward the little-known glider resupply missions flown thereafter. During these missions, commanders realized the full potential of gliders. A discussion of their ability to (1) deliver heavy equipment behind enemy lines in a (2) precise, (3) cohesive, and (4) timely manner explains why commanders utilized gliders more than airdrops in the crucial task of resupply. To prove this point, the author utilized several primary sources including eyewitness interviews, operations reports, and technical data discovered in the Eisenhower Presidential Library Archives and the Clark Special Collections Library at the United States Air Force Academy. Other sources include several books, articles, and dissertations all relating to the Normandy invasion.

Abstract:

The Mexican Revolution (1910–1920) proved to be a critical turning point in the nation's history. It was the climax of years of the Mexican people's frustration, due to unfair social and economic treatment. A small group of upper-class elites, known as científicos, which included the long-reigning president Porfirio Díaz, had immense influence over the middle and lower classes; as a result, the embittered Mexican population launched the Mexican Revolution. Various influences and figures from all over the nation ignited and then fueled the Revolution, including the Flores Magón brothers, who founded the often overlooked but influential newspaper, *Regeneración*. This newspaper agency set out to expose the figures at the top of the social hierarchy responsible for the hardships the Mexican people faced, particularly Porfirio Díaz, by describing to the middle and lower classes the typically unseen corruption that went on in the government. *Regeneración* stirred the longtime boiling pot of frustration within the Mexican populace, igniting within them the desire to revolt and make change in the frameworks of the Mexican government. Ordinary people looked to *Regeneración* for inspiration and became zealous revolutionaries, dedicated to overthrowing the oppressive Mexican government. Thus, this single newspaper played a critical role in the intellectual movement, which recruited the Mexican people for the movement. This essay translated and analyzes multiple articles published in *Regeneración* during the Revolution and describes how they influenced the growth of the uprising.

Flores Magón Brothers



Figure 4.1 Jesús, Ricardo, and Enrique Flores Magón. Courtesy of the Casa del Hijo del Ahuizote, Mexico City.

Ricardo, Jesus and Enrique Magón were noted Mexican social reform activists in the late nineteenth and early twentieth century Mexico. They played a crucial role in helping spark the Mexican Revolution. Ricardo Flores Magón led the Partido Liberal Mexicano even after he was forced to leave Mexico.

Cold War Espionage: 1953-1964
C3C Jonathan Myles
Faculty Mentor: Dr. Meredith Scott

Abstract:

The Cold War that engulfed the post-World War Two nations of the United States of American and the Soviet Union encompassed more than proxy wars and nuclear threats. Espionage, or the use of spies and spying, became the most prevalent source of keeping the Cold War tensions cool. Mainly, this paper explores espionage and more specifically, the uses and results of human intelligence that both the United States extensively used during the Cold War. The work done by spies were essential in preventing or causing many things to happen during the Cold War era. One of the more important epochs of espionage came during 1953-1964 or the Khrushchev era, when the Cuban Missile Crisis occurred. In addition to this brief introduction of what this paper addresses, the main argument focuses on the work and recruitment of spies in the Khrushchev era and how those spies were an essential hidden entity that shaped the history of warfare, intelligence gathering, and the outcome of the Cold War.



Encroachment of COVID-19 State Executive Emergency Powers on Civil Liberties: The Inverse Relationship between Permanent Enforcement and Constitutionality

C2C Jessica Williams

Faculty Mentor: Prof Douglas B. McKechnie

Abstract:

In response to the global pandemic, executives have rapidly exercised expansive emergency powers, significantly restricting civil liberties to maintain public health. However, as COVID-19 continues into its second year, the legal community, including Justices of the United States Supreme Court in *Roman Catholic Diocese of Brooklyn v. Cuomo*, challenge whether state executive emergency rules that diminish these liberties are the least restrictive way of protecting citizens. This paper explores the constitutionality of state emergency powers in response to the unprecedented COVID-19 pandemic through analyzing the unique circumstances of Pennsylvania. It suggests that there is an inverse relationship between the emergency powers' permanence and its constitutionality and, thus, state executives may surpass their constitutional authority if rules remain in force long past their triggering event. The paper begins by providing the constitutional and legislative framework for the establishment of executive emergency powers. It then examines past precedent to define state executives' emergency rulemaking scope. I then examine Pennsylvania executive emergency powers and courts' responses during the COVID-19 pandemic to determine whether executives transgressed their constitutional bounds. Ultimately, I posit that the Pennsylvania executive branch's recent emergency rulemaking may unconstitutionally violate civil liberties and expand future state executive emergency powers.



The Motivators and Morality of Espionage

C2C Paul Khang

Faculty Mentor: Maj Jeremy Grunert

Abstract:

The term "moral spies" is contradicting. Spies are expected to break the laws of foreign countries by manipulating their citizens through lies, coercion, and other espionage techniques that question ethical standards, yet they are required to meticulously comply by their own nation's laws and moral principles. Consolidating the moral limits of espionage creates difficulties as what constitutes an acceptable moral behavior varies upon the individual. However, time after time, numerous studies indicate that spies are driven by common motivators when conducting espionage. This presentation first examines the motivators for spies to conduct espionage through a multi-tiered framework using the acronyms MICE. MICE, which stands for money, ideology, coercion or compromise, and ego or excitement, is an organizational framework that was commonly used by the KGB, the former Soviet Union's primary security agency, to identify the major motivators when recruiting their agents. This presentation will ultimately assess the morality of espionage through ethical frameworks, which include, but are not limited to, utilitarianism, subjectivism, and egoism. By examining this intriguing topic of the motivators and morality of espionage, I aim to clarify not only what motivates spies to engage in behaviors that, at times, question ethical standards, but whether spying is actually unethical. I posit that the ethics of spies cannot be assessed under one particular ethical framework because of their various motivations to participate in espionage. Instead, the morality of their spying must be assessed individually based on their individual motivators for espionage. I obtained the sources of research that support my findings from various intelligence publications by the Central Intelligence Agency (CIA), various primary sources written by former spies and their handlers, and the International Journal of Intelligence Ethics, which is a compilation of journals produced by numerous intelligence professionals.



Department of Management

Economic Impacts of U.S. Air Force Aircraft Refueling Operations in the Asia-Pacific Region (151)

C1C Lucas Castro, C1C Natalie Holley, C1C Scott Johnson, and C1C Matthew Polzin

Faculty Mentor: Dr. Johnathon Dulin

Abstract:

Thanks to recent military refueling operations in Brunei, the United States positively impacted the local economy and strategic diplomatic relations with the nation. As a result of a small investment from the United States, the Nation reaped tangible benefits and the United States strengthened its position in the region. This event suggested that there may be an avenue for tanker operations to help develop the economy and influence second- and third-order effects in the Asia-Pacific Region and sparked the question, "How can the United States Air Force leverage its military means to positively affect the economic sector of nations in the Asia-Pacific Region?" Using an econometrics model based on the Gross Domestic Product expenditure approach, we were able to find the amount of routine tanker aircraft stops necessary to make a "significant" economic impact. Based on these findings, the United States Air Force is now developing plans to expand these operations within the region and build flight paths based on significant benefit realized by smaller countries from a minimal investment by the United States.

Satellite Acquisition and Constellation Optimization with Genetic Algorithms

C1C Dylan Alexander, C1C Toby Foelix, C1C Benjamin Howard, and C1C Dhruv Odedra

Faculty Mentor: Dr. Johnathon Dulin

Abstract:

The American taxpayer funds the acquisition of satellites in support of national security purposes such as intelligence collection. Satellite constellations and systems are in turn acquired and used by government agencies, such as the National Reconnaissance Office, to gather information and disseminate intelligence. There is no current data-driven process to acquire and position satellites; instead, these decisions are made by subject matter experts following qualitative approaches. Therefore, we investigate what type of algorithms can provide a better way to analytically ensure satellite constellations are being procured and placed in the most optimal way. We devise a conceptual methodology and create an accessible interface to allow the user to input certain specifications and constraints. Our algorithm then proposes satellite constellation placements that maximize coverage of an area of interest under a set of notional input parameters. Ultimately, the algorithm provides a process to acquire and place satellite constellations, so they are both highly capable and cost effective.



Genetic Evolutionary Algorithm Process

$$\begin{aligned}
 & \max(X_{sat_{coverage}} - \gamma Y_{num_{sats}} - \sigma Z_{altitude}) \\
 & \text{Where } \gamma \text{ and } \sigma \text{ are cost parameters} \\
 & 200 \text{ km} \leq alt \leq 2000 \text{ km} \\
 & 1 \leq planes \leq \text{floor}\left(\frac{polar_{circumference}}{alt * \tan(conic_{halfwidth})}\right)
 \end{aligned}$$

— Equations Used in Algorithm —

Ice Cream Demand Forecasting and Production Optimization
C1C Seth Allen, C1C Colton Blatchford, C1C Luke Kilianski, and C1C Nakai Lake
Faculty Mentor: Faculty Mentor: Dr. Johnathon Dulin

Abstract:

Ice cream production is a \$55 billion industry in the United States, with the average American consuming about 12 pounds of ice cream every year. Josh and John's is a staple ice cream company in the state of Colorado and has several stores and wholesale accounts that contribute directly to the local economy. To maintain its status as a Colorado icon while considering expansion options, the company needs to minimize the cost of production while still meeting monthly demand. We accomplish this by developing an accurate forecast of demand and providing insight into the ice cream production process. Using production and sales data we are able to measure historical demand, which in turn feeds a simulation of the production process that allows us to establish an optimal production and distribution schedule, evaluate the impact of equipment breakdowns and changes in demand, and ensure effective operations. By analyzing the production process in this manner, and having developed an accurate prediction methodology for ice cream demand, we provide Josh and John's with a dynamic tool that supports real time production and distribution decisions.

