Predoctoral Fellowship Awards 2019

Monday, April 16, 2019

Rackham Graduate School

The Rackham Predoctoral Fellowship is one of the most prestigious awards given to graduate students by the Rackham Graduate School. Those selected for this twelve-month fellowship have advanced to candidacy and are anticipating finishing their Ph.D. within six years of beginning their studies. The award takes into consideration professional papers and presentations, publications, honors, as well as academic standing. This booklet contains the dissertation abstracts of all the 2019-20 Predoctoral Fellows.

The Rackham Predoctoral Fellowships are supported by the Horace Rackham Endowment which was created in 1935 by a gift to the University of Michigan from the Horace and Mary Rackham Fund. More than 2,300 doctoral students have received this fellowship since it was established.

Abunya Agi
Education and Psychology

What Does It Mean to Be Black in North America? Interrogating Ethnic-Racial Identity in Context

This dissertation aims to illuminate the racialization experiences of black immigrant-origin youth (IOY) in North America, a population that is often overlooked in ethnic-racial identity (ERI) research. Paper 1 draws on the phenomenological variant of ecological systems theory (Spencer et al., 2015) and intersectional invisibility (Purdie-Vaughns & Eibach, 2008) to highlight conceptual and methodological gaps in the way ERI is studied among black youth. Paper 2 tests whether commonly used ERI and discrimination measures are invariant for black IOY and non-IOY in the United States. Paper 3 examines the cultural orientations of black Canadian IOY, and how their perceptions of their racial group's status serve as an important link between their engagement with white North American culture and their psychological well-being. Given the detrimental impact of negative stereotypes and racial discrimination on black youth, this dissertation will unpack the processes through which those with immigrant origins develop more adaptive outcomes.

Phoebe Aron
Earth and Environmental Sciences

Tracing Natural Water Cycling and Variability with Stable Water Isotopes

The water cycle is one of the most essential components of life, but is threatened by climate change and natural stressors. Given these pressures and the broad societal impacts of hydrologic change, we must work towards a more complete understanding of water cycling. I use stable water isotopes to trace environmental water fluxes and assess spatiotemporal variability of the water cycle. Chapters one and two quantify the contribution of vegetation to local and regional water budgets. Chapters three and four show a previously unidentified Pacific moisture source in the western Andes. Chapter five presents a global dataset and mechanistic explanation of an emerging oxygen isotope system. Chapters three and five rely on a citizen science project (#17Owatermap) to crowdsource samples. This involves non-scientists in a rigorous research project and is an efficient approach to collect water from around the world.

Maryam Aziz
American Culture

Built with Our Empty Fists: The Rise and Circulation of Black Nationalist Martial Artistry During the Cold War

My dissertation explores the history of unarmed self-defense and martial arts in Black community organizing between the 1950s and 1970s. "Built with Our Empty Fists: The Rise and Circulation of Black Liberation Martial Artistry during the Cold War" intervenes into Black Power studies, Afro-Asian studies, and popular culture history. Using a Black feminist, social movement analysis and a critical approach to U.S. militarism, it challenges what is recognize as Black Power athleticism, cultural production, and self-defense between 1955 and 1978. It alters current understandings of anti-colonial Black martial artistry by complicating the narrative that 1970s kung fu films largely sparked African American martial artistry. I analyze how U.S. Cold War occupation of places like Okinawa facilitated the study of arts like karate by enabling military sponsorship and influencing Asian migration. While its roots can be traced to U.S. empire, I argue that martial arts contributed to holistic, community engagement practices rooted in political, spiritual, and physical well-being. Utilizing oral histories and archival research, I explore martial arts practices in three organizational case studies. Between the 1950s and 1970s, the Nation of Islam taught jujutsu to create a security apparatus that fostered masculine, character building nationwide. During the late 1960s and early 1970s, the Congress of African People practiced while trying to both safely elect Black politicians and create a distinctive, Black culture in the Northeast. Finally, the Black Panther Party designed a physical education curriculum taught that included Jeet Kun Do and tae kwon, enabling them to cater to the body and soul of Oakland youth. I conclude by connecting these organizers to the portrayals of Black martial artists in Blaxploitation films as well as the shifting depictions of African Americans in the American popular imaginary and lexicon. My intersectional lens centers a critical approach to Black nationalist masculinity. It also situates how development's in Black women's leadership impacted the gender norms and pedagogy of combat sports and self-defense.

Alejandro Azocar
Mechanical Engineering

Perception, Design, and Control of Impedance-Based Lower-Limb Robots

Millions of individuals with lower-limb amputations or neurological disorders suffer from a reduced quality of life. Recent robotic prostheses and orthoses, which mimic the mechanical impedance (i.e., the dynamic relationship between movement and effort) of the human body, have the potential to improve quality of life; however, the appropriate way to implement impedance in assistive devices is unknown. In this dissertation, I seek to improve impedance-based assistive devices through perception, design, and control. First, I investigate how well people perceive changes in the impedance of lower-limb orthoses/exoskeletons and prostheses. Second, I develop an open-source robotic leg prosthesis. Finally, I use this prosthesis to design and test a biologically-accurate impedance controller. This dissertation provides insight into the relationship between mechanical impedance, the human sensorimotor system, and control of impedance-based assistive devices, and introduces a hardware platform to improve prosthesis control systems further.

Trevor Bailey
Physics

Magnetotransport Studies of Superior Thermoelectric Materials

As a means of converting waste heat into usable electricity, thermoelectric materials should be an important facet of the global energy portfolio. Due to low conversion efficiency, thermoelectric materials have mainly been used in focused applications, such as providing the on-board power in space missions. To implement thermoelectric materials more broadly, the conversion efficiency must be improved. Understanding the route for improvement requires knowledge of the physical constraints limiting high performance, which we have gained through physical property characterization of several known thermoelectric materials. In the superionic conductor Cu2Se, we found that replacing small percentages of Cu with Sn enhances the thermoelectric efficiency and chemically stabilizes the compound. For the phase-separated (Ti,Zr,Hf)NiSn half-Heusler compound, we demonstrated that bound magnetic polarons can optimize thermoelectric performance. Finally, we show that external magnetic fields enhance heat-to-electricity conversion in Dirac semimetal ZrTe5 due to its unique electronic energy band structure.

Summer Baker Dockrey
Chemistry

Development of biocatalytic oxidative methods and applications to chemoenzymatic total synthesis

Natural products, compounds synthesized by all kingdoms of life, offer a wealth of structural diversity. Corresponding to this diversity is an array of biological activity. For centuries chemists looked to nature for the discovery of new medicines; more recently, chemists have begun employing nature's tools for complex molecule synthesis in the generation of novel compounds. My thesis work seeks to develop new oxidative biocatalytic methods and employ these methods in the synthesis of biologically relevant molecules. By exploring the substrate scope and selectivity of wild-type enzymes a suite of complementary catalysts have been characterized. We have developed chemoenzymatic cascades to access three families of natural products. Structural and mechanistic studies of these biocatalysts have led to the expansion of this methodology to new reaction manifolds.

Josefina Banales
Psychology

Critical Consciousness Development Among Diverse Youth: Students' Perceptions of Racism in Society and School

Racial intolerance is on the rise in the United States (Southern Poverty Law Center, 2018), affecting adolescents' beliefs, feelings, and actions towards racism. How adolescents learn about, contend with, and challenge racism shapes intergroup relations between youth of color and white youth (Richards-Schuster & Aldana, 2013). My dissertation illuminates how racially/ethnically diverse adolescents develop beliefs, feelings, and actions towards racism. Study 1 determines how youth define racism and the extent their personal demographics (e.g., race) and interracial relations in their schools and neighborhoods relate to their conceptions of racism. Study 2 clarifies how school racial messages predict adolescents' understanding of structural inequality, confidence to create social change, anger towards social injustice, and civic behavior. This study also explores whether youths' anger towards social injustice is productive in prompting youth into civic action. The results of these studies have implications for how we—as adults—support youths' anti-racism development.

Aaron Bart
Biophysics

Human Cytochrome P450 Enzymes in Drug Metabolism and Chemical Activation

Human cytochrome P450 enzymes transform chemicals from drugs to pollution to foods. While often enabling clearance, P450 catalysis can also create molecules with new pharmacological actions or toxicity. Prediction of P450 products is difficult, due to the P450 substrate binding site promiscuity and complex P450/protein interactions. The goal of my dissertation research is to identify structural features allowing P450 enzymes to bind and transform diverse chemicals. X-ray crystallography defined how different chemicals are bound in the P450 enzyme 1A1, identifying distinct orientations resulting in non-toxic versus toxic products. Following substrate binding, individual P450 enzymes are differentially modulated by interactions with cytochrome b5. Using solution NMR spectroscopy I identified distinct b5 surfaces interacting with major drug-metabolizing P450 enzymes and related this to catalysis. This clearer understanding of P450 chemical binding and metabolism can be used to improve the design of new drugs to minimize undesirable toxicities and promote desired pharmacological effects.

Lauren Benjamin
Comparative Literature and English Language and Literature

Feral Modernisms

Feral Modernisms uses the interpretive concept of the feral as a guide for understanding the difficulty that modernist texts associate with being at home as they emphasize the fraught ambivalence characterizing home and domestic life. "Feral" names that which has once been part of the domestic sphere and has subsequently either escaped or been banished; drawing from evolutionary biology, I invoke it not merely as a synonym for "wild" but rather as an articulation of a ragged and unpredictable relationship with home. I use this ambivalence to demonstrate the ways in which some modernist texts concern themselves with a fraught relationship to domestication and domestic space that is neither an acquiescence to the confines of the domestic, nor a wild way out of the domestic altogether. The authors I consider narrate an existence that is both inside the domestic and outside of it, challenging what it means to belong to any particular place.

Irene Brisson
Architecture

Speaking, Gesturing, Drawing, Building: Relational Techniques of a Kreyòl Architecture

The everyday languages—vernaculars and creoles—used to produce the majority of the global built environment continue to be delegitimized as ways of knowing, building, and inhabiting by an architectural discipline centered in the global North. My research recuperates these voices through studying the communicative practices of speech, gesture, drawing, and demonstration that people use to design houses in post-earthquake Leogane, Haiti. With a model of architecture as a set of relational techniques between diverse actors, I analyze the exclusions that contribute to a systematically vulnerable built environment in Haiti. This ethnographic study of quotidian architecture shows how class-based hierarchies of linguistic, visual, and material representations of space contribute to meaning-making in architecture and construction. Based on the functioning and malfunctioning of communicative relationships, I theorize Kreyòl architecture as a syncretic negotiation of global influences that both manifests and disrupts spatial politics.

