



# **Georgia Tech Fall 2023 Postdoctoral Research Symposium**

Friday, November 3, 2023  
Parker H. Petit Institute for Bioengineering and Bioscience (IBB)  
Suddath Room (1128)

## **Abstract Book**

\*Indicates presenter

## Research Talk Session I: 10:00 – 10:55 a.m.

### 01. The heterogeneity of judgmental forecasts: An empirical investigation of inflation forecasts

*Neslihan Ozlu\**

The recent surge in prices has brought the issue of future inflation to the forefront for many businesses. What's interesting, however, is that even professionals with similar educational backgrounds and access to the same information often make different predictions. So, what causes this discrepancy?

To find out, we examined a dataset containing the individual predictions of 26 professional forecasters over a 13-year period for three different categories of inflation basket items. Our analysis revealed that, in addition to the available information, a person's lifetime experience with inflation can also impact their predictions and explain the variability in forecasts.

For example, in the apparel category, where inflation tends to follow more predictable trends, forecasters rely more heavily on the available information. Additionally, we found that there were differences in predictions among groups of forecasters with similar lifetime experiences, as determined by demographic data and a clustering algorithm.

These findings contribute to the growing body of research on the effects of experience on forecasting. By shedding light on how individuals learn and make judgments based on their experiences, this study underscores the importance of managers understanding their employees' work histories and lifetime experiences.

### 02. Brain-inspired hardware system for energy efficient artificial intelligence computing

*Foroozan Karimzadeh\**

*Abstract cannot be shared publicly.*



### 03. Wireless sleep monitoring biopatch for clinical assessment of at-home sleep quality and sleep apnea

*Hyeonsook Kim\**

Sleep quality and duration are critical to physical, mental, and social health as an integral part of human life. However, obstructive sleep apnea affects 12% of US adults, but 80% of cases are undiagnosed, according to AASM. Because the current gold standard polysomnography (PSG) at a hospital is costly and time-consuming, hard-wired sensors may disrupt sleep patterns, affecting diagnosis. Presenting a wearable sleep monitoring biopatch for at-home use, which boasts comparable signal quality and demonstrates strong agreement in manual scoring with the established standard PSG. The system features an unobtrusive, skin-conformal, soft form factor that builds upon reliability and scalability which enables enhanced usability as an at-home sleep monitoring device. Leveraging deep learning techniques, we achieve remarkable performance in automated sleep scoring and apnea detection, validated through pilot clinical studies in sleep laboratories and meticulous comparisons with prior research efforts. This cutting-edge hardware platform, combined with intelligent signal processing, has the potential to significantly elevate the capabilities of existing wearable systems and democratize sleep health monitoring.



#### 04. Controlling vibrations using targeted energy transfer through vibro-impact systems

*Rahul Kumar\**, Rachel Kuske, Daniil Yurchenko

Excessive vibration in engineering systems is not desirable for human comfort as well as for their smooth operation and hence needs to be controlled. This is one of the fundamental problems across many sectors, whether to improve passenger experience in vehicles, reduce seismic damage in buildings, increase the comfort and performance of medical prosthetics, or to harvest energy for remote sensors. In the realm of engineering, a fascinating concept known as Targeted Energy Transfer (TET) offers a way to achieve this in a surprisingly passive way. In general, to implement TET, an auxiliary structure is attached to the main structure and tuned to shape the energy flow. The result is irreversibly transferring energy away from the main structure to the auxiliary structure and dissipated through a damping mechanism.

Traditional methods of reducing vibration typically involve adding extra damping or stiffness, but these solutions are often limited in scope. Vibro-impact nonlinear energy sink (VINES), on the other hand, presents an ingenious approach. What makes VINES particularly intriguing is its ability to work over a wide range of frequencies. Imagine an oscillatory motion inside a machine, where a ball collides with the walls, transmitting energy that acts as a vibration regulator. While previous studies primarily explored VINES under specific conditions, our research goes a step further. We investigate how introducing different features into VINES affect TET across a broad spectrum of vibration frequencies, creating a more versatile and effective solution.

In this talk, we will present numerical results, validating them against mathematically exact analytical findings derived from a map-based approach. This study advocates the merit of vibro-impact system for efficient energy transfer over broad range of scenarios and makes it more reliable for practical engineering applications.

#### 05. The evolution of stem cell production: Smart bioreactors with seamless wireless technology

*Jimin Lee\**, W. Hong Yeo

*Abstract cannot be shared publicly.*



## Lightning Talk Session I: 11:00 – 11:30 a.m.

### 06. Exploring the interplay between personal and enacted pedagogical content knowledge of middle school engineering teachers

*Dyanne Baptiste Porter\**, J Gale, M Alemdar, S Newton, J Choi

*Abstract cannot be shared publicly.*

### 07. Chitosan hydrogels with MK2 inhibitor peptide-loaded nanoparticles to treat atopic dermatitis

*Vanessa FC Dartora\**, Julia Sapienza Passos, Blanca Osorio, Ruei-Chun Hung, Michael Nguyen, Aijun Wang, Alyssa Panitch