Improving the Ziberty Custom Home Construction Cost Algorithm
C1C Andrew Grove, C1C Jonathan Imperial, C1C Nicholas Parham, and C1C Alec Schrank
Faculty Mentor: Dr. Johnathon Dulin

Abstract:

Home building costs have increased dramatically in the last decade. But with historically low interest rates, consumer buying power is stronger than ever and so demand for new homes is at an all-time high. A confounding factor in meeting this demand, though, is that construction costs have been difficult to manage because builder budgets are both complex and dynamic. Historically, home developers have struggled to stick to their initial budget. Due to extensive varieties of available materials and styles, with sometimes vastly different quality and cost levels, accurately predicting construction costs for custom built homes is a complicated task. Yet these predictions need to be accurate and precise in order to build a realistic budget, thereby allowing contractors to provide an up-front, final cost to the home buyer that allows them to secure appropriate funding. In this paper we evaluate common machine learning algorithms to identify the factors that describe as much of the variation in construction costs as possible. We find that regressions are the best tradeoff between interpretability and accuracy.

Biomedical Machine Maintenance Scheduling
C1C Danielle Katz, C1C Serena Kim, C1C Alexandra King, and C1C Elisha Palm
Faculty Mentor: Dr. Johnathon Dulin

Abstract:

Tissue banks procure approximately 45,000 tissue donors per year, providing nearly 9,000,000 individuals with life-enhancing and life-saving medical procedures. Proper biobank machine maintenance is imperative to this process. Mandatory forms of maintenance are critical to avoid

unexpected malfunctions which can halt operations and render samples unusable. Each machine has a unique reliability rate within the overall system; although some can quickly be repaired or replaced, many processes rely on a singular machine and even planned downtime can have significant impacts on tissue processing. AlloSource, one of the largest tissue manufacturers in the United States, too often schedules these preventive events unnecessarily or at the wrong time, resulting in machines sometimes breaking down at inopportune times. In response to these inefficiencies we ask, "What is the best consolidated and standardized equipment maintenance schedule that minimizes production downtime while meeting the demand of the biomedical manufacturing network?" We use an integer programming model to consider equipment reliability, downtime, availability, and demand to develop a standardized schedule. Our analysis balances the objectives of minimizing maintenance requirements while maximizing tissue bank functionality. Ultimately, we are able to decrease average downtime and increase equipment availability, proving the standardized schedule provides more opportunities for tissue therapies.

Machine Learning Model to Rank Air Force Officers

C1C Rhett Harms, C1C Garrett Miyaoka, C1C Ethan Richards, and C1C Connor Shaw
Faculty Mentor: Dr. Johnathon Dulin

Abstract:

With the evolution of warfare, the need for dynamic military leaders is greater than it has ever been in the past. Promotion boards are subjective, and reviewers have only limited time to evaluate personnel records. With the help of a data-driven model, we can focus their efforts to make more accurate decisions regarding which officers have best demonstrated the qualities that are vital to success in the higher ranks. By evaluating attributes of past effective leaders within the Air Force Special Operations Command, we can predict officers' standing in a promotion board based on both qualitative and quantitative information and forecast where a given officer ranks against his or her peers. We develop an automatic data cleaning software bundled with machine learning algorithms to accomplish this task, and ensure our program continues to learn in future years while allowing the user to easily replicate the entire process. Our software combines these to provide decision makers an easy-to-use result to save time and to make better-informed decisions about military promotions.



Test Equipment Transportation Using the Traveling Salesman Problem

C1C Donna Borer, C1C Winifred Chen, C1C Michael Leonard, and C1C Alana Tallman

Faculty Mentor: Dr. Johnathon Dulin

Abstract:

When transporting testing equipment, organizations often run into complications over the competing interests of minimizing both travel time and the associated costs. More specifically, it is difficult to quantify the value of time and compare it to the costs associated with a specific event. There are a multitude of factors that must be considered in the transportation of any equipment. For example, the type of testing associated with a particular event further increases the complexity of the issue, as some missions do not require a considerable amount of equipment while others may require a much more significant investment of time and resources to execute. These aspects of the equipment transportation process, among others, make the minimization of costs and travel time difficult to achieve. The goal of this project was therefore to create a decision support methodology for scheduling test events that (1) lowers costs, (2) decreases travel times, and (3) accommodates more customers, with the objectives addressed in that order. With testing locations scattered across the nation and broken up into relevant groupings, implementing a traveling salesman approach was found to be the optimal equipment transportation methodology. This technique allow for an increase in the ability to supply testing equipment to meet the growing demand which is prevalent throughout the testing community.

Object Detection Using Artificial Intelligence: Predicting Traffic Congestion to Improve Emergency Response to Mass Casualty Incidents

C1C Miranda Ahlers, C1C Alexander Hamilton, C1C Rye Julson, and C1C Michael Kolesar

Faculty Mentor: Dr. Johnathon Dulin

Abstract:

In the last decade, over two billion people have become casualties of natural disasters, transportation accidents, industry mishaps, building collapses and several other destructive incidents. These events are categorized as mass casualty incidents, and the success of the emergency response to such events depends heavily on efficient emergency vehicle transportation. During a mass casualty incident, the status of transportation pathways is constantly fluctuating due to natural obstructions and infrastructure damage making it difficult to evaluate real-time traffic delays. Due to this complexity, standard traffic delay software is not reliable in routing emergency resources to the site of the incident. This paper asks the question, "How can image recognition and deep-learning be used in real-time to aid emergency vehicles in mass casualty incident efforts?" The primary approach taken to address this problem is the "You-Only-Look-Once" method, used to provide accurate vehicle detection. Supporting methods include a vanishing point detection system for road detection and a deep-learning approach to produce a final congestion classification. The combination of these methods yields a classification of traffic congestion and a binary indication of whether a pathway is available for emergency vehicles. The resulting output will ultimately guide a decision-maker or supplemental model to optimize emergency vehicle deployment, thus saving lives.

Key Metric Selection for Automated Scheduling in the Hotel Industry

C1C Spencer Brown, C1C Luke Chilcutt, C1C Clarissa Jolley, and C1C Brandon Smyth

Faculty Mentor: Dr. Johnathon Dulin

Abstract:

The hotel industry relies heavily on people to perform manual tasks and support customer needs. Labor costs make up 50% of a hotel's expenses, therefore maximizing the utilization of staffing is key to a hotel's profit margin. Work schedules are often created manually, though, requiring a significant amount of time to produce and often failing to maximize utilization rates. Commercial software has been successfully used in many industries to reduce the time needed to produce schedules, but an important aspect is identifying what factors are the most important to the organization. In this paper we evaluate the relationships among room occupancy, number of hosted events, and labor rates for a hotel in order to determine the optimal number of employees to schedule based on predicted demand. This analysis allows us to answer the question, "What metrics are the most appropriate to deliver reliable schedules that minimize cost by optimizing staff utilization?"

Using Business Process Re-engineering to Find Solutions for the Most Common Improper Payment Errors in the Defense Travel System Trip-Planning Process

C1C Thomas Haskell, C1C Stephen Kimatian, C1C Christopher Meno, and C1C Franklin Sun

Faculty Mentor: Dr. Johnathon Dulin

Abstract:

Companies, organizations, and government services need an effective, reliable travel planning and reimbursement system to repay costs and manage financial resources. The original intent of the Defense Travel System was to facilitate user-friendly travel and financial management; however, the system's average improper payment rate of 4.1% causes administrative workload burdens, and an estimated \$18.9 million dollars expended through improper payments every month across all Department of Defense service branches and agencies. The aim of this study is to use business process re-engineering to create a model to assist in the determination of invalid versus valid receipts, decreasing both the administrative burden and improper payments rate. Our approach combines a third party open source receipt optical character recognition library with a receipt validation algorithm to determine the probability that a receipt is valid, thus focusing the attention of Authorizing Officials on payment requests that have the greatest risk of containing errors. Preliminary validation criteria was set by examining a training and testing set of both valid and invalid receipts with these results further improved through feedback from operational Authorizing Officials.