Molly Brookfield
History and Women's Studies

Watching the Girls Go By: Citizenship and Sexual Harassment in the American Street, 1850-1980

From their first forays into American urban space, women have endured uninvited sexual remarks, stares, and touching from male strangers in public places. This dissertation details the emergence, persistence, and normalization of these intrusive behaviors in the nineteenth and twentieth centuries. Drawing on archival materials such as newspapers, legislation, interviews, and personal papers, this dissertation demonstrates that men's harassment of women in public has contributed to women's fear of violence in public space and limited their freedom of mobility. It argues that sexual harassment curtailed women's access to, and power within, American urban space even as that access grew.

Breane Budaitis
Cellular and Molecular Biology

Structural and Mechanical Elements for Kinesin Force Generation in Cells

Force production by kinesin motors is critical for cellular processes including cell division and intracellular trafficking. Force generation involves ATP-induced docking of the neck linker (NL) along the motor's core; however, the contributions of proposed substeps of NL docking are unclear. Furthermore, the necessity of NL docking for transport of membrane-bound cargo in a cellular context is unknown. Using cellular transport assays, I found that teams of kinesin-1 or kinesin-3 motors could drive transport of high-load cargo in cells. I used in vitro and cellular assays to determine the structural and mechanical elements responsible for high-load transport by kinesin-1 motors. I also examined the impact of a human disease mutation on transport driven by kinesin-3 motors under different loads. This work identifies the NL as a mechanical element critical for kinesin transport and drives our understanding of how different kinesins have adapted this feature for their functional roles in cells.

Lu Chen
Physics

Torque Differential Magnetometry With the qPlus Mode of a Quartz Tuning Fork

A quartz tuning fork is the key component of a high-resolution atomic force microscope. Because of its high quality factor, a quartz tuning fork can also be used for high-sensitivity magnetometry. We develop a highly sensitive torque differential magnetometry using the qPlus mode of a quartz tuning fork. The tuning fork is driven by an ac voltage, and its deflection is measured by the resultant ac current. We observe a sharp resonance of the quartz tuning fork at low temperatures down to 1.6 K. We calibrate our torque differential magnetometry by measuring the angular dependence of the hysteresis loop in single-crystal Fe0.25TaS2. Furthermore, we demonstrate the high sensitivity of the torque differential magnetometry by measuring the quantum oscillations of a bismuth single crystal and studying the charge density wave (CDW) and vortex solid states in underdoped high-temperature superconductor YBa2Cu3O6.55.

Joseph Cicchese
Chemical Engineering

Simulating tuberculosis disease and treatment to optimize antibiotic efficacy

Tuberculosis (TB) is an infectious disease caused by Mycobacterium tuberculosis, and is treated with at least six months of antibiotics. Length of treatment and the emergence of drug-resistant tuberculosis indicate the need for better antibiotic treatments. I present here the use of an agent-based model for TB granuloma formation and an antibiotic pharmacokinetic-pharmacodynamic (PK-PD) model for computational simulation of antibiotic treatment efficacy. Using this modeling framework, I predict antibiotic distribution in TB granulomas and how treatments influence antibiotic resistance. In addition to antibiotic modeling, I combine optimization algorithms with this computational treatment model to locate better antibiotic regimens. Using a virtual clinical trial, I compare the identified optimal treatments to current TB treatments and show that different combinations of antibiotics can improve and shorten TB therapy.

Brittany Clawson
Molecular, Cellular, and Developmental Biology

Investigating the Role of Sleep-Dependent Memory Consolidation in Experience Activated Neurons

From honey bees to human beings, sleep is critical for long-term memory storage. However, the mechanism by which sleep promotes synaptic plasticity is not well understood. The Sleep Homeostasis Hypothesis (SHY) posits that sleep uniformly decreases synaptic strength in brain networks, while the Active System Consolidation (ASC) hypothesis postulates that during sleep, synapses are strengthened selectively in neurons active during recent learning. My thesis work tests the hypothesis that both synaptic strengthening and weakening can simultaneously occur during sleep—with strengthening of synaptic connections in learning activated neurons and simultaneous reductions of synaptic strength in others. I am testing this hypothesis using a combination of recently-developed genetic tools for targeting gene expression to learning-activated populations, in vivo recording of neurons undergoing sleep-dependent plasticity in the visual cortex, behavioral manipulations, and optogenetic techniques for controlling neuronal activity.

Jessica Cote
Neuroscience

The brain-specific alpha and delta isoforms of adaptor protein SH2B1 serve highly specialized roles in metabolism at the whole-animal and cellular levels

Humans with mutations in SH2B1 are obese and diabetic, as are mice lacking SH2B1 adaptor proteins. SH2B1 regulates metabolism primarily through its expression in neurons. SH2B1 is alternatively spliced into four isoforms (alpha, beta, gamma, delta). Despite having nearly identical sequences, the isoforms have unique properties. SH2B1beta/gamma are expressed ubiquitously whereas SH2B1alpha/delta are expressed primarily in brain. SH2B1beta/gamma promote neuronal growth-associated activities in vitro whereas SH2B1alpha suppresses these activities. In my dissertation, I aim to understand how the brain-specific SH2B1alpha/delta isoforms contribute to metabolism at the whole-animal and cellular levels. First, I demonstrate that the removal of SH2B1alpha/delta protects mice against obesity. Surprisingly, this lean phenotype arises independent of leptin action. I also demonstrate that SH2B1delta enhances multiple activities downstream of neurotrophic factor receptors, which are often involved in metabolic regulation. Collectively, my findings demonstrate that SH2B1alpha/delta serve highly specialized roles in metabolism in vivo and in vitro.

Amelia Couture Bue
Communication Studies

Empowerment Sold Separately: Eye Tracking Messages of Empowerment and Objectification in Contemporary Advertising

Empowerment-themed advertisements are becoming an attractive marketing strategy for companies due to their popularity among female consumers. While the explicit narrative of these advertisements may seem empowering, the visual messages still resemble traditionally objectifying campaigns. This dissertation uses scale development and eye tracking experiments to explore participants' responses to these media messages, examining tensions between felt empowerment and self-objectification when the two constructs are presented simultaneously. The goals are three-fold: 1) measurement: development of a context-flexible tool to measure affective empowerment, 2) mechanism: assessment of schema activation when empowering and objectifying messages are presented simultaneously, and 3) message: combining self-report measures with eye tracking data to test the effect of specific message components (i.e., text and imagery) in empowerment-themed messages. Together, these experiments evaluate message processing of empowerment-themed media, and can be used to determine how visual processing relates to participants' psychological outcomes.

Sampurna Datta
Civil and Environmental Engineering

Coupled Hydro-Biochemical-Mechanical Modeling of MSW Degradation for Energy Generation in Next-Generation Reactor Facilities

This dissertation aims to promote a shift in waste management practices by transforming landfills from containment facilities to energy reactors. The sub-optimal degradation of municipal solid waste (MSW) in landfills results in the generation of biogas (methane and carbon dioxide, both greenhouse gases) at slow rates that is mostly leaked to the atmosphere. However, with proper control, degradation in landfills can truly become efficient, generating biogas at high rates, thus becoming a sustainable source for power and heat generation. Due to their legacy, landfill practices remain highly empirical owing to lack of a comprehensive understanding of the degradation process. To promote energy generation from landfills, a high performance model is developed which captures the dynamics of the evolving physical-biochemical-mechanical processes during degradation. The model is calibrated against unique large-size laboratory experiments, and then scaled-up using data from field monitoring sensors, to guide decision-making of landfill operations towards optimizing energy generation.

Jon Dean
Molecular and Integrative Physiology

The Role of the Prefrontal Cortex in Mediating Level of Consciousness

Clinical/correlative studies yield contradictory evidence for a role for prefrontal cortex (PFC) in consciousness. Causal studies are lacking. My central hypothesis is PFC is critical in mediating level of consciousness. I have been testing this by stimulating different brain areas in anesthetized rats, including transgenic rats in chemogenetic activation/ inhibition studies. Aim 1 showed cholinergic stimulation of PFC induces wakefulness. Aim 2 demonstrated induced wakefulness does not rescue cortical connectivity, an electrical surrogate of wakefulness. Aim 3 assesses the role of a PFC-basal forebrain neural loop in wakefulness. Activation of basal forebrain cholinergic neurons was sufficient to induce wakefulness. Remaining experiments will stimulate basal forebrain cholinergic neurons while inhibiting PFC; and stimulate PFC while inhibiting basal forebrain cholinergic neurons. Collectively, these studies provide causal evidence for a PFC role in level of consciousness, show an intricate role of cortical oscillations in consciousness, and will determine whether PFC is necessary for wakefulness.

Joseph DeLeon
Film, Television, and Media

Social Media at the Margins: Crafting Community Media in the 1980s

My dissertation project analyzes four activist communities and their self-created platforms for communication and solidarity throughout the long-1980s. My case studies focus on marginalized social actors whose work anticipated and informed practices now associated with the rise of social media platforms: the Community Memory public computing terminal project in Berkeley, California; Nelson Sullivan's archive of videos of a 1980s queer nightlife scene in New York City; the queer punk zine and underground film scene of Toronto, Ontario; and the queer anarchist and environmentalist movement fostered around the radical publication Fifth Estate of Detroit, Michigan. Joseph interrogates how these sites of subcultural production have been understood as foundations for contemporary facets of digital culture today. Joseph's project argues that a multi-sited, archival approach to the history of social media can revitalize the past contexts and contributions to digital media culture of women and LGBTQ individuals.