Predicting F/A-18 Component Failure Rates

C1C Gregory Barry, C1C Connor McCormick, C1C Grace Metzgar, and C1C Adrian Robinson

Faculty Mentor: Dr. Johnathon Dulin

Abstract:

The Department of Defense budget decisions have had a significant impact on the mission effectiveness of military service branches and units. The United States Navy's most prominent fighter and attack jet, the F/A-18, has seen a drastic decrease in the percentage of aircraft that are mission-ready in the fleet over the past 12 years. This rapid decrease in the mission capable rate of the F/A-18 fleet requires a thorough analysis of the fleet's sustainment process. Using a model of the sustainment process that incorporates an accurate depiction of aircraft component failures, we can provide decision-makers with data-driven recommendations on where budget spending will most benefit the sustainment process and improve the mission effectiveness of the F/A-18 fleet. To accurately forecast the aircraft mission capable rate for inclusion in the model, we determine how much historical data to utilize for relevant aircraft component failure rates and use that period of data to predict the rates of critical aircraft components, allowing for more proactive parts ordering and maintenance scheduling.



Results and Impacts

Better prediction of parts will:

- Save millions of dollars
- Allow maintenance shops better stocking of parts
- Increase the MC rate of the F/A-18 fleet

Time Window	Flat Average Error Rate	EMA Error Rate
9-Month Windows	57.28%	42.81%
2-Month Windows	54.99%	22.12%
1-Month Windows	60.19%	14.52%
Variable Windows	53.89%	24.70%

Note: There were 187,175 true failures for Jan 2018 - May 2020

Department of Mechanical Engineering

Comparison of Critical Aircraft Design Properties of Additive Manufactured and Ingot Manufactured Titanium Alloy Ti-6Al-4V

C1C Tessa Barbosa and C1C Elijah Palm

Faculty Mentor: Dr. Ralph Bush

Abstract:

Titanium alloy Ti-6Al-4V is commonly used for critical structural parts in Air Force aircraft. However titanium material and machining titanium parts to their final shape are very costly. Typical part fabrication processes involve the purchase of thick plates of ingot manufactured material and machining away a high percentage of the plate to make complex shaped parts. Additive manufacturing provides a method by which net shape parts can be manufactured, eliminating many of the costs associated with machining and purchase of material that is not used in the final part. This research sought to compare important mechanical properties of additive manufactured (AM) and ingot manufactured (IM) Ti-6Al-4V titanium material to determine the feasibility of replacing ingot manufactured parts with additive manufactured parts. Microstructure and tensile, fracture toughness, and fatigue crack growth properties of AM and IM Ti-6Al-4V material were measured and compared. The IM material was supplied in two conditions, mill annealed and ELI β annealed.

Microstructural analysis showed that the IM β annealed material had a coarse lamellar structure, the AM a fine lamellar structure and the IM mill annealed a mixed mode structure. Tensile and yield strengths of the IM mill annealed material were about 4 to 5% greater than those of the AM material. Whereas, the IM β annealed strengths were 9 to 14% less than those of the AM material. Fracture toughness values of IM β annealed material were between 25 to 30% greater than AM material, which in turn were 25 to 30% greater than the IM mill annealed material. Fatigue crack growth testing revealed that cracks grew at a similar rate in IM mill annealed and AM material in the ΔK region between 10 and 20 ksi-in^{1/2}. However, at higher ΔK ranges, crack in the AM material grew slower. Above ΔK ranges of 40 ksi-in^{1/2}, the crack growth rate in AM material was 10 times slower than the IM mill-annealed material. Cracks in the IM β annealed material grew 3 to 10 times slower than AM and IM mill-annealed material between 10 and 20 ksi-in^{1/2}, about twice as slow as those in MA material between 20 and 40 ksi-in^{1/2} and 2 to 5 times slower than AM material above 40 ksi-in^{1/2}.

Literature review indicates that lamellar microstructures in titanium alloys exhibit superior fracture toughness and fatigue growth properties and inferior tensile properties as compared to mixed mode microstructures. Coarse lamellar microstructures have improved fracture toughness and fatigue crack growth properties as compared to fine lamellar microstructures. This work shows that the differences between the AM and IM materials are primarily due to the different microstructures, which in turn are due to the different thermal histories experienced by each material. Future work will concentrate on exploring changes in thermal history of the AM product to tailor properties to those required for a specific aircraft part.

Enhanced Composite Material Damping via Embedded Honeycomb Resonators

C2C Becket Andersen, C2C James "Reid" Boudrie

Faculty Mentors: Lt Col Eric Dittman and Lt Col Matt Snyder

Abstract:

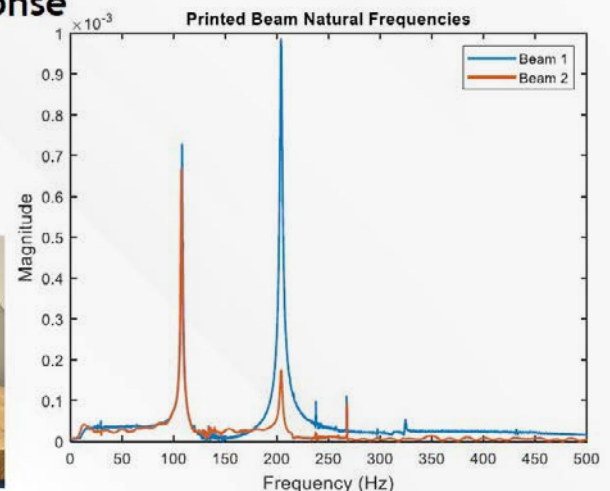
Reinforced fiber composite materials offer several advantages to traditional isotropic materials particularly for applications requiring high, or tailored, strength properties and low weight. However, mechanical resonance can shorten the life of a composite as these vibrations may exacerbate existing damage in the matrix leading to failure. The addition of a matrix embedded cellular honeycomb structure with resonating beams may provide a method to maintain the strength of the composite while providing enhanced damping capability. The unit cell design includes a repeating hexagonal cellular structure, honeycomb, with a cantilever beam protruding from a cell wall to the center of the unit. A tailorable point mass is fixed to the end of the beam in order to tune the dynamic response of the structure. This particular study will involve design, analysis and testing of the hexagonal cellular structure where each cell is sized between 1–2 inches in diameter. Initial analysis includes modeling of the resonator to determine ideal geometric and material properties modeling a single unit cell. The model will be extended to $n \times n$ unit cells using NASTRAN and the finite element capabilities in Fusion 360. The team will additively manufacture the proposed concepts and test using accelerometers and a laser vibrometer in order to characterize the response. Initial concepts will focus on a single unit cell and then additional cells will be added and the interactions between the resonators studied to understand the effect of additional resonators on the response of the system.

■ AM printed 2 beam specimens

■ Laser vibrometer to capture frequency response

	Predicted	Experimental
First bending	128 Hz	106 Hz
First in-plane bending	256 Hz	? 202 Hz ?

ABS-30 Material Properties	
E (Gpa)	2.2
Density (g/cm ³)	1.04
Density measured	0.55



Department of Military and Strategic Studies

Air Force Sexual Assault Prevention: A Conversation Based Approach to Changing Culture

C2C Jacob Boone, C2C Felicity Horan, and C2C Jacob Vierra

Faculty Mentor: Dr. Kyleanne Hunter

Abstract:

After hearing multiple stories of victims experiencing sexual assault in the Air Force, we have identified a major problem facing the Air Force. Specifically, there exists cultural norms and attitudes within the ranks that contributes to a perception of stigma when it comes to reporting sexual assault cases. This is because sexual assault does not just affect one gender or age group in the Air Force population. It affects all Air Force members through gender, age, AFSC, rank, and sexual orientation. With an increasingly high rate of occurrence of sexual assault cases over the last decade, this not only affects the Air Force mission, but contributes to psychological damage that disrupts team cohesion and trust within the ranks and across the Joint Force. By relying on the spectrum of improper behaviors, sexual harassment is usually a precursor behavior that eventually leads to sexual assault. Thus, sexual harassment prevention cannot be treated as a separate issue in isolation because it should be acknowledged in sexual assault prevention programs. As Airmen must always strive towards the team concept, this requires loyalty and trust in each other, which supports Air Force readiness and lethality. The best way to change culture, norms, and attitudes is to have discussion. Hence, we are prototyping a training program that will encourage Airmen to talk openly. Presently, Air Force SAPR training consists of a large group of Airmen meeting once or twice a year for briefings on Sexual Assault topics. This type of training does not promote a change in culture. Instead, it contributes to cynical attitudes where Airmen become resentful about Sexual Assault training and conversations about the topic. Additionally, the cold, clinical training approach discourages Airmen from changing the culture surrounding sexual assault. Our new training model emphasizes discussions within and outside of units to foster mutual understanding and trust, while supporting team cohesion. Led by E4-E6's, who have been trained to moderate through a new course in Airmen Leadership School, they will ensure civil conversation, mutual respect, and prevent unrelated topics. To ensure accountability, SAPR (or designated representatives) will randomly sit in on discussions. Changing SAPR training helps the Air Force improve culture, create accountability, and normalizes the topic of sexual assault, much as the suicide topic has evolved in the Air Force.

21st Century Defense Prioritization: Towards a Strategic Value Proposition

C1C Olivia Cretella

Faculty Mentor: Dr. Kyleanne Hunter

Abstract:

The American way of budgeting for strategy is backwards. There is a need for the US to rebalance priorities and defense assets based on regional and DIME (Diplomatic, Information, Military, and Economic) related value propositions. To resolve this puzzle, a quantitative system was developed for this defense priority process, which synthesized/weighted data based on National Defense Priorities outlined in the NSS. Her research identifies smarter uses of strategic resources in pursuit of US national security interests so that strategy drives the budget process.

Role 2 Medical Care in the US Military: Information Leads to Saving Lives

C1C Zachary Flash

Faculty Mentor: Dr. Kyleanne Hunter

Abstract:

Medical treatment in a deployed environment requires a skilled and well-equipped team. This is difficult to coordinate, especially when teams belong to different branches of the US military and are expected to treat all military and civilian patients. Lack of standardized staffing, equipping, training, and reporting of forward surgical teams has prompted this Joint Trauma System (JTS) project to collect data about the: organization, preparedness, and operations of various Role 2 medical teams. This is problematic as the 1986 Goldwater-Nichols Act specifically directed jointness across the Department of Defense, and yet, medical teams struggle with interservice treatment. With this information, the JTS will improve deployed medicine by developing standardized procedures and practices, as well as consistent training and logistics. Four main ideas from JTS reports highlight the (1) importance of medical imaging, (2) lack of standardized training, (3) confusion surrounding documentation, and (4) emphasis on clarifying Role 2 team responsibilities.

DoD Suicide Prevention Programs: Accepting Things Need to Change

C1C Kaylynn Harvey

Faculty Mentor: Dr. Kyleanne Hunter

Abstract:

My capstone is involved with the Suicide Research project – specifically targeting the suicide prevention programs currently in place throughout the DoD. In recent years, military suicides have gone up at an alarming rate through my research, I assess current DoD program efforts to prevent military suicides – exploring best practices and areas needing improvement. This evaluation includes civilian programs, identifying what they are doing differently (if they are) and highlighting activities that result in mental health improvements. In addition, I interview a variety of subject matter experts on suicide prevention programs and issues to better understand this complex issue. Data from this project will be utilized to generate a policy proposal about program changes needed within the DoD to help those most in need. Finding root causes (or contributing factors at the very least) will contribute to understanding what can be done to properly address this mental health crisis.

Department of Physics

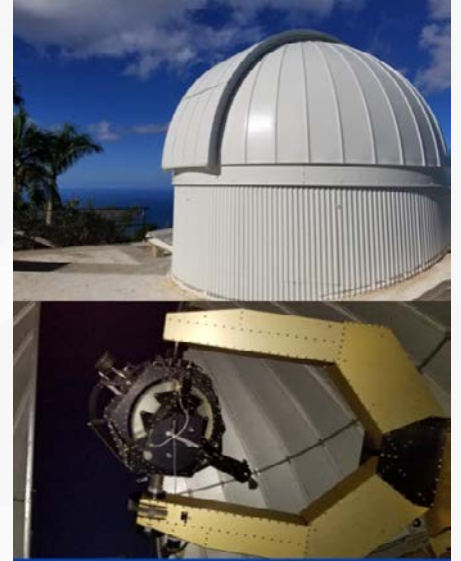
A Limiting Magnitude Study of the Virgin Islands Robotic Telescope (VIRT)

C3C Madison Marsh

Faculty Mentor: Dr. Timothy Giblin

Abstract:

We have performed a limiting magnitude study of the Virgin Islands Robotic Telescope (VIRT) using select Landolt Standard star fields. VIRT is a 0.5 m Cassegrain focus robotic optical telescope on Crown Mountain on the island of St. Thomas in the US Virgin Islands. The limiting magnitude study determines the faintest objects visible within a photometric uncertainty of $\sim 10\%$. The limiting magnitude study will provide guidance for the observing cadence of rapid ground-based follow-up observations of Gamma-Ray Bursts (GRB) detected by NASA's Swift spacecraft and Gravitational Wave (GW) triggers detected by LIGO and VIRGO, an ongoing collaborative research project between the University of the Virgin Islands and the US Air Force Academy. The detection of optical counterparts and afterglows of GRB/GW sources constrain the physics of relativistic jets from their progenitors, currently understood to be compact binary mergers and the formation of black holes from massive stars.



Machine Learning Approach to 2D Space Weather Modeling

C1C Nicolette Clark

Faculty Mentors: Dr. Matthew McHarg, Lt Col Casey Pellizzari, and Gabriel Wilson

Abstract:

A real-time map of space weather provides an operational advantage for satellite missions. In this work, we present a technique for estimating ionospheric plasma density in two dimensions based on sparsely-sampled data from a single satellite. Three global magnetic indices, along with location and solar elevation angle, are the drivers for a feed-forward neural network model of ionospheric space weather. We use in situ measurements taken by an integrated miniaturized electrostatic analyzer (iMESA) as target values for training the network, achieving an overall correlation coefficient of 0.556 when checked against testing data. The model results are used to construct a two-dimensional map of ionospheric conditions, which we then compare to International Reference Ionosphere data as an external validation measure.

Event-Based Sensing of Satellites

C2C Rayomand Bam

Faculty Mentors: Maj Daniel O'Keefe and Dr. Matthew McHarg

Abstract:

This research focuses on the recording and analysis of satellite orbits via event-based sensing. Traditional optical tracking and monitoring of satellite orbits utilize a charge-coupled device (CCD) to record satellite streaks across a background of reference stars. CCDs convert photons incident on a pixel array into electronic signals to create an image. Instead of recording an entire image based on intensity of incident photons at a particular time, event-base cameras work by detecting changes in intensity of individual pixels. When the intensity of a single pixel changes by a predetermined threshold, an event is recorded with that pixel's location, the time, and whether the pixel's intensity increased or decreased. Benefits of event-based sensing over traditional optical methods include high dynamic range and low data rate, both of which are beneficial for Space Situational Awareness. In this research, we mount the DAVIS 240C event-based camera onto a USAFA telescope, point it ahead of a satellite's predicted pass based on its Two-Line Element, and record event-based data with CCD context imagery. Our aim is to develop algorithms for analyzing event-based data and to characterize the DAVIS 240C's ability to detect and identify satellites in preparation for its upcoming deployment on the International Space Station in 2022.

Spectral Calibration of the FTN for GEO Satellite Spectral Signatures

C1C Erik G. Jensen

Faculty Mentors: Capt Joshua A. Key, Lt Col Jacob L. Harley, Dr. Francis K. Chun, David M. Strong, and Casey P. Schuetz-Christy

Abstract:

Since 2014, the United States Air Force Academy (USAFA) has developed slitless spectroscopy techniques using diffraction gratings on small telescopes. During this time, most of the satellite spectral signatures collected by USAFA were through a 16-inch telescope located on our campus. These measurements indicate that the spectral signatures of aglint from an operational geosynchronous communication satellites are from the satellite's solar panels. Our off-campus telescopes, the Falcon Telescope Network (FTN), also have diffraction gratings in their filter wheel for slitless spectroscopy measurements. However, not until recently have we begun using the FTN for spectral observations. In this presentation, we report on the calibration effort to determine the pixel-to-wavelength conversion of individual telescopes in the FTN. Additionally, we also determine the responsivity of the CCD camera to different wavelengths. Finally, we present preliminary satellite spectral signatures observed by the FTN during the early part of the 2021 vernal equinox glint season.

2D Beta-Gamma Spectrum Analysis for Radioxenon Detection
C1C Megan Cordone and C2C Johnathan Caldwell
Faculty Mentor: Lt Col James Scoville

Abstract:

Global monitoring of xenon isotopes, specifically ^{131m}Xe , ^{133}Xe , ^{133m}Xe and ^{135}Xe , can provide "smoking gun" evidence of an underground nuclear fission event. Thus, radioxenon analysis plays an important role in nuclear treaty verification. Current software used to quantify xenon isotope concentrations utilizes an algorithm known as the Region of Interest (ROI) method to sort beta-gamma coincidence counts. A few significant errors exist in the ROI method to include issues deconvoluting overlapping ROIs and accounting for changes in detector calibration over time. Peak fitting provides a unique alternative method to the ROI algorithm that seeks to address these problems. By using fitting functions to model the distinctive peaks that correspond to each xenon isotope of interest, this mathematical modeling method can better adjust for machine changes over time and the complex nature of xenon isotope spectra. In this work we compare peak fitting and ROI algorithm performance on an extensive radioxenon data set.