Maxwell DeNies
Cellular and Molecular Biology

Investigation of how endocytosis, receptor post-translational modification, and localization regulate CXCR4 signaling and trafficking

Cell signaling is an essential mechanism used by cells to translate extracellular stimuli into actionable intracellular information. Due to the importance of signaling for both homeostatic and pathogenic biological processes and growing need for new therapies, a quantitative understanding of the molecular players and basic mechanisms of these transient events is fundamental to both basic research and drug development. Using advanced systems biology and cell biology methodologies we are investigating the interface between endocytic trafficking and receptor regulation—signaling, post-translational modification, and degradation. To do so we use a clinically relevant chemokine CXC receptor 4 (CXCR4) as a model. The goal of this research is to mechanistically understand how cells use spatiotemporal processing to regulate CXCR4 signaling and trafficking and to identify previously unknown master regulators of CXCR4 biology. Completion of this work will begin to elucidate the molecular mechanisms by which endocytosis regulates CXCR4 signaling and trafficking.

Domenic DeSocio
Germanic Languages and Literatures

The Time of Their Lives: Queer and Female Modernism, 1910-1934

This interdisciplinary project analyzes queer and female visions and figures of modern existence in German-language modernist literature during the early twentieth century. Asking what happens when we foreground sexual difference in thinking and writing 'the modern,' I interpret the ways in which these historically marginalized subjects conceive of the experience of their modern realities through the lenses of time, subjectivity, and desire. Bringing literary criticism, queer and feminist theory, and philosophy to bear on interpretations of modernist texts, I rethink modern German history, culture, and literature by centering voices and texts that have customarily been neglected in scholarship. Out of these analyses, I develop an inherently 'queer' understanding of modernity as an ethos in which these subjects conceived of and practiced subjectivities of becoming rather than being and fashioned fluid, unforeclosed, yet coherent selves that thrive in potentiality.

Briana Doering
Anthropology

Leaving the Subarctic Behind: Evaluating the Social and Environmental Process of the Athabascan Migration

Approximately 1500 years ago, Athabascans radically altered their lifestyle in central Alaska and the Yukon, and many ultimately left this region entirely. In my dissertation, I evaluate the causes of this drastic transition using a multiscalar archaeological dataset that draws from excavation, geospatial, and ethnographic data that I have collected from the region. Specifically, I consider how a massive volcanic eruption and significant population change contributed to a sudden, wide-scale shift in Subarctic technology, diet, and trade, and an ultimate southward migration. The diachronic nature of archaeological research allows me to model this transition as a process, rather than an event, that can be compared to similar cultural and behavioral processes to provide a comprehensive understanding of resilience, adaptation, and migration at different periods of history and around the world.

Luis Miguel dos Santos Vicente
Romance Languages and Literatures - Spanish

Foreign Origins: Geographies of Alterity in Medieval Castilian Narratives

My dissertation is framed within the current context of growing discourses of racism, cultural exclusion, and hate across the world, as a distorted idea about the medieval past has been coopted by alt-right groups to defend a fictitious homogeneous origin of modern nations. In my doctoral dissertation, I analyze strategies to negotiate, incorporate, and appropriate the cultural legacy of traditions that were conceived as foreign in medieval Castile. I study the thematization of transmission, translation, and displacement in a varied range of narrative texts produced between thirteenth and fifteenth centuries: scientific treatises, romances, historiographical chronicles, and travel narratives. These works problematize the alterity of languages, religions, physiognomies, and mores that were perceived as external to European Christendom. I argue that the incorporation of "foreign origins" into Castilian literary traditions destabilizes the conceptualization of alterity as the origin of unbridgeable cultural and embodied differences in medieval and contemporary intellectual debates.

Alexander Furnas
Political Science

Outsourced Congress: How Congress Relies on Outside Organizational Policy Information

How does Congress select information to use in the policy-making process? I situate Congress within a wider ecosystem of political and policy knowledge production, where institutional informational needs, staffers' competing incentives, extended partisan and ideological networks, and interest group activities combine to create a system of information processing for the institution. My dissertation is comprised of three separate studies. The first study maps the ideological and partisan coalitions or research organizations using a board inter-lock network. The second study uses substantive interviews of staffers with two original surveys to examine how staffers navigate their information environments as they evaluate and select information to make recommendations. The third study explores the pattern of legislative subsidy by using computational natural language processing to identify text-reuse, where language has been borrowed or modified from documents produced by think tanks and included in reports written within Congress.

Bri Gauger
Urban and Regional Planning

Urban Planning and Its Feminist Histories

The rise of modern feminism in the United States coincided with a pivotal period in the history of American urban planning. Planning began shifting from an elite, technocratic enterprise to a socially and politically engaged discipline in the 1960s, breaking away from a singular focus on physical land use and design and redefining itself as an applied social science with a strong normative commitment to social justice. Because the significant contributions of feminist thought and activism to this transformation are largely absent from planning's intellectual history, "Urban Planning and its Feminist Histories" traces the genealogy of feminist ideas and practices through the profession and academic discipline from 1965 to the present. Building on oral histories conducted with many of the first women to become planning scholars, this work reveals feminism's contradictory legacy in shaping contemporary approaches to planning practice, theory, and education.

Jessica Gillooly
Public Policy and Sociology

"9-1-1, what's your emergency?": How 9-1-1 Operators Construct Emergencies and Shape Call-Driven Policing

Unlike proactive policing where officers use discretion to decide where to patrol and whom to stop, reactive, or call-driven policing has long held legitimacy among scholars. The reason scholars have favored reactive policing is due to its assumption that police have the assent of the public before acting. Yet several high-profile racially-motivated incidents stemming from 9-1-1 calls raise concerns about when citizens mobilize the law and the role that 9-1-1 operators play in processing citizens' demands. Using ethnographic, conversation analytic, and quantitative methods, I challenge the legitimacy of reactive policing by showing how interactions inside dispatch contribute to inequality in the criminal justice system. I analyze two-years of participant observation field-notes from working as a 9-1-1 operator, audio recordings of calls, and call-for-service administrative records to find that the types of requests citizens make, and the actions of call-takers, have consequences for the people and places already most targeted by police.

Kristen Glasener
Higher Education

Shaping Elite College Pathways: Mapping the Field of Feeder High Schools in the United States

Although top colleges have pledged to increase socioeconomic diversity, the percentage of low-income students enrolled in elite colleges has remained stagnant for over two decades. One unexplored but potentially powerful mechanism shaping college pathways is the network of feeder relationships between high schools and elite colleges. Although evidence suggests these longstanding relationships influence admissions outcomes, we know relatively little about how and why they form. In this mixed methods study, I use social network analysis to map feeder relationships between high schools and elite colleges. I then use qualitative interviews with high school counselors and admissions officers to understand why these feeder ties develop and examine their influence on the selective admissions process. In addition to providing theoretical insights into interorganizational relationships, this research is the first to map the high school feeder network for elite colleges in the United States, with critical implications for class stratification in higher education.

Camden Gowler
Ecology and Evolutionary Biology

Ecological and evolutionary dynamics of complex host-parasite communities

Parasites are ubiquitous in nature, and embedded in complex communities of hosts and parasites. Most parasite species infect multiple host species, and most host species are infected by multiple parasite species. However, it's very challenging to study the complex web of host-parasite interactions in natural settings, and controlled lab experiments are often limited to small numbers of host or parasite species. Additionally, parasites can evolve rapidly, so host-parasite interactions change over time. In my dissertation, I used field surveys, network analyses, mathematical models, and lab experiments to understand how different host species influence parasite infections in another host species, how parasites differ in their ability to infect multiple host species, and how parasites evolve over the course of an epidemic. I found that particular host and parasite species disproportionately contribute to cross-species transmission, and parasite virulence can evolve rapidly over the course of a natural epidemic.

Yuqi Gu
Statistics

Statistical Analysis of Structured Latent Attribute Models

Latent variable models are popular statistical tools in social and biological sciences. This dissertation addresses several important problems of Structured Latent Attributes Models (SLAMs), a special family of latent variable models widely used in educational, psychological, and medical diagnosis. Despite the popularity of SLAMs, the fundamental statistical problems of identifiability and learnability remain unsolved due to the complex structure of latent variables in the model. In the first part, we develop identifiability theory for various types of SLAMs, and derive necessary and sufficient identifiability conditions. These easily checkable conditions not only advance our theoretical understanding about SLAMs, but also serve as practical guidelines for practitioners. In the second part, we develop methodology for estimating SLAMs in the high-dimensional sparse latent classes setting. We propose a penalized likelihood method, and establish theoretical guarantees for model learnability and model selection consistency. We then develop efficient algorithms and apply them to analyze real data.

Samantha Hahn
Nutritional Sciences

Examining the relationships between weight-related self-monitoring usage and eating disorder risk among college students

Weight-related self-monitoring (WRSM) involves recording or tracking weight, physical activity, and/or dietary intake. WRSM is recommended for the treatment of overweight/obesity, but millions of people among the general public, particularly college students, also engage in WRSM. Despite the widespread use of WRSM, there is little research evaluating the potential consequences. Of particular concern is the potential for WRSM to increase eating disorder risk. Prior research examining this relationship is almost exclusively cross-sectional, focused on self-weighing, and has failed to capture how various forms of WRSM are used together. The objectives of this dissertation are to: 1) understand how various forms of WRSM are used together among college students, 2) examine whether WRSM is associated with increased eating disorder risk among college students and explore potential moderators of these relationships, and 3) conduct a randomized controlled trial to determine whether dietary tracking increases eating disorder risk among female college students.

Brent Heard
Environment and Sustainability

Anticipating the Effects of Expanded Refrigeration on Food System Sustainability

Refrigeration transforms food systems. This dissertation examines refrigeration from a systems perspective, studying both the technical and behavioral effects of refrigeration on food system sustainability. Despite its notable environmental connections, refrigeration is surprisingly understudied in the sustainability literature. A bounding analysis conducted by the author on refrigerated supply chain introduction into a developing food system indicates that refrigeration may add more emissions than it saves through food loss reductions. Findings from this study also indicate that diet shifts enabled by refrigeration can dramatically influence emissions outcomes. As next steps, the author will model the effectiveness of technical improvements to refrigerated supply chains in mitigating emissions increases, as well as employ econometric techniques to assess how refrigeration introduction shifts diets. Refrigeration is a transformative technology whose sustainability impacts must be examined from both technical and behavioral perspectives.