Characterizing Satellites Using Near-Simultaneous Polarization Measurements
C1C Audra M. Jensen
Faculty Mentors: Maj Michael K. Plummer, Maj Daniel O'Keefe, David M. Strong, and Dr. Francis K. Chun

Abstract:

The United States Air Force Academy operates an f/8.2 16-inch telescope fitted with an Andor Alta U47 1024×1024 pixel CCD camera and a nine-position filter wheel. In 2019 and 2020, we used this telescope to observe geosynchronous communication satellites during the glint seasons, which occur near the fall and spring equinoxes. We captured near-simultaneous polarization images of several clusters of operational geosynchronous communication satellites using linear polarization filters with specific orientations (0° , 45° , 90° , 135°) relative to the CCD camera's vertical axis. We converted the measured intensities through these filters to determine the first three Stokes parameters (S_0 , S_1 , S_2) of the light reflecting off the satellites and incident to the telescope. After removing corrupted observations from the dataset, we analyzed the resulting Stokes parameters and the associated degree of linear polarization (DOLP) before and during the solar panel glints. Differences in the satellites' Stokes parameters are potentially indicative of different satellite materials or geometries altering the polarization properties of the initially unpolarized sunlight.

Photometric Calibration of the FTN for GEO Satellite Photometric Signatures

C1C Ethan M. Albrecht

Faculty Mentors: Capt Kody A. Wilson, Dr. Francis K. Chun, David M. Strong, and Casey P. Schuetz-Christy

Abstract:

Ground-based, optical observations of satellites are a key component of Space Domain Awareness and support the mission of the United States Space Force. Simultaneous satellite observations from geographically diverse sites can more effectively characterize elements of the satellite's orbit and

physical properties. However, satellite observations cannot be compared simultaneously without a common basis for comparison. The Falcon Telescope Network (FTN) consists of six telescopes in Colorado, one in Pennsylvania, one in Chile, one in Germany, and two in Australia. These telescope systems have identical hardware components such as the mount, camera, filter wheel, and photometric filters. The U.S.-based FTN telescopes were used to observe simultaneously, when possible, calibration stars of different magnitudes and air mass. Satellite observations were collected throughout the winter and spring, and photometric calculations were applied to the images. The extinction coefficients and zero points of the individual FTN telescopes were determined using calibration stars throughout the year 2020.

- **Signal aperture w/ background annulus**

- Ensure equal area for each

- $R_{outer} = \sqrt{R_{inner}^2 + R_{middle}^2}$ pixels

- **Calculate magnitude (m_i) from counts/sec**

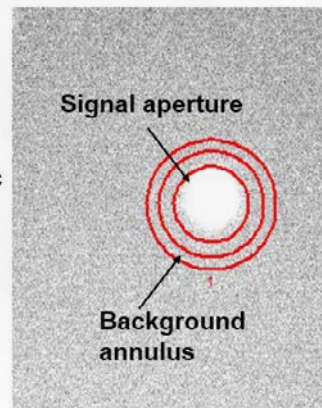
- $F_{CalStar} = \frac{Star-Background}{exposure\ time}$

- $F_{CalStar}$ is the CalStar's flux

- $m_i = -2.5 \log(F_{CalStar})$

- **MATLAB – rectangular aperture**

- **Mira Pro – circular aperture**



HD139197, R Filter

Thermal Modal Instability

C1C Pierce Goldtrap and C1C Gunnar Schultz

Faculty Mentor: Dr. Monte Anderson

Abstract:

Fiber lasers are used in both the private and public sectors in applications including manufacturing, communications, and researching physical phenomena. Initially, the trend of maximum fiber-laser power output was growing exponentially, yet recent fiber technology has been unable to continue this growth. This power ceiling is attributed to stimulated thermal Rayleigh scattering (STRS) and thermal modal instability (TMI). This paper will focus on TMI which is the tendency for signals above a threshold power to shift towards higher order modes within fibers causing significant signal degradation. We seek to characterize TMI by generating a single sideband seeder to be used for future analysis and countering TMI effects.

Space Weather "Nowcast" Through the Merging of Empirical Models

C1C Camila Quintero Hilsaca

Faculty Mentor: Lt Col Casey Pellizzari and Dr. Matthew McHarg

Abstract:

For decades the U.S. military, as well as the civilian sector, have relied heavily on satellites for their capabilities. However, the natural space environment and its effects on space systems present many challenges concerning the design, development, and operation of these satellites. Interactions between spacecraft operating in low-Earth orbit (LEO) and the ionosphere can lead to interference in GPS and communication signals, and even electric arcing, damaging expensive electronics in these space systems. A near real-time (nowcast) two-dimensional map of plasma density measures in the ionosphere would minimize the dangers of space weather on satellites by giving the military and civilian sector the ability to adapt to any changes in conditions. This project will discuss a method for combining two empirical models to predict plasma density in the ionosphere. Through the Multi-Agent Consensus Equilibrium (MACE) framework, we will design two agents whose outputs are consistent with the two models. The mathematical framework will then balance the agents consistent with the International Reference Ionosphere (IRI) model and a feed forward neural network model that uses integrated Miniaturized Electrostatic Energy Analyzer (iMESA) data. This will result in a model that produces a plasma density "nowcast" merging both the IRI model and iMESA measurements.

Excited State Dynamics of DNA in 77K Aqueous Glasses

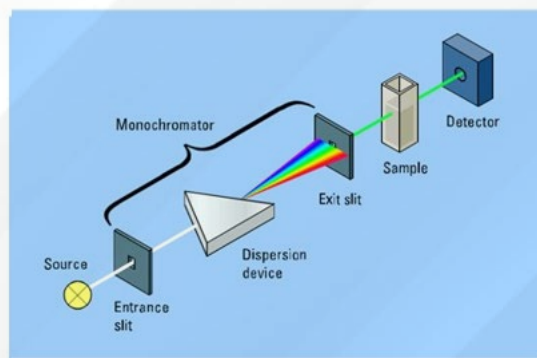
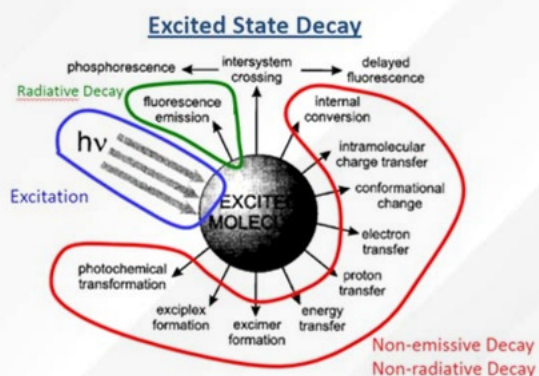
C1C Lindsay Powley

Faculty Mentor: Dr. Kimberly de La Harpe

Abstract:

Silicon-based electronics technology is quickly approaching its limit of size and speed as transistors become more densely packed in integrated circuits. A possible solution to the efficiency limit is molecular electronics, which exploits the electronic properties of individual molecules. DNA is an optimal choice for molecular electronics due to its designability, stability, information density, ability to self-assemble, and its capability to sustain electron transfer. Understanding the photophysics and dynamics of DNA excited states is a crucial first step in developing DNA-based electronics. This research modernizes sampling techniques for preparing DNA in solid aqueous matrices and characterizes the excited-state dynamics of 77K DNA glasses using nanosecond transient absorption techniques and time-correlated single photon counting (TCSPC) techniques.

Excited State Characterization



**ANALYSIS OF THE ISOTOPE SHIFT AND HYPERFINE SPLITTING IN THE
6s $3/2$ [$3/2$] 2 AND 6p $3/2$ [$5/2$] 3 STATES IN ^{131}mXe , ^{133}Xe , ^{133}mXe , and ^{135}Xe
C1C Jacob C. DeLange and C1C Daniel R. Reinfurt
Faculty Mentors: Capt Sarah T. Castro and Dr. Randy J Knize
Industry Mentor: Michael K. Shaffer, Shaffer Consulting Inc, Centennial CO 80112**

Abstract:

The leading candidates for remote detection of nuclear activity are Xe and its isotopes, particularly ^{131}mXe , ^{133}Xe , ^{133}mXe , and ^{135}Xe . In the past decade, a technology has emerged that is capable of separating and counting rare gas radioisotopes and at sensitivities of 10^{-16} using laser cooling and trapping and a Magneto-Optical Trap (MOT) called Atom Trap Trace Analysis (ATTA). This technique takes advantage of a cycling transition within the electronic energy level structure of Xe which varies between the many isotopes and isomers of Xe. This variation, which enables the ATTA system to be more selective than existing detection methods, is caused by changes in isotope mass, nuclear charge distribution, and nuclear spin, which give rise to the isotope shift, the isomer shift, and hyperfine splitting, respectively. While the spectra for the stable isotopes of Xe on this transition have been well documented, they are unknown for the four radioisotopes of interest. For the ATTA system to quantify the abundance of these radioisotopes, it is imperative that their energy level shifts and splittings be experimentally determined. We report on the progress of our spectroscopic investigation on Xe radioisotopes.