Kathryn Holihan
Germanic Languages and Literatures

Staging the Somatic: The Popular Hygiene Exhibition in Germany, 1882-1931

My dissertation examines how a series of hygiene exhibitions in Germany from the late nineteenth to mid-twentieth century transmitted critical health information to a broad audience, prompting both museum and public health reform. Employing methods from cultural history and science and technology studies (STS), I investigate the production and popularization of hygiene knowledge through exhibition experimentations with didactic representations of the body and interactive display technologies. Moving beyond an internal narrative of institutional maturation, I demonstrate the political nature of the hygiene exhibition—a site where the "social question" and "museum question" overlapped, as concerns of class, welfare, and biological citizenship became entangled with issues of communication, access, and participation. Intervening in scholarship that regards the museum as an extra-political space, or which hastily deems hygiene exhibitions as proto-Nazi productions, my study exposes the democratic impulses underlying German hygiene exhibitions and their simultaneous commitments to early eugenic science.

Iris Holmes
Ecology and Evolutionary Biology

Mechanisms of microbiome assembly in squamate reptiles: the roles of ecology, evolutionary history, and geography

Like all multicellular organisms, snakes and lizards are dependent on the bacteria that live throughout their body to help digest their food and resist some diseases. These bacteria, collectively called the microbiome, form ecological communities within the host. I use extensive sampling across locations and host species to identify the mechanisms that determine how the bacteria communities assemble themselves within a host. The microbiome community is critical to host survival and adaptability to changing environments, so understanding microbiome ecology is a key advance that is important to many branches of ecology, evolution, and conservation.

Kevin Hughes
Biomedical Engineering

A Biodegradable Nanoparticle Platform for Treatment of Food Allergy

Food allergy is a life-threatening immunological disorder with a prevalence that is steadily increasing. The current methods to manage food allergies are limited primarily to avoidance of the allergen or high-risk oral immunotherapy (OIT), which is poorly understood and exhibits considerable variability in both the magnitude and duration of efficacy. In addition to reducing mortality, well-tolerated methods to induce a robust desensitization to food allergens would represent a tremendous success for the fields of biomedical engineering and immunology and would significantly improve patient quality of life. This project encompasses our development of a biodegradable nanoparticle platform capable of inducing tolerance to high oral doses of allergens in multiple food allergy models. Importantly, we demonstrate elimination of allergen-associated anaphylactic reactions in both prophylactic and therapeutic contexts without adverse reactions to the therapy. This research represents a highly translatable technology that provides critical immunological insights that are relevant to many immunological diseases.

Joseph Iafrate
Applied Physics

Current-Induced Spin Polarization and Dynamic Nuclear Polarization: Generation and Manipulation of Electron and Nuclear Spin Polarization in Gallium Arsenide

Spintronics would utilize the spin of the electron, as opposed to the charge, for information processing and storage, leading to devices that are smaller, faster, and more energy-efficient than their electronic counterparts. Before these spin-based devices can be fully realized, we must understand the behavior of electron spins in semiconductors. First, I modify an electrical technique to study current-induced spin polarization in indium gallium arsenide to extend the capabilities of our measurements and open new regimes of experiment. Then, I investigate dynamic nuclear polarization in gallium arsenide under periodic optical electron spin generation. I observe evidence of a minutes-long precise memory of the electron-nuclear system's magnetic field history, unaccounted for by current theory, and work to elucidate the underlying mechanisms. Taken together, this research aims to further the understanding necessary to bring about semiconductor spintronic devices.

John Jasa
Aerospace Engineering

Path-Dependent Design Optimization of a Supersonic Aircraft Considering Thermal-Propulsive Performance

Aircraft are multidisciplinary systems that are challenging to optimally design due to interactions between the subsystems. The relevant subsystem disciplines, such as aerodynamics, structures, thermal, and propulsion, must be considered simultaneously in a path-dependent formulation to accurately predict aircraft performance. The overarching contribution of this work is the construction and exploration of a coupled aero-thermal-propulsive-mission multidisciplinary model to optimize supersonic aircraft performance. We first optimize the flight path of a thermally constrained aircraft, then we design a variable cycle engine for optimal propulsive performance across multiple flight conditions. Finally, we couple these disciplines together and find the optimal mission trajectory while simultaneously designing the engine and thermal systems subject to realistic operating conditions for a representative mission. Through this work, we both increase military aircraft capability and contribute to a more globally connected and sustainable world by enabling more efficient commercial airliner operations.

Callum Jones
Physics

Applications of On-Shell Methods in Effective Field Theory

Effective field theory methods are now widely used to describe quantum field theories at low-energies; even where the ultraviolet completion is unknown. Often, the non-physical redundancy of the formalism of Wilsonian effective actions produce a barrier to what is practically calculable, obscuring the underlying physics. As an alternative, we use a variety of modern on-shell methods to directly study the S-matrix for a wide class of effective field theories. Results include: (i) Extension of soft theorems for photons and gravitons to sub-sub-leading order including a complete understanding of irrelevant operators (ii) Development of an on-shell approach to the classification of EFTs for Goldstone modes (iii) A completely on-shell construction of the S-matrix of models of partially broken supersymmetry and electric-magnetic duality using subtracted recursion (iv) Discovery of a one-loop color-kinematics anomaly in Born-Infeld electrodynamics via generalized unitarity.

William Kelley
Chemical Engineering

Neutrophil Interactions with Particle Drug Carriers and Behavior in Inflammation

Despite comprising approximately 60% of all circulating leukocytes, neutrophils are relatively less well-studied than other subpopulations of leukocytes. Specifically, we know very little about how neutrophils interact with particle drug carriers designed for various therapies and how neutrophils behave in flow in inflammatory conditions. Filling in these gaps in the knowledge is crucial for advancement of the field of targeted drug delivery and treatments for inflammatory diseases and will help to design particle drug carriers and therapies. This dissertation aims to explore these topics via four specific aims: (1) investigate the impact of particle drug carriers on WBC adhesion in inflammation in vitro, (2) investigate the impact of particle drug carriers on WBC response to inflammation in vivo and develop into a therapeutic strategy, (3) determine the impact of a common nonfouling coating, polyethylene glycol (PEG), on drug carrier uptake by neutrophils, and (4) investigate neutrophil behavior in antiphospholipid syndrome.

Esmaeil Keyvanshokooh
Industrial and Operations Engineering

Online Learning and Personalized Decision-Making Theory with Applications in Healthcare

My research is a fundamentally new way of thinking about online (or real-time) decision making and presents a significant advance to both theoretical and practical aspects of healthcare delivery systems, and chronic disease treatment management and control. In collaboration with the University of Michigan Health System and the Kellogg Eye Center, this research offers substantial opportunities to help and protect our communities from a wide-range of chronic diseases and to develop new healthcare delivery systems that lack historical data. I have developed a data-driven online learning framework to address the problem of personalized learning and treatment control of chronic diseases and online robust/stochastic optimization methodologies for outpatient delivery systems.

Janelle Kirsch
Chemistry

New Developments of Palladium-Catalyzed Alkene Difunctionalization Reactions for Small Molecule Synthesis

This dissertation will describe the development and exploration of two new palladium-catalyzed alkene difunctionalization reactions. The first couples aryl triflates bearing pendant alkenes with heteroaromatic nucleophiles to provide carbocyclic products by forming two new carbon-carbon bonds. The products of this reaction are formed in moderate to good yields and have observed diastereoselectivities up to >20:1. The second reaction is a new type of alkene difunctionalization reaction of N-allylguanidines and ureas. In this reaction, we utilize nitrogen-centered electrophiles, derived from acylated hydroxylamines, to afford heterocyclic alkene diamination products in good to excellent yields and moderate diastereoselectivites. Further explorations on the scope of this reaction, along with efforts to improve the stereospecific generation of products that result from either anti or syn addition to the alkene will be discussed. Additionally preliminary mechanistic findings will also be presented, including studies to determine whether these transformations proceed through a Pd(0)/(II) vs Pd(II)/(IV) catalytic cycle.

Michail Kitsos
Middle East Studies

The Torah Is Not in Heaven: The Humanization of the Divine Through Jewish and Christian Multivocal Works

Ancient Christian and Jewish authors have written extensively on the topic of the divine each from the perspective of their religious tradition. Scholars have identified in these works the political agendas of their writers to define the parameters of their "orthodoxy." Theological discussions on the divine appear also in Jewish and Christian multivocal dialogical works, namely the Dialogues Against the Jews and rabbinic multivocal narratives, which have not received scholarly attention. My dissertation investigates the reasons why Christians and rabbis used multivocality through which they presented Christians dialoging with Jews and rabbis conversing with each other and with non-Jews to discuss the divine. I am arguing that Jews and Christians were equally concerned with accessing the divine and to do so they had to humanize it. This humanization of the divine was achieved by writing dialogues through which the divine was presented to be part of everyday conversations.

Aleksandra Kuznetsova
Astronomy and Astrophysics

Numerical Studies of Star and Disk Formation

Protoplanetary disks are ubiquitous and play a significant role in the early stages of star and planet formation; stars grow their mass from disks and conditions within the disk determine potential routes for planet formation. A testable theory of star and planet formation requires predictions of the range and relative distribution of disk properties. The goals of this thesis are to identify and understand the dominant physical processes that dictate disk properties and behavior using a series of numerical experiments. We model the beginning of disk formation in a top-down fashion, starting with star cluster size scales in order to obtain a set of initial conditions for populations of protostars, with and without magnetic fields. Concurrently, we motivate the use of the cold (subvirial) collapse model of star cluster formation and investigate the role of gravitationally focused accretion in assembling clusters and setting the stellar initial mass function.

Joanna Larson
Ecology and Evolutionary Biology

Ecological and dietary diversity of frogs along the latitudinal diversity gradient

An enduring question in biology is why species are unevenly distributed between geographic regions and between groups of organisms. Particularly intriguing is that there are more species in the tropics than in temperate areas, a pattern known as the latitudinal diversity gradient. Using large morphological and diet datasets that I created, I explore how frogs use ecological resources along this gradient in the New World. I also test how frog resource use can impact the diversity of frogs by either promoting or slowing the formation of new species. To assemble my diet dataset, I collected over 3,000 samples from eight field sites and used high-throughput sequencing to create a dataset that is both precise and broadly sampled taxonomically and geographically. I present a novel framework for studying the evolution of diet that is more statistically robust and ecologically informative than previous methods.

Zoey Laskaris
Epidemiology

Air pollution and respiratory health among workers of the informal electronic-waste recovery trade: application of new methods to target risk-mitigating interventions and improve environmental and occupational health

This interdisciplinary dissertation provides epidemiologic evidence on the association between inhalation pollutants released during informal electronic-waste (e-waste) recovery practices and respiratory health of workers. Using evidence gathered at the Agbogbloshie e-waste site in Ghana, I aim to: 1) describe an innovative data collection method using personal wearable cameras that is applicable in this and other informal job sectors where unprotected workers are vulnerable to physical, social, and economic pressures; 2) establish job-specific exposure estimates to respirable (fine and coarse) particulate matter, a component of air pollution and a known carcinogen, to inform targeted interventions that reduce occupational and community health risks; and 3) add to the limited evidence from low- and middle-income countries on the adverse respiratory health effects from exposure to high concentrations of respirable particulate matter using pre- and post-work shift measures of lung function.

Jieun Lee
Public Policy and Political Science

Foreign Direct Investment in Political Influence

This three-paper dissertation aims to understand the political interests and engagement of global firms in other countries. In the first paper, I demonstrate that local subsidiaries of foreign firms engage in U.S. federal elections on behalf of their foreign parents. In fact, U.S. subsidiaries of foreign firms are more likely to sponsor a Political Action Committee and give a greater amount of campaign contributions than comparable American firms. The second paper shows how these subsidiaries actively lobby the U.S. government regarding issue areas of interest to their foreign parents. In the third paper, I confirm that foreign acquisition of an American firm alters its campaign giving and lobbying behavior in ways consistent with findings of the first two papers, insofar as they become more politically engaged. Collectively, these papers lend support to a theory that foreign firms use local subsidiaries to gain political access and leverage elsewhere. Thus, foreign direct investment partly serves as an investment in political influence.

Joshua Leonardis
Movement Science

The Influence of Breast Reconstruction Choice on Functional Shoulder Biomechanics in Women Undergoing Mastectomy for Breast Cancer

A majority of women that undergo a mastectomy as treatment for breast cancer will have a reconstructive surgery performed to restore the look and feel of healthy breast tissue. Common breast reconstruction techniques require removing shoulder muscles from their skeletal attachments. This removal often leads to reductions in quality of life and shoulder function, but it is unknown how the nervous system compensates for the removal of key shoulder musculature. This dissertation (1) examines how remaining, intact muscles compensate for the removal of musculature during breast reconstruction, and (2) identifies how certain neuromuscular adaptations relate to quality of life. Thirty patients that underwent one of three breast reconstruction procedures (>18 months post-operative) will have their neuromuscular shoulder function assessed during a single experimental session. Findings from this dissertation will (1) strengthen the surgical decision making process and (2) assist clinicians in developing targeted rehabilitation protocols.

Jun Li
Health Services Organization and Policy

Understanding the effects of Medicare's home health Star Ratings: patient choice and unintended consequences

U.S. policymakers have increasingly relied on Star Ratings to provide greater transparency to consumers about the quality of care delivered across the health care system. The home health Star Ratings program is Medicare's flagship initiative to help patients find high quality home health care. Using a rigorous regression discontinuity design, this study is the first to estimate the causal implications of the program on patients. This dissertation will determine whether the program achieved its primary goal to inform patient choice and shift patients into higher rated home health agencies. It also assesses whether the program had heterogeneous effects on patient choice across markets with varying levels of competition. Finally, the research will determine whether the program led to decreased access to higher rated home health care among vulnerable patients. The output will inform the ongoing debate among policymakers in how to address suboptimal quality in the home health sector.

Da Li
Civil Engineering

Harnessing Human-Building Interactions for Enabling Healthy, Productive, and Sustainable Built Environments

More than 40% of the energy produced globally is consumed within buildings. However, despite the significant impacts of such energy consumption on the environment, the lack of thermal comfort among occupants is a common problem. This dissertation introduces new research in human-building interaction that attempts to address these issues. Specifically, several key limitations in existing approaches of assessing thermal comfort are discussed, such as the lack of actionable human data. To address these gaps, this research demonstrates how human bio-signals collected from heterogeneous sources can establish robust prediction models. The proposed methods are expected to achieve automated control of built environments to improve human experience and well-being. Further, this research demonstrates how human cognitive processes can affect energy-saving behaviors through a socio-psychological framework, which suggests that favorable behaviors can be promoted through motivation and removing environmental constraints. This framework provides insights to develop effective interventions to reduce building energy use.

Dominic Liao-McPherson
Aerospace Engineering

Variational and Semismooth Numerical Methods for Model Predictive Control

This dissertation presents several numerical methods for solving optimal control problems (OCPs) in real-time, motivated by Model Predictive Control (MPC). First, I present the Fischer-Burmeister Regularized and Smoothed (FBRS) and Proximally Stabilized Fischer-Burmeister (FBstab) methods for quadratic programming. Both can exploit problem structure, are easy to warmstart, and have strong convergence guarantees. Second, I present a systems theoretical analysis of suboptimal MPC (SOMPC), a technique for reducing the computational complexity of MPC controller by exploiting the robustness of MPC controllers to incomplete optimization. By viewing the plant and optimizer as interconnected dynamics systems I derive stability and robustness properties for the closed-loop system using input-to-state stability concepts. Finally, I present an emissions oriented MPC controller which is implemented using SOMPC concepts and the FBRS solver. We experimentally demonstrate a 10-15% reduction in cumulative emissions over the WLTC driving cycle.

April Lukowski
Chemical Biology

Elucidation of the saxitoxin biosynthetic pathway

Saxitoxin is a potent neurotoxin that is produced by freshwater cyanobacteria and marine dinoflagellates. The tricyclic bisguanidine molecule is implicated in harmful algal blooms, toxic red tides, and paralytic shellfish poisoning. Despite its notoriety as a biological toxin, saxitoxin has been an indispensable tool for structure and function studies of mammalian voltage-gated sodium channels (VGSCs) for several decades. The biosynthetic pathway for this high-profile molecule has not been elucidated, but the gene clusters associated with biosynthesis have been previously identified. This work comprises the in vitro biochemical characterization of enzymes involved in the biosynthesis of saxitoxin and its analogs. This research has the potential to provide the tools necessary to enable efficient biocatalytic methods for the synthesis and derivatization of the saxitoxin scaffold, which can be applied to the design of drugs targeting VGSCs for non-opioid pain management and the treatment of neurological disorders.

Lan Luo
Biostatistics

Renewable Estimation and Incremental Inference with Streaming Health Datasets

This dissertation is largely motived by the modeling and analysis of streaming health data that become increasingly popular in the biomedical sciences and public health. By streaming data, it refers to high throughput recording for large volumes of observations collected sequentially and perpetually over time, including national disease registry, mobile health, and disease surveillance, among others. This dissertation primarily concerns the development of fast real-time statistical methodology for regression analysis, with a serious attempt to optimize the space of streaming data storage and information updates. Utilizing the powerful Lambda architecture in Spark, I develop a new statistical procedure for both estimation and inference of regression parameters based on the utility of current data and summary statistics of historical data, rather than historical subject-level data. Termed as renewable estimation in my dissertation, this new methodology helps greatly improve computing speed and data storage capacity. I establish both theoretical justification and numerical implementation for updating both parameter estimates and their standard errors along with data streams. The proposed algorithms for incremental inference are applicable to both generalized linear models (GLM) for cross-sectional data and quadratic inference functions (QIF) for correlated data. I demonstrate the proposed methods and algorithms with streaming datasets collected by the national kidney transplant registry data that are continually updated over time by the Scientific Registry of Transplant Recipients (SRTR) of the United States. In the analysis I illustrate that re-evaluation of risk factors for mortality or graft loss can be effectively carried out with no use of voluminous historical subject-level data, but only available summary statistics and newly collected data.

Lauren Mancia
Mechanical Engineering

Numerical investigations of cavitation in tissue

Acoustic cavitation involves the formation and response of vapor bubbles to pressure changes produced, for instance, by high-amplitude ultrasound. Cavitation is important in focused ultrasound procedures used to fractionate soft tissue. Focused ultrasound is a promising non-invasive treatment for solid tumors; however, cavitation damage mechanisms are extremely transient and difficult to quantify experimentally. A numerical model of single bubble dynamics is presented to support the development of tissue damage metrics for monitoring cavitation-based focused ultrasound. Simulation results are first validated by measurements of bubble radius as a function of time for acoustically-generated single bubbles. A method is then presented that combines experimental data and single-bubble simulations to infer the distribution of cavitation nuclei sizes. The validated model is then used for an investigation of cavitation damage mechanisms. Simulations are used to quantify stress, strain, and strain rate fields developed around a cavitation bubble. A dimensionless parameter combining tissue and waveform characteristics is derived that dictates the dominant damage mechanism (strain vs. strain rate) as a function of distance from the bubble nucleus. These results are used to explain sparing of critical structures in focused ultrasound treatment of liver tumors.

Eduardo Martinez
Philosophy

Democratic Evaluation and Improvement: A Set of Standards for Citizens and Representative Institutions

I develop a set of standards with which to evaluate democracies and guide interventions to improve political decision-making within them. The first standard is democratic health, which is a feature of the epistemic environment in which citizens operate. I argue that a democratically healthy environment is one in which citizens can develop key capacities to reason and communicate about their interests, and that democratic health can affect whether the values that justify democracy are, in fact, realized. The second standard is responsiveness. I argue that observed public opinion and the values, goals, and commitments of citizens can stand in tension, and that representative democracies must balance both factors for responsive representation. The third standard is formal civic education. I argue that the civic education program necessary to improve democratic health can avoid instilling particular substantive values in citizens, thereby overcoming objections of social engineering.