**Construction of a Diode-Pumped Dye Laser Using a Tapered Optical Fiber
C1C Zachary Eyler
Faculty Mentors: Dr. Reni Ayachitula, Dr. Brian Patterson, Dr. Randy Knize**

Abstract:

We describe the development of a dye laser using a tapered single mode optical fiber. The tapered section with a minimum diameter of $1\text{ }\mu\text{m}$ is submerged in Rhodamine-6G laser dye, which serves as the gain medium. Pump light from a 520-nm diode laser is launched into the fiber. The strong evanescent field just outside of the tapered region interacts with the dye, producing stimulated emission which is coupled back into the fiber. Dichroic mirrors are used to construct an optical cavity around the tapered fiber in order to provide the optical feedback required to cause lasing. We characterize the lasing threshold and laser output spectrum and discuss the manufacturing methods for the tapered regions. The tapered fiber dye laser is a good introductory project which will help us to fine-tune our tapering process to create fibers for future atomic physics experiments.

Department of Political Science

Hegemonic Threat to the United States: Latin American is Bleeding Chinese Red

C2C Richard Pardey

Faculty Mentor: Dr. John Riley

Abstract:

Almost from its founding, the United States installed itself as the regional hegemon, and via the Monroe Doctrine or the Roosevelt Corollary the U.S. adopted a posture to counter European threats to the region. Sometimes without the consent of the governments, and often without the opinion of the citizenries, the United States exported its vision of democracy, capitalism, and trade in Latin America. Centuries later, the United States remains a dominant world actor, however, its relationship with Latin America continues to degrade due to inept and overzealous U.S.-Latin American policies. The United States continually fails to address the repercussions of their actions, ultimately leading to China's rise as an alternative state sponsor. Essentially, China is filling the vacuum. Be it through the extraction of resources, investment in infrastructure, or emerging military ties, China has become a ubiquitous presence throughout Latin America. China 2025 initiative and The Belt and Road Initiative clearly signal Beijing's intent to economically exploit Latin America. Will the rise of China in Latin America lead to democratic backsliding? This paper will examine the reversal of the third wave of democratization from a hegemonic stability perspective. The argument advanced here is that the United States' inefficient foreign policies towards Latin America has granted China an opportunity on advancing their economic and social beliefs in the region which could potentially lead to a conflict of hegemonic stability.

Mitigating Corruption in Brazil: U.S. Strategy to Strengthen U.S.-Brazil Relations

C1C Anthony Alix Jacques

Faculty Mentor: Dr. Lynne Chandler Garcia

Abstract:

As the United States has shifted its policy to focus on the reemergence of near competitor state actors, namely China and Russia, the importance of the relationships within the country's own hemisphere, seem to be neglected. Known as the sleeping giant, Brazil's resources and global position could be of great mutual benefit to the United States but an issue that tends to cause strain on this international relationship is corruption and cronyism in Brazil. By leveraging techniques from past U.S. engagements with other countries that had high levels of corruption, the United States can mitigate this issue, thus strengthening the relationship between Brazil and itself, allowing for a strong ally against China and Russia. This paper seeks to answer the question: what are the best policies the United States has used to work with corrupt governments in other countries and which strategies are most applicable to Brazil in order to maximize the relationship between the two countries?



Aid for Influence: An Assessment of China's Attempts to Leverage the COVID-19 Pandemic in Latin America

C3C James Landy

Faculty Mentor: Dr. Kelly Piazza

Abstract:

The United States has long enjoyed exclusive hegemonic status in the Western Hemisphere, acting as the major foreign influence for most countries in the region. However, since the "China Boom" began in 2003, China has challenged this hegemony and worked to gain economic and political footholds in South America. The COVID-19 pandemic provides a unique opportunity for China to make further inroads in the region, and, potentially increase its soft power among Latin American countries. The Chinese government has used the pandemic as an opportunity to extend a "helping hand" to the region, principally in the form of medical supplies donations, sending millions of dollars of ventilators, test kits, and PPE to the region. The extent to which these efforts have affected China's political and social influence in Latin America remains unclear. This paper studies the relationship between China's financial and medical assistance efforts and its resulting soft power in the region. I will analyze the levels of COVID-19 assistance from China to individual Latin American states to see if there exists a relationship between Latin American perceptions of China and the allocation of Chinese aid. Ultimately, I will use modern indicators of soft power in the region to assess the extent to which China's savior-like approach to increasing influence in Latin America has been successful.

An Assessment of Military Politicization in Brazilian Politics

C1C Kylie Stronko and C3C James Landy

Faculty Mentor: Dr. Kelly Piazza

Abstract:

Civilian leadership of the armed forces and the absence of military politicization are fundamental democratic norms. In recent years, some democratically elected leaders have consciously subverted these norms. As a result of his appointment of military men to vice president and cabinet positions, among other efforts to politicize the armed forces, Brazilian president, Jair Bolsonaro, has earned a reputation for bringing the military back into the political arena. Although the majority of the Brazilian public has expressed their opposition to Bolsonaro's military appointments to high-ranking national political positions, it is unclear if these perceptions extend into other levels of government. In this research, I seek to understand whether national-level politicization of the military, and the public's perception of this politicization, extends to influence local politics in terms of the strategies used by candidates in their local election campaigns. To do so, I begin by analyzing the candidate campaigns from Brazil's 2016 and 2020 municipal elections to identify any increases in the use of military-affiliated titles by those running for office. An increase in the use of military titles in these campaigns might indicate the use of military titles as a political strategy, given the increased military presence at the national level and the high levels of trust in the armed forces among the Brazilian public. My preliminary analyses suggest that national politicization has notably increased intentional expressions of military affiliation among Brazilian mayoral candidates. To the extent that national politicization of Brazil's most trusted institution resonates with and trickles down to influence personal politics at the local level, the country's future democratic prospects are weakened.

The American Dream and American Hegemony

C1C Matthew Morales

Faculty Mentor: N/A

Abstract:

It is widely accepted that China is threatening America's hegemonic position on the world stage. As a concerned American, this begs the question: What can still be done to ensure that this does not happen? The answer to this question lies within the nostalgic belief in the "American Dream". Although the very idea of the American Dream is a divisive topic, this paper will intend to redefine the classic idea of the American dream, while also providing logic as to why it will be crucial to sustaining not only the American way of life, but also the greater good of all people across the globe. A redefinition of, revival to and newfound belief in this American Dream will be paramount to America prolonging our position as the world's hegemon. The significance in ensuring that the US is able to keep our hegemonic position within the world relies on the lack of other viable candidates. More specifically, when looking at China and their exploitation of their own people, the world is shown a bleak glimpse into the future of what the world order might look like with China as the world's dominant force. I will argue that in the hegemonic position the US will do more "good" than the Chinese would, should they reach that position. This frames this issue into the "greater good" not only for the world as a whole, but also the scope of domestic affairs to due hegemonic war theory. If the US wants to prevent a potential war with China, further entrenchment of our hegemonic position is necessary and can be achieved through a revival of the American dream.

Policy Paper on the Venezuelan Crisis

C1C Andrea Wieman

Faculty Mentor: N/A

Abstract:

Venezuela has been in turmoil for many years now, each year worsening their political and economic situation. Hugo Chavez's successor, Nicolas Maduro, has successfully created one of the world's worst humanitarian crises and has established relationships with China, Russia, and other US adversaries. Despite having the world's largest oil reserve, Venezuela's inflation rate is also one of the worst the world has ever seen in modern times, making the bolivar worthless. Medicine, running water, infrastructure, and staff in hospitals, are all depleted adding to the humanitarian crisis and worsening COVID-19's effects. Maduro is doing nothing to alleviate the situation and has continuously made matters worse. Because of this, millions of Venezuelans are fleeing the country, migrating to surrounding countries in Latin America and even into the United States, creating instability in the region and undermining security. The Trump administration's foreign policy towards Venezuela was not effective and even worsened the situation. In order to reverse this damage, the Biden administration much greatly improve their policies in response to this crisis.

- Socialist leaders and policies
 - Hugo Chavez
 - Nicolas Maduro
- Resource curse
 - Over dependency on their oil reserves



ASATs: Proceed with Caution

C1C Sophia Bynum

Faculty Mentor: Dr. Lynne Chandler Garcia

Abstract:

A key issue that will need to be addressed with the coming of a new space age is the emerging threat from anti-satellite (or ASAT) weapons. Any object or "technology that can physically or non-kinetically damage a satellite can be considered an ASAT weapon" (Blatt 2020). Defining ASATs has proved to be a challenge as anything can be an ASAT if it has the ability to destroy or disrupt the capabilities or physical structure of a satellite. Many problems accompany the use or implementation of such weapons. The Space Race used to be centered around space exploration capabilities and missions but now we have entered a new space age that involves the competition for arms. Countries are striving to advance their ASAT capabilities in the name of national security. Although this logic is sensible as the world becomes dependent on satellites in order to operate life on Earth, it is important to recognize that many risks partner with the implementation or mass abundance of such weapons. A space arms race has large potential to promote or incite global conflict as well as advance the accumulation of more space debris. An arms race also is a distraction from scientific driven missions and could limit this new space age's potential if resources are poured into deterring weaponry instead of advancements in science and exploration.