Flor Mendez
Cell and Developmental Biology

Molecular mechanisms mediated by ACVR1 G328V and H3K27M in pediatric brainstem tumors

Diffuse intrinsic pontine glioma (DIPG) is a brain tumor most commonly diagnosed in children and the prognosis is very poor. There is currently no effective treatment for DIPG. Genomic studies of autopsy and biopsy tissue revealed the presence of recurrent mutations in ACVR1 and lysine to methionine mutations at position 27 in the genes encoding histone H3 variants, H3.3 and H3.1. To study the role of these mutations on DIPG tumorigenesis we developed a genetically engineered immune competent mouse model of ACVR1 and H3.1 K27M mutant brainstem glioma that we used to study the tumor biology, tumor microenvironment, and to test the response of brainstem gliomas with ACVR1 and H3.1 K27M mutations to immune stimulatory gene therapy. We have demonstrated, in vitro and in vivo, that our model is reliably modeling the human disease, and our results from the immunotherapy studies will help design novel therapies for children with DIPG.

Kelsey Mengle
Materials Science and Engineering

First-Principles Calculations on the Electronic, Optical, and Vibrational Properties of Ultra-Wide-Band-Gap Semiconductors

Modern society relies heavily on electricity and optoelectronics, but devices suffer from significant energy loss. Efficient power conversion is necessary to transform between voltages for use in all electronics, and higher-efficiency LEDs are required for energy-efficient lighting. My research investigates the viability of ultra-wide-band-gap-semiconductor materials in high-power electronic and deep-ultraviolet luminescence applications using atomistic calculations based on density functional theory. My results for beta-Ga2O3 and h-BN uncover the viability of these indirect-gap materials for deep-ultraviolet light-emitting devices. I also show how stacking faults in GaN structures impact their electronic transport properties. I obtained the first ab initio estimate of the breakdown field of beta-Ga2O3, a value crucial for high-power electronics devices. Last, I propose a new material, r-GeO2, with a wider band gap and higher electron mobility that can overcome the limitations of beta-Ga2O3.

Mehrdad Moharrami
Electrical and Computer Engineering

A Study of Phase Transition in New Random Graph Families

Random graphs are mathematical models for understanding real-world networks. Important properties can be captured, processes studied, and rigorous predictions made. Phase transitions (sudden changes in structural properties caused by varying an underlying parameter) are commonly observed in random graphs. Our work focuses on phase transitions in three models. We study emergence of cascades and impact of community structure on phase transition in threshold-based contagion models using modular random graphs generated by configuration model and differential equation method. Using local weak analysis, we study a new graph model generated by bilateral agreement of individuals and analyze when a giant component emerges. Using the objective method and motivated by particle tracking in physics and object tracking in videos, we study detectability threshold of a hidden planted matching in a complete bipartite randomly weighted graph.

Janée Moses
American Culture

"A House to Sing In: Extra/Ordinary Black Women's Narratives About Black Power"

My dissertation considers racial and gender tensions that arise for black women who identified as revolutionary because of and despite their participation in phallocentric versions of black radicalism. These versions of black radicalism required adherence to a domestic role that upheld patriarchal traditions and restricted their movement and capacity to tell the truth. This black feminist study focuses, in particular, on how black womanhood is voiced in interviews, life writing, and gendered performances by Amina Baraka, Nina Simone, and Elaine Brown, each of whom fail fully to adhere to gendered formulations of revolutionary identities in their negotiations of the period between WWII and Black Power through the late 1970s. I demonstrate that black women's desire to possess a house to sing in, as a manifestation of their social and cultural capital, is complicated by their participation in forms of black radicalism which reflect, at their very core, foundational, patriarchal traditions.

Matthew Naglak
Classical Art and Archaeology

The Rhythm of the Forum: A Reconsideration of Piazza Spaces in Roman Italy

Piazzas have long been places of community, interaction, and conflict within urban environments. This was certainly the case in Roman Italy, where the forum was the economic, political, and social center of most towns. Nevertheless, scholarly focus is almost always on elite political messaging within these spaces. My dissertation instead emphasizes the dynamic, integrative nature of piazzas, places where individuals of all social classes, genders, and occupations visited and moved through daily, by combining aspects of architect A. Rapoport's architectural-communication theory with sociologist H. Lefebvre's concept of rhythmanalysis. Using a mixture of textual, archaeological, and ethnographic evidence organized around varying time and permanence scales, along with a consideration of modern urban theory, this study results in a better understanding of the variety of lived experiences within the forum and, in particular, how individuals and the environment shape and reshape one another as co-participants in unique and rhythmic events.

Simeon Newman
Sociology

The Political Development of Urban Clientelism in Twentieth Century Latin America: Mexico City, Lima, and Caracas in Comparative-Historical Perspective

Social theorists have tended to consider urbanization a key aspect of societal modernization, and to qualify clientelism—informal and hierarchical quid-pro-quo relations mediated by brokers—as nonmodern. I find, instead, that urbanization underwrote clientelism in twentieth century Latin America. From the 1940s to the 1980s, that region experienced the fastest and most extensive urban growth in world history, during which vast squatter settlements were established around its large cities. Focusing on Mexico City, Lima, Peru, and Caracas, Venezuela, and based on original archival evidence, I show, first, that this gave rise to informal quid-pro-quo relations between squatters and the state that were mediated by brokers. Second, I find that urban growth bolstered urban brokers' power: it generated conflicts between older and newer squatter generations which drove the latter into urban brokers' arms for protection, giving brokers the ability mobilize them to extend control over settlement turf and extract rent.

Hayley O'Malley
English Language and Literature

Dreaming Black Cinema: The Filmic Turn in African American Literary Production

My dissertation argues that African American authors in the late 20th century increasingly came to see film as a unique tool for self-expression and political empowerment. They therefore experimented consistently with filmmaking, in a way that ultimately remade both black cultural production and American cinema. Beginning in the late 1960s, black writers dove into an emerging independent black film scene by directing, producing, and editing films, writing screenplays and film criticism, and organizing film festivals. This turn to film has not yet been mapped by scholars, but it is a key part of the story of contemporary media culture and African American art and literature. In particular, drawing on extensive archival research, I show how black writers' engagement with film inspired their literary experiments, shaped theories and practices of black feminism, drove participation in transnational artistic collectives, and propelled efforts to reach new public audiences and transform their worldviews.

Peter Orchard
Bioinformatics

Skeletal muscle chromatin architecture mediates genetic regulatory effects in type 2 diabetes and a rat model for exercise capacity

Genomic loci linked to Type 2 diabetes (T2D) risk lie primarily in non-coding regions of the genome. Determining which genetic variants in these regions are causally related to T2D and elucidating their mechanisms of action is difficult. Here we integrate enhancer RNA, ATAC-seq, and ChIP-seq profiles to map the non-coding genome in skeletal muscle, a T2D-relevant tissue. We use this resource to fine-map T2D risk variants. We additionally integrate genotype, phenotype, and muscle ATAC-seq and RNA-seq data from 294 individuals to determine which gene regulatory elements and chromatin accessibility-altering variants associate with T2D risk. Lastly, to gain insight into the genetic regulation of chromatin architecture and its association with aerobic exercise capacity (a phenotype negatively correlated with T2D susceptibility), we analyze muscle ATAC-seq, RNA-seq, and genotype data from a rat model for untrained running capacity. We uncover regulatory elements, genes, and cell types associated with exercise response and exercise capacity.

David Patterson
History

Weather and Climate in Early Medieval Francia (c. 500–900)

My dissertation investigates weather and climate in the early medieval Frankish world, from the mid-sixth to early tenth centuries. This chronological span straddles dramatic political, social, and cultural change, as well as two distinct climatic phases: the 'Late Antique Little Ice Age' ca. 536–660 CE, and the 'Medieval Quiet [or Warm] Period', beginning as early as 725 CE. The former has been associated with the so-called 'Dark Ages,' while the latter is sometimes connected with the economic and demographic growth of the Carolingian Renaissance. Recent years have witnessed a rapid proliferation of studies using proxy data (past climate signals preserved in natural archives) to reconstruct climates of the past, supplemented where possible by documentary records. By interrogating early medieval ideas and assumptions about weather and climate—which were closely connected to politics and theology—I aim to broaden our understanding of the complex meteo-discourse of the early Middle Ages.

Devon Pendlebury
Chemical Biology

Structurally and Biochemically dissecting the telomere-inner nuclear membrane interface

A critical step in meiosis is the pairing of homologous chromosomes so that they can recombine, leading to production of gametes with genetic diversity. For pairing to occur the ends of chromosomes, telomeres, must be tethered to cellular motors via the inner nuclear membrane. This nuclear tethering occurs between ubiquitous telomeric proteins, members of the shelterin complex, and meiosis specific proteins including TRF1, TERB1, TERB2 and MAJIN. I have mapped the binding interface between TRF1 and TERB1, the initiating interaction for telomere tethering, and solved a novel TERB1 structure, as well as biochemically characterizing this interaction and the consequences of disrupted binding. I have also investigated TERB1-TERB2 binding as well as other protein-protein interactions involved in this critical process essential for fertility.

Janet Price
Molecular, Cellular, and Developmental Biology

Internal Molecular Controls of Escherichia coli Extracellular Matrix Production

A defining characteristic of the bacterial lifestyle is the formation of a biofilm, a community of cells living together, usually with the aid of a secreted extracellular matrix. The extracellular matrix produced by Escherichia coli primarily consists of protein and carbohydrate polymers called curli and cellulose, respectively, under the control of the master biofilm regulator, CsgD. We found that E. coli biofilms stratify into at least two distinct sub populations, cells that produce the extracellular matrix and cells that do not. Subpopulation development is driven in part by oxygen exclusion, which generates a redox gradient through the biofilm with more oxidized cells producing matrix compared to the more reduced, anoxic underlying cells. To understand the differences between matrix and non-matrix cells, we looked at the roles of redox-sensitive periplasmic proteins and generated transcriptional profiles of the two biofilm subpopulations using RNAseq to identify the transcriptional networks impacted differentially between cell populations.