A Forward-Thinking Russia Strategy

C1C Sarah Whitley

Faculty Mentor: Dr. Lynne Chandler Garcia

Abstract:

The United States continues to have its security interests threatened by the ever-emboldened revisionist powers of Russia and China. The 2017 National Security Strategy clearly identifies Russia as a major geopolitical threat to the United States, and sought to promote unipolarity by denying Russian spheres of influence (Rumer and Sokolsky). The Biden Administration can be expected to continue to view Russia as an adversary, largely as a result of interference in the 2016 presidential election. Since the U.S. position is anticipated to shift some with the incoming administration, it is crucial to critically evaluate current posture to prepare for the next four to eight years. Answering the following questions is imperative to developing a more effective strategy for Russia: what threats are emerging? How do we want to be perceived by Russia? And finally, should we plan to contend with the Putin government 10 years from now?

President Biden and Iranian Nuclear Proliferation

C1C Nico Ferrara

Faculty Mentor: Dr. Lynne Chandler Garcia

Abstract:

The importance of the U.S.-Israeli strategic partnership centers on deterring Russian encroachment into Syria and Iranian power in the Middle East. Iran is a state sponsor of terrorism with the Quds Force, the external arm of the Revolutionary Guard, being classified as a terrorist organization. In January of 2016,

however, the international community lead by the Obama administration began lifting Iranian nuclear related sanctions after the International Atomic Energy Agency verified that Iran's nuclear capacity had decreased to the point of peaceful use. The inherent flaws of the Joint Comprehensive Plan of Action (JCPOA) is that it allows the theocratic regime to develop advanced centrifuges, has no language limiting the development of ballistic missiles, and does not solidify the language of United Nations Security Council Resolution 2231 which outlines the inspection process of the JCPOA. From a realist perspective, the JCPOA is a failure of the international system as the most powerful state, the U.S., ceded in allowing Iran to enrich uranium. President Obama therefore rejected American hegemony, the concept that the international order is dictated by the most powerful state in the system, the U.S. The "maximum pressure" campaign by the Trump administration was, in contrast, a nod to realist theory as the U.S. imposed its will on Iran in regards to economic sanctions, and military operations. It is therefore important to understand how the JCPOA affects other states in the Middle East, namely Israel.

Chinese Encroachment and Influence in the Latin American and Caribbean Region

C1C Anna LoGrande

Faculty Mentor: N/A

Abstract:

In terms of U.S. national security and defense, the Latin American and Caribbean region is economically and politically intertwined with the U.S. as it is home to 25% of key global infrastructure and U.S. exports. In every pertinent domain—land, sea, air, space, and cyberspace — this region carries a great deal of strategic importance as it poses both unique potential for cooperation and diplomacy and also a vulnerability and an opportunity for outside global threats. Chinese encroachment and influence in the Latin American and Caribbean region has been on the rise for the last 20 years and continues to pose a significant threat to domestic security in the U.S. and to the maintenance of a favorable regional balance of power. Beyond China's "One Belt one Road" initiative, 25 out of 31 countries in the region are hosts to Chinese infrastructure projects that have strategic value for military usage. South America's strategic location and geographic advantage makes it greatly valuable to China which has been proven by its current active pursuit to gain access to regional space infrastructure. Expansion of the Chinese space infrastructure in the "competitive space" of the South American region is an incredibly relevant issue that concerns U.S. national security and foreign policy with South America. In this research project, I plan to carry out a historical analysis of Chinese-Latin American relations, provide a context for how China and Latin America currently cooperate in the development of space infrastructure, and to address the following questions: (1) What incentive does South America have to allow China within its borders to expand its space infrastructure? (2) What can the U.S. offer the Latin American and Caribbean region to deter our adversary's influence? I predict that the more fragile and impoverished governments in South America will be the targets for Chinese partnerships and space infrastructure development.



Political Polarization within the United States and Japan

C1C Chloe Camello

Faculty Mentor: N/A

Abstract:

Throughout the world, dissenting opinions regarding diplomatic policy and political parties are not uncommon in the political domain. Both are commonly present, especially in the American and Japanese governments. The issue, however, comes from the political polarization between the elites that govern and the general public. Despite experiencing similar economic achievements within the United States' Gilded Age and Japan's Golden Age, the current status of political polarization for each country is vastly different from each other, largely due to differing economic experiences, social interactions with other countries, cultural interactions between individuals, and general demographics. The topic I would like to study are the causal effects that determine political polarization within the United States and Japan. Within this topic, I would like to investigate what factors significantly impact political polarization in both countries. In addition, comparing the two countries would help me to create a successful recommendation that could possibly assist the United States in approaching the political polarization issue in an effective manner that brings U.S. citizens together (again). I would also like to provide a recommendation for Japan that would encourage the maintenance of a stable political environment within the country. Since they are successful, the country should share their knowledge globally with struggling nations.

China's use of COVID-19 as Their Gateway into Latin America

C1C Nkosi Jones

Faculty Mentor: Dr. Lynne Chandler Garcia

Abstract:

Due to the increasing amount of needs that Latin America is experiencing and will continue to live through, China's strategic move will be aimed at deepening its economic and political roots by flooding the market with large loan packages and the eventual introduction of their first military base in the continent under the pretext of "humanitarian outreach". Part of this outreach includes the distribution of vaccines that are yet to be vetoed for human use, but that give the appearance that action is being taken in order to decrease the spread of the virus. As a method to counteracting it, the United States may seek to strengthen relations with countries who continue to be allies as a way to project more presence and deter further Chinese expansion. In terms of economics, the United States might resort to increase the amount of financing that it is already extending to the region through the Inter-American Development Bank, who has already provided over 1 billion in financing for countries with smaller budget to purchase vaccines.

Analyzing Factors That Influence Religious or Secular Trends Through an OLS Regression Model

C1C Luke St. Pierre

Faculty Mentor: Dr. Lynne Chandler Garcia

Abstract:

Why are some people more secular than others? Religion has always played a formative role in any society's culture and politics. Yet throughout the past several decades, an adherence to traditional religious practices has undeniably experienced a notable decline. Understanding motives for the retention or abandonment of conventional religious thought can have far-reaching effects, not only for domestic and international politics, but for the nature of mankind. However, discovering what drives this secularity remains hidden in a cloud of ambiguity. Of course, numerous factors influence religious-secular trends, but their significance can be difficult to pinpoint. Using country-level data from the 2010–2014 World Values Survey, an OLS regression model is used to create un-standardized coefficients that will allow for relative comparisons through effect sizes. The effects for democracy, human development, and education levels were analyzed to test how one's home country influences their self-identified level of secularity. It was discovered that an increase in human development causes an increase in secularity, but education and democracy levels do not produce the anticipated shift.

Space: Which Regime comes out on Top?

C1C Johnathan Casoni

Faculty Mentor: N/A

Abstract:

The following capstone project will examine the relationship between regime type and subsequent approach to the development of space technologies. Looking at the United States, China, and Russia, this topic will analyze quantitative research to determine which government regime has the greatest advantage in defensive policies. Considering the rise of unconventional warfare within the 21st century as a means to an end, particularly hegemonic status, this overarching space question examines national security and foreign policies of each country. By understanding the functionality of each regime type, this topic applies these policies from past, present, and future decisions to determine which regime type has the greatest advantage to control the space domain. As a result, this paper will offer recommendations that the other two countries should take moving forward. This particular topic relates to my interests because I have done extensive research on space policy in PolSci 302 concerning China and the United States, and this paper gives me the opportunity of expanding this issue with the addition of Russia and independent factors relating to the regime type. Comparative politics and the effects of regime type, which I plan to incorporate in this paper, came from PolSci 394 interest. The emergence of unconventional warfare throughout world affairs interests me as well, especially with the creation of the U.S. Space Force and my future within cyber operations. As this technology advances, the United States needs to prepare for the offensive and the defensive.

Obesity as a Multi-faceted Threat

C1C Faith Van Havel

Faculty Mentor: Dr. Lynne Chandler Garcia

Abstract:

In my capstone I wish to pursue the idea that the prevalence of obesity and other health conditions within the American population pose a serious threat to not only domestic U.S. policy but also U.S. foreign policy. The prevalence and increase in obesity rates and the increase in associated health conditions in the U.S. population undeniably causes stresses upon the American medical system, domestic health policy, and health care reform. What is harder to see is the impact of obesity and associated health conditions upon American national security and foreign policy which we shall touch upon in this proposal.

A Comparison of Presidential Foreign Policy

C1C Dusten Wayne Ault

Faculty Mentor: N/A

Abstract:

Since the dissolution of the Soviet Union in 1991, the United States has enjoyed the uncontested role of the global hegemon. However, about a decade ago, scholars and experts started discussing the global rise of China and alluded to the possibility that the United States could lose its position as the world's leading power, economy, and influence. Due to this global emergence, China's position has created one of the most complex national security issues of the 21st century. Although such an issue requires a delicate crafting of foreign policy, the past two executive administrations enacted diametrically opposite strategies in US-China relations. This essay will examine global hegemonic theory, conduct a foreign policy analysis for both the Obama and Trump administrations, as well as predict the direction of US-China relations under President Joe Biden. Most importantly, my research will seek to answer the question: "will President Biden's foreign policy approach to China mirror those policies conducted during the Obama era when he served as Vice President?"