Sunming Qin
Nuclear Engineering and Radiological Sciences

High-Resolution Experiments and Computations on Mixing of Turbulent Buoyant Jets in Uniform and Stratified Environments

Turbulent buoyant jets have applications varying from nuclear reactor safety analysis to oceanography. To understand the underlying physics of such jets, non-intrusive optical methods of flow visualization, like particle image velocimetry (PIV) and laser-induced fluorescence (LIF), are applied to obtain highly-resolved velocity and concentration fields. However, high-resolution measurements of flows with density differences are challenging because changes in density correspond with changes in refractive index (RI), yielding blurred images. Refractive indices must match throughout mixing. This dissertation is focused first on developing a novel methodology based on mixing behaviors of ternary-component systems, achieving experiments with density differences up to about 9% (three times larger than previously achieved). Additionally, the novel technique allows systematic screening for new ternary-component systems with even higher values of density differences. This work initializes a novel, high-resolution database for the mixing of turbulent buoyant jets in stratified environments, enhancing predictive capabilities of computational fluid dynamic models.

Nana Osei Quarshie
Anthropology and History

Making Alien Lunatics: Migration and Psychiatry in Urban Ghana

"Making Alien Lunatics" examines the place of psychiatric care in processes of social stratification and in the production of national, regional, and ethnic diversity. Taking the history of the care at the Accra Psychiatric Hospital (formerly the Accra Asylum) in Ghana from the 1880s to the present as a point of departure, I ask: 1. How have psychiatric practices evolved and adapted to changes in societal diversity? 2. How have people—historically and in the present—deployed psychiatric institutions to manage changing socio-cultural conditions? Drawing on evidence from patient files and participant-observation of doctor-patient interactions, I uncover how psychiatric practices produced diversity by articulating person-related differences through confinement and the deployment of diagnostic and other technologies. Departing from a long-standing scholarly premise, I argue that European psychiatry in Africa did not displace the power of pre-existing indigenous psycho-therapeutic norms; rather, it was built upon and adapted to them.

Kimberly Ransom
Educational Studies

There Are Children Here: (Re)imagining Black Childhood in Rosenwald Schools of Pickens County Alabama (1940-1969)

Research examining education for blacks across eras of slavery, Reconstruction, and Jim Crow have captured whites and blacks competing interpretations of the warrant for and function of black education; or the conditions of schools and value of black educators. Yet, how black children experienced childhood or articulated agency in schools is not apparent. Drawing from scholarship that asserts black childhood has been unimagined due to their devalued position and disregard within the social conception of childhood, I use ethnohistorical methods to examine archival sources, oral histories, and material objects of once-children who attended Rosenwald Schools in Pickens County, Alabama (1940-1969). Foregrounding the perspectives and products of black children, my dissertation study aims to understand what might be learned about the agency of black children and the character of black childhood in and around pre-Brown segregated schools; and by implication black childhood in this space and time.

Rachna Reddy
Anthropology

The Development of Male Reproductive Strategies in Wild Chimpanzees

Males animals compete for mates, and large, strong, and old males typically win competitive encounters. Nevertheless, adolescent and young adult male chimpanzees, who are physically and socially immature, father many offspring. To investigate how they do so, I studied 30 males in a community of chimpanzees at Ngogo, Kibale National Park, Uganda. Adolescent and young adult males mated by forming relationships with females. These involved grooming and comforting females and their offspring, and behaving aggressively toward females. Although males of all ages were aggressive to females, the impact of aggression on mating success increased with male age; as they grew older, larger, and increasingly high-ranking, males used aggression to coerce females sexually. Coercion was most effective when used against females with whom males were familiar. These results shed light on the evolution of social bonds between human females and males, which can involve affiliation, co-parenting, and sometimes coercive violence.

Emanuel Reinecke
Mathematics

The cohomology of moduli spaces of curves at infinite level

One of the major goals of algebraic geometry is the classification of solution sets of polynomial equations. For example, various types of algebraic curves can be parameterized by so-called moduli spaces, which are geometric objects with interesting structures. This dissertation gives a new perspective, inspired by number theory, on the computation of invariants associated to these spaces. I focus on the vanishing of cohomology in high degrees, which was first studied by Harer with tools from geometric topology.

Harry Richman
Mathematics

Quantization on the real line and on metric graphs

Physicists and philosophers have argued for millennia over whether the “true” nature of the world is continuous or discrete. The attempt to bridge these realms of continuous and discrete phenomena is known as quantization or discretization. On the real number line, we have simple models of quantization but complex and volatile behavior arises in the interaction of quantization at different scales. On metric graphs, a robust theory of quantization has yet to be developed but novel ideas of tropicalization promise to shed new light on this problem by building from the fertile theory of Riemann surfaces. In each of these contexts my research provides a more clear and precise understanding of the interplay between the discrete and the continuous.

Nicole Rockey
Environmental Engineering

Characterization and detection of viral pathogens through water reuse treatment processes

Direct potable reuse (DPR), an advanced technology that transforms wastewater into drinking water, requires extensive and consistent pathogen removal to ensure public health. Viral pathogens are of principal concern in DPR because they can be present in elevated concentrations in wastewater and are highly infectious. Virus removal is difficult to validate in various treatment processes, likely resulting in overengineered DPR systems. In my Ph.D. research, I am improving on methods used to characterize viral pathogen removal through unit processes. My work combines several emerging microbiological methods, including digital PCR, flow virometry, and novel cell culture systems. The outcomes of my Ph.D. include knowledge on viral pathogen fate through treatment and methods that more accurately and rapidly assess virus reduction through DPR. This work will aid in the development of a regulatory framework for DPR and in turn make treatment more feasible, economical, and sustainable while still guaranteeing public health protection.

Rosina Rodriguez Olivera
Economics

Optimal Pricing and Design of Information in Diverse Strategic Environments

My research analyzes a setting with two data-buyers and one data-seller. The model has two stages: an information acquisition stage and a strategic stage. In the information acquisition stage, players with private information simultaneously purchase additional information to reduce their uncertainty from the data-seller. Information acquisition decisions are observable, but the information itself is private. In the strategic stage, buyers simultaneously choose actions, which can either be strategic complements or substitutes. In this context, I address the following questions: How do strategic incentives influence information acquisition decisions? How do players' information acquisition decisions depend on the information purchased by other players? What is the optimal pricing and design of information? I characterize the optimal mechanism, which assigns a joint experiment to buyers in exchange of a transfer. Furthermore, I analyze the case in which the data-seller is restricted to offering a menu of experiment and determines the optimal menu.

Lauren Schmitt
Resource Ecology and Management

Biotic drivers of leaf litter decomposition in shaded coffee agro-forestry systems in Chiapas, Mexico

Decomposition in coffee agro-forestry systems is not well understood, despite its importance as the start of nutrient cycling. Biotic factors like other plant species and decomposer organisms impact decomposition, but past research rarely includes biotic factors. Understanding the interactions between and relative importance of all factors is crucial for land-managers who want to maximize yields and of great interest to ecologists interested in decomposition dynamics and ecosystem function across management intensities. First, this research assesses the impact of coffee leaf species and location, as well as the impacts of decomposing with other plant species. Second, it examines the impact of a keystone ant species and the decomposer community on decomposition dynamics. Finally, this research quantifies the trade-off between allocation of nitrogen to growth versus defense in testing the growth differentiation hypothesis. This work leverages field methods from ecosystem ecology and community ecology, combined with laboratory analysis and greenhouse experiments.

Anuska Shrestha
Chemistry

Application of Organo-Electrochemistry for Development of Redox Flow Batteries and Greener Organic Transformations

Electrochemistry is an increasingly attractive tool that has the potential to provide alternative solutions to traditional challenges. My thesis focuses on two such problems: 1) energy storage and 2) accessing reactive, high-valent organometallic intermediates. First, this work presents a strategic design of new generations of organic molecules by identifying pathways through which a prototype redox flow battery loses its capacity. Second, a new method to access reactive high-valent Pd(IV)-complex is presented using electric current as a cheaper and more sustainable replacement for chemical oxidants. Through these studies, we have gained a fundamental understanding of organo-electrochemical processes and leverage such insight to enhance the existing technology for both energy storage and fine chemical development.

Shilva Shrestha
Civil and Environmental Engineering

Recovering High-Value Chemicals from Brewery Waste Through Mixed-Culture, Anaerobic Fermentation, and Chain Elongation Technologies

Motivated by the high volume of waste generated in U.S. cities, my dissertation focuses on recovering high-value chemicals from organic waste, particularly brewery waste. Implementing biotechnologies to recover resources from waste provides opportunities for revenue in addition to reduced environmental impacts through waste treatment. My research aims to develop anaerobic fermentation and chain elongation technologies for brewery waste valorization into medium chain carboxylic acids (MCCAs), which are platform chemicals used as building blocks for several industrial and agricultural products. The mixed-culture microbial communities involved in this process are characterized using a novel combination of stable isotope probing and meta'omics approaches to inform engineering decisions to enhance MCCAs production. I am also applying mathematical modeling to evaluate the environmental impact and economic feasibility of MCCAs production to ultimately support the design and implementation of this technology.

Adam Smercina
Astronomy and Astrophysics

The Social Lives of Massive Galaxies: Mergers and Satellites, and Their Impact on Galactic Evolution

My thesis work explores how Milky Way-like galaxies assemble. I have undertaken a campaign to measure satellite populations of nearby galaxies. This survey has led to important discoveries, such as the 'lonely giant' problem around M94, which has exciting implications for how low-mass galaxies form. I have also explored the 'stellar halos' of these galaxies, which encode vital information about past merger events. These are among the highest quality such datasets ever produced, yielding powerful insights into galaxy evolution. With these data, we can begin to interpret the most significant events in these galaxies' lifetimes, such as an ongoing triple-merger in M81, or the accretion of a massive gaseous disk in M64. My work has significantly progressed our understanding of galaxy formation in the dark matter paradigm and the influence of mergers on galactic evolution, providing important context for understanding the formation of our own Local Group.

Derek Smith
Earth and Environmental Science

Investigating impacts of hydrogen peroxide microbial interactions and metabolism during toxic cyanobacterial blooms in western Lake Erie

Cyanobacterial blooms are global threats to human health because some strains of the causative organism in freshwaters, Microcystis spp., can produce the toxin microcystin. These events are increasing in frequency and severity due to increasing anthropogenic eutrophication and climate change, but the environmental drivers of microcystin production are unknown. It is hypothesized that microcystin protects Microcystis from damage by H2O2 by shielding sensitive proteins, and so high H2O2 concentrations may favor toxic over nontoxic Microcystis spp. during blooms. However, how H2O2 impacts the growth of different Microcystis strains, which microbial community members degrade H2O2 in natural blooms, and H2O2 flux rates during blooms are unknown. Results show that Microcystis lacks catalases, thus depends on associated bacteria to degrade H2O2. Furthermore, H2O2 was found to accumulate to levels that can impact Microcystis fitness during natural blooms through biological production, suggesting bacterial H2O2 production and decay may impact bloom development and toxicity.

Zachariah Sperry
Biomedical Engineering

Characterizing Dorsal Root Ganglia for Extracellular Neural Recording

The next generation of medical devices will utilize signals from patients' sensory nervous systems as feedback to improve function. One promising source of these signals is the dorsal root ganglion (DRG), the assembly of sensory cell bodies in each spinal root. In previous studies, recordings from DRG have been used to decode physiological states such as limb movement and bladder pressure. However, no optimal recording electrode exists for the DRG. Previous work has failed to address how extracellular electrodes should be designed to accommodate the specific morphology of DRG. The goal of this research was to combine anatomical analysis with electrophysiological recordings to inform the design parameters of an ideal DRG recording interface. I utilized quantitative models of cell distribution in multiple species DRG and high-density neural recordings in feline DRG with novel microelectrodes to recommend optimal interface parameters. This work develops a foundation for developing future neural feedback devices.

Alexandra Sun
Chemistry

Visible Light-Driven C–H Functionalization Reactions: Methodology Design and Development of a Droplet Microfluidics Screening Platform

My dissertation research focuses on the development of visible light-mediated methods for the late-stage functionalization of heterocyclic drug scaffolds, as well as the design of a droplet microfluidics platform for the high-throughput screening of photocatalytic reactions. Late-stage introduction of alkyl and perfluoroalkylated groups onto unfunctionalized positions on a drug scaffold holds significant potential for accelerating the drug discovery process. As such, I have developed a photocatalytic method for the C–H functionalization of heterocyclic drug scaffolds, employing inexpensive and abundant carboxylic acid derivatives as alkylating reagents. Furthermore, my dissertation research involves the development of a novel droplet microfluidics platform, which can enable the efficient screening of complex pharmaceutical scaffolds for visible light-mediated late-stage functionalization reactions. This platform is anticipated to enable the direct optimization of flow reaction parameters and in turn, expedite the translation of discovery scale flow conditions to pilot scale continuous flow operations.

Adrianna Trusiak
Earth and Environmental Sciences

The role of iron in the arctic carbon cycle

Tremendous amounts of previously frozen organic carbon (C) are thawing as the Arctic warms. Interactions between iron and C that convert this thawed C to CO2, a heat-trapping gas warming our planet, were investigated in arctic soils. Iron oxidation produced hydroxyl radical (•OH), a reactive C oxidant, that converted dissolved C to CO2. •OH and thus CO2 production were greater in soils where iron was bound to dissolved C than those where iron was free. •OH and CO2 production depended on oxygen supply to the soils under waterlogged conditions and iron supply during rainfall. An average rainfall event produced three times greater CO2 than produced under waterlogged conditions, suggesting CO2 production depends on rainfall patterns. The conversion of C to CO2 by •OH is an important component of the arctic carbon cycle that will reinforce warming as more C thaws.

Bryan VanSaders
Materials Science and Engineering

Colloidal Crystal Microstructure Engineering

Much like traditional metals, colloidal crystals display complex defect microstructures that have a significant impact on material properties. Due to the large length scale of colloidal particles (microns) novel approaches to microstructure engineering are possible. One promising approach which has seen little study is the application of specially designed active particles into colloidal crystals to impart local forces that drive microstructure evolution towards a desired configuration. This dissertation explores several methods of designing and employing such particles as agents of microstructural control. Throughout this work a heavy emphasis is placed upon interstitial particle-dislocation interactions. Also discussed is the use of swellable particles to create mobile defect species in colloidal crystals. Lastly, the impact of different defect species upon the optical properties of colloidal assemblies is explored through an experimental collaboration.

Michael Wang
Materials Science and Engineering

Enabling Thin-Film Li7La3Zr2O12 Electrolytes for High Energy Density All-Solid-State Li-Metal Batteries

Due to the potential of solid electrolytes to stabilize the Li metal-electrolyte interface, all-solid-state batteries not only improve the safety of, but can also drastically increase the energy density of Li-ion batteries. Although the ceramic Li7La3Zr2O12 (LLZO) electrolyte has emerged as a viable solid electrolyte, several challenges remain to achieve realistic operating conditions. In this work, the interfacial mechanics and kinetics at the Li-LLZO interface are analyzed, demonstrating cycling of Li-LLZO cells at rates relevant to electric vehicles (>1mA/cm2). Furthermore, by analysis of charge transport, a set of design criteria for composite cathodes are outlined. Finally, using novel manufacturing processes, thin-film LLZO films will be fabricated and assembled into prototypical Li metal all-solid-state batteries at realistic length scales. These results not only provide a guideline for the future design of all-solid-state batteries, but also provide a deeper understanding of electrochemistry and mechanics in the context of all-solid-state batteries.

Rachel Webb
Mathematics

Quiver Mutations in Gromov-Witten Theory

Physicists Benini-Park-Zhao recently gave evidence that when a quiver with potential is mutated, the corresponding physical theory undergoes a cluster algebra coordinate change ("Cluster algebras from dualities of 2d N=(2,2) quiver gauge theories," Comm. Math. Phys., 3401.1 pp. 47-104). This thesis explores the extent to which that same coordinate change is observed in the mathematical gauged linear sigma model defined by the quiver with potential, extending classical Grassmanian duality. In the course of our investigation, we prove two results that are of independent interest. The first is the abelian/nonabelian correspondence for I-functions, which relates the I-function of V//G to that of V//T when T is a maximal torus of G. The second, joint with Qile Chen and Felix Janda, is the identification of the Gromov-Witten moduli space of a smooth complete intersection with the moduli space of p-fields.

Jung Yoon Wie
Composition

Han: Otherness and Syncretism

My dissertation, "Han: Otherness and Syncretism," attempts to transform static notions of identity as fixed by appearance and language by suggesting multiple identities, cultural hybridity, and women's experiences in an intercultural context by merging visual and musical art and re-appropriating technological modes of presentation. The new composition created by myself, Han for string quartet, dance, and digital video promotes a syncretic approach to these themes by drawing from diverse musical sources such as Korean, traditional, folk, American, and European music and representing marginalized female voices with the concept of han, a specifically Korean emotion characterized by contradictory emotions such as sadness, anger, vengeance, hope, isolation, and passion.

Courtney Wilder
History of Art

Novel Impressions in Printed Textiles, 1815-1851

My dissertation examines the dramatic expansions in French and British printed textile production and printmaking that led these media to cross paths during the second quarter of the nineteenth century. More specifically, it asks how print media, broadly conceived, informed the creation and reception of three key styles of visually-unprecedented printed textiles. These boldly colored and graphically-experimental styles appear uncannily modern-looking, and polarized contemporary opinion; yet, they are surprisingly little-known today. In identifying and analyzing the cross-media relationships that existed between these textiles and various types of works on paper, such as watercolors, printed money, wood engravings, lithographs, and the earliest experiments with photography, the dissertation offers new interpretations of not just textiles or prints, but of how imagery functioned across the rapidly changing nineteenth-century visual economy. These inter-medial translations in turn point to shifting contemporary attitudes towards technology, capitalism, and design.

Charnan Williams
History

The History of Slavery and Freedom in California from Mexican Independence to the U.S. Civil War, 1821-1865

This research examines the understudied subject of the experience of both black and indigenous populations in California from Mexican Independence in 1821 to the end of the U.S. Civil War in 1865. Through exploring the construction of racial categories and the nature of slavery and freedom over time in California, I incorporate the American West into national debates that concern slavery, the Civil War, and emancipation in the United States. In scholarship, California is often viewed as exceptional to national conflict around slavery and freedom. Yet, my research project complicates these narratives that exclude California from the North/South divide. Engaging with legal records, manuscripts, diaries, and correspondences, this dissertation includes California into historical analyses on slavery, the Civil War, and emancipation in the United States.

Zhengtian Xu
Civil and Environmental Engineering

On the System Supply of Ride-Sourcing Services: Theory, Observation, and Practice

The proliferation of smartphones has catalyzed rapid growth of ride-sourcing services, such as Uber, Lyft, and Didi Chuxing. Such on-demand e-hailing services significantly reduce the meeting frictions between drivers and riders and endow the platform with unprecedented flexibility and challenges in system management. My dissertation contributes to the ongoing quest of modeling, examining, and managing the ride-sourcing services by concentrating on the supply state of the system. I aim to study the underlying physics behind the service operations, understand the system behaviors under different strategies and policies, and target the issues that can potentially undermine the system supply. Parsimonious models are built up to reveal the fundamental characteristics of the system supply under different contexts, with empirical validations conducted using a comprehensive collection of observations from major ride-sourcing companies. Various control strategies are further proposed to guide and strengthen the supply management for ride-sourcing services in practice.

Da Seul Yang
Macromolecular Science and Engineering

Rational Molecular Design of Conjugated Polymers for Directed Self-Assembly Toward High Performance Flexible and Wearable Electronics

Alignment of conjugated polymers (CPs), which promotes efficient charge transport in organic electronic devices, is difficult to achieve because of the amorphous nature of CPs and lack of strategies for directed assembly. In the first chapter, universal molecular design rules of CPs for directed self-assembly are explored. The experimental results highlight the importance of avoiding massive aggregations while maintaining a low surface energy of CP backbones. In the second chapter, a straightforward but very powerful aligned film fabrication method is studied. Specifically, an optimum amount of a high boiling point solvent is critical to improve CP alignment. By adapting this floating film transfer method, the effect of having two different molecular orientations in a multilayer film on the device performance is systematically investigated. The last chapter discusses the work function modification mechanism with polyelectrolytes for effective charge injection which can lead to high performance in electronic devices.

Rackham Graduate School
University of Michigan
915 E. Washington Street
Ann Arbor, Michigan 48109-1070
Phone: (734) 764-4400
https://rackham.umich.edu

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