Presidential Foreign Policy Towards China



The Extraterrestrial Blind Spot

C1C Kyle Spencer

Faculty Mentor: N/A

Abstract:

The question of "are we alone" in the universe has been topic of discussion for millennia. Dating back to the polis, scholars and wondrous minds alike have persisted with questions with such. Crazy haired conspiracy theorist have projected their claims that aliens have been here since the ancient Egyptians as seen in hieroglyphs on the walls of tombs. In recent history, we have seen interesting phenomena that many have attributed to weather balloons or aurora borealis. These claims have peaked interest in not only the minds of farmers who claim they have seen floating orbs of flashing lights but interesting enough, the upper echelon of governmental intelligence agencies. CIA, NSA, and the State Department have all began to investigate such claims and with the new government spending budget an interesting mandate has been issued by congress. These government agencies are now required to release all documents regarding unidentified aerial phenomena (UAPs), unidentified aerial threats (UATs), and unidentified flying objects (UFOs) for public review. The United States has strategic plans for near peer adversaries such as Russia and China, these plans also extend to unconventional threats as well. Unfortunately, there is a blind spot in public defense policy in regards to the possibility of extraterrestrial intelligent life. With the threat, becoming increasingly possible new legislation is critical to fill in the gaps our current policies have.

Understanding Ideologies

C1C Riley Graves

Faculty Mentor: N/A

Abstract:

As any Americanist can tell you, the United States has become increasingly polarized in recent years, specifically along party lines. A trend that has accompanied this is the ideological sorting of liberals and conservatives into the Democratic Party and the Republican Party respectively. It is not often today that one sees a liberal republican or conservative democrat for that very reason. Ideology may seem incidental to the actions of party martinets encouraging representatives and senators to toe the party line and not cross the aisle, but is could be the key to finally finding a path to better and more consistent partisan cooperation, not only in government but among American citizens as well.

No Method to Madness: Madman Diplomacy's Terrible Temptation

C1C Henry Gilchrist

Faculty Mentor: Dr. David Sacko

Abstract:

This paper explores the role of irrationality at the nexus between nuclear diplomacy and political psychology. Madman diplomacy is a strategic posture which relies on irrationality to intimidate an adversary and augment the credibility component of deterrence. While President Nixon popularized the term and its relevance to nuclear deterrence in the 1970s, the idea of using irrationality for intimidation is prevalent throughout reflections on historical realism if not actual policy documents. Several

prominent scholars of deterrence have weighed the disappointing policy impacts of Nixon's implementation, but this paper examines a variety of case studies and critiques madman diplomacy from a theoretical standpoint. Not only has madman diplomacy failed to work as advertised. Internal contradictions of the strategy in its ideal form, reduce the chances it will succeed in future crises. While madman tactics may survive an isolated confrontation, the long-term strategy proves unsustainable by undermining the rational foundation of deterrence. This paper analyzes madman diplomacy using two variables from the literature on psychology and deterrence: type of irrationality seized by coercer and adversary perception. A classic fourfold table of possible outcomes in theory explains why madman diplomacy nowhere succeeds. It always fails in the final analysis to increase long-term deterrence. The plausibility of this table is reinforced through empirical analysis of multiple conflicts. By analyzing a large dataset of strategic standoffs where one or more actors introduced irrational behavior, this paper criticizes madman diplomacy's inability to prevent or resolve conflict and highlights the strategy's escalatory nature. The madman table and supporting data warn that, rather than following folk wisdom and treating madman diplomacy as viable, world leaders should exploit the strategy's weaknesses as it infatuates and beguiles their adversaries.

The Future of the United States in NATO

C1C Jessica Groen

Faculty Mentor: Dr. Lynne Chandler Garcia

Abstract:

The North Atlantic Treaty Organization is one the world's most recognizable and longest-lasting alliances. However, with recent developments it seems to be that this partnership could be disintegrating. In recent years, Europe has become more Eurosceptic and the United States latest presidential administration did not make this alliance a priority. As Britain leaves the EU and Germany takes on the role of superpower in Europe this will create a new dynamic in Euro-American relations. Germany has strong economic ties to Russia and it is hard to know which side Germany will choose if they have to. Chancellor Angela Merkel and President Donald Trump did not see eye-to-eye, but both are transitioning out of office so it will be interesting to see how these two interact in the coming years. The United States is set to lose more than it will gain by cutting ties with NATO, and while transitioning into a new administration should reinforce ties with this essential ally.

Interest-Based Policymaking: The Solution to Incoherent U.S. Strategy in Southeast Asia

C1C Joshua Lambert

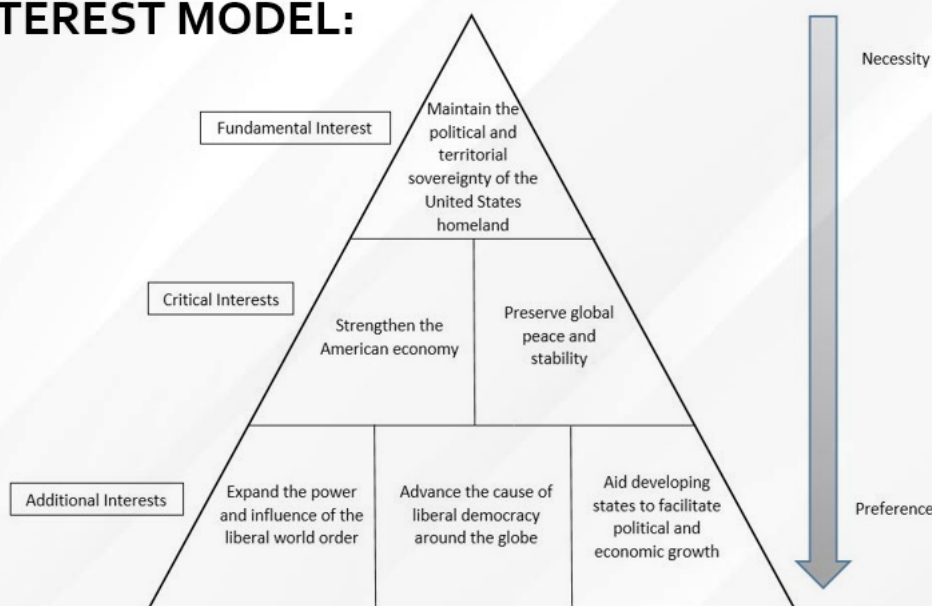
Faculty Mentor: Dr. Lynne Chandler Garcia

Abstract:

This paper critiques existing U.S. foreign policy in Southeast Asia and investigates an alternative interest-based method of formulating new policies for the region. President Barack Obama's "Pivot to Asia" publically affirmed the increasing importance of the Asia-Pacific region in U.S. foreign policy. Given the globe's drifting economic center of gravity and the growth of China as a regional hegemon, such a shift appeared inevitable. For nearly a decade afterwards however, U.S. foreign policy for the Asia-Pacific region lacked coherent objectives and effective strategy to protect American interests. This failure of foreign policy became especially apparent in Southeast Asia, an increasingly contentious region and global economic hub. The incoming Biden administration has the potential to rectify the existing shortcomings of U.S. strategy in Southeast Asia, but not without a clear and unified plan for doing so.

This paper evaluates the primary, secondary, and tertiary interests of the United States in Southeast Asia. It then utilizes the aforementioned interest to define desired policy outcomes. Finally, the paper suggests policies that optimize the accomplishment of high-priority objectives without exhausting the limited resources that the United States can dedicate to the region. The interest-based method represents an efficient foreign policy system that uses the prioritization of objectives to streamline the policymaking process. By tying each policy to a fundamental interest of the United States, the resultant Southeast Asian strategy avoids the waste and counterproductive consequences of past strategies. The policies themselves are evaluated using cost-benefit analysis to ensure their implementation will result in favorable outcomes, therefore improving the foreign policy success of the Biden administration.

INTEREST MODEL:



Strategy for Puerto Rican Statehood

C1C Michael Beverley

Faculty Mentor: N/A

Abstract:

The New Progressive Party of Puerto Rico should align itself and work with the Democratic Party of the United States to pass legislation in Washington that would put Puerto Rico on track to be a state. Puerto Rico has been an unincorporated territory of the United States for 123 years. American citizens living in Puerto Rico are not represented by voting members in Congress and cannot vote in presidential elections. Furthermore, only certain provisions of the Constitution apply to Puerto Rican citizens, as detailed in the Supreme Court opinions known as the Insular Cases held in 1901. However, Puerto Ricans have expressed their desire for statehood in the most recent referendum. Congress is likely to avoid debating and acting on this issue due to the uncertainty that admitting Puerto Rico as a new state brings. In my capstone, I plan to develop a strategy that the New Progressive Party of Puerto Rico should take to make Puerto Rico the fifty-first state in the union.



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