Atopic dermatitis (AD) is a chronic inflammatory skin disorder that lacks ideal long-term treatment options due to a series of side effects, such as skin atrophy, related to the most common treatment prescribed to manage moderate-to-severe AD. In this study, a cell-penetrating MK2 inhibitor peptide YARA (YARAAARQARAKALNRQGLVAA) was loaded into hollow thermo-responsive pNIPAM nanoparticles (NP), which were further incorporated into chitosan hydrogels (H-NP-YARA) to promote local drug delivery, improve moisture and the anti-inflammatory activity. The NPs exhibited high loading efficiency (>50%) and the hydrogel remained porous following NP incorporation as observed by scanning electron microscopy (SEM). Both nanoparticles and hydrogels were able to improve the release of YARA and sustained release to up to 120 h. The hydrogels and NPs delivered 2 and 4-fold more YARA into viable skin layers of porcine skin in vitro at 12 h post-application than the non-encapsulated compound in intact and impaired barrier conditions. Furthermore, the YARA-loaded NPs (NP-YARA) and H-NP-YARA treatment decreased the levels of inflammatory cytokines up to 20 time-fold compared with the non-treated group of human keratinocytes under inflammatory conditions. Consistent with the results in cell culture, the loading of YARA in NP reduced the levels of IL-1 $\beta$ , IL-6, and TNF- $\alpha$  up to 3.3 times in an ex vivo skin culture model after induction of inflammation. A further decrease of up to 17 times-fold was observed with H-NP-YARA treatment compared to the drug in solution. Our data collectively suggest that chitosan hydrogel containing YARA-loaded nanoparticles is a promising new formulation for the topical treatment of AD.

## 08. Populist rhetoric and counter rhetoric: The farmer as “annadaata”

*Sagnika Chanda\**

I propose a 1500-word essay that will address populist political attitudes and counter attitudes contextualizing farmworkers as food providers or “annadaatas” during the 2020-21 farmworkers’ protest in India. The protest was to oppose three farm acts in India which had been described as “anti-farmer laws” by many farmer unions and opposing politicians. They said that it would leave farmers at the “mercy of corporates”. Soon after the acts were introduced, local unions, mostly in Punjab, held protests and after two months farmer unions in Punjab and Haryana began the Dilli Chalo movement. The protests posed a serious challenge to the populist hegemony of the right-wing Indian government. While earlier protesting factions received backlash in the form of epithets like “Urban Naxals” (Dalit protests against Bhima Koregaon case), “Tukde-tukde gang” (student protests against fee hike) etc. similar populist rhetoric failed to impose a sectarian narrative of farm protests being led by Khalistanis and rich farmers from Punjab. The farmers countered by projecting the imagery of protesting for the food security of India and against corporate encroachment into agriculture. The placards seen during protests that read ‘No Farmer, No Food’ and marshalling the figure of the farmer as not a laborer but “annadaata” or “provider of food” amassed public support for the campaign. I will analyze the print cultures that have been written and circulated to spread the counterimage of the protesting farmer such as the bi-weekly newspaper Trolley Times and how grassroots media counteracted the populist rhetoric fabricated and forwarded by the mainstream media.

## 09. A sea squirt's insight into brain development and disease

*Eduardo D. Gigante\** and Alberto Stolfi

Tunicates are the sister group to the vertebrates, yet most species have a life cycle split between swimming larva and sedentary adult phases. During metamorphosis, the transition between larval and adult phases, larval neurons are largely replaced by adult-specific ones. This is thought to require the establishment of quiescent neural progenitors during the larval phase. The regulatory mechanisms underlying this neural replacement remain largely unknown. Using tissue-specific CRISPR/Cas9-mediated mutagenesis in the tunicate *Ciona*, we show that orthologs of conserved hindbrain and branchiomeric neuron regulatory factors Pax2/5/8 and Phox2 are required to specify the “Neck”, a compartment of cells set aside in the larva to give rise to cranial motor neuron-like neurons in the adult. Using bulk and single-cell RNAseq analyses, we also characterize the transcriptome of the Neck downstream of Pax2/5/8. Surprisingly, we find that Neck-derived adult ciliomotor neurons begin to differentiate in the larva, contrary to the long-held assumption that the adult nervous system is formed only after settlement and the death of larval neurons during metamorphosis. Finally, we show that manipulating FGF signaling during the larval phase alters the patterning of the Neck and its derivatives. Suppression of FGF converts Neck cells into larval neurons that fail to survive metamorphosis, while prolonged FGF signaling promotes an adult neural stem cell-like fate instead. Taken together, we provide the first insight into Neck-specific gene regulatory networks and unique cell behaviors not yet characterized.



## 10. Fermenting gold? Development of transcriptional programming tools for the industrial strain chassis *Bacillus sp.*

*Samuel Gowland\**, Brian Huang, Sumin Lee, Ndeh Tadzong, Corey Wilson

By harnessing our ability to control biological systems to biomanufacture such products as RNA-based vaccines, bio-based chemicals, and gut-soothing microbiota, the U.S. bioeconomy has made an estimated total economic impact of nearly \$1 trillion per year in recent years. The field of synthetic biology promises to improve our ability to control and manipulate biological systems to biomanufacture such next-generation materials, medicines, and other biological products.

Recently, concerted effort within the synthetic biology community has been made to adapt relatively untamed, non-model organisms that have advantageous traits for biological fermentation processes. One such organism is *Bacillus licheniformis*, a soil bacterium prized as an industrial strain chassis for its enzyme secretion capabilities and its relatively long periods of productive growth. However, *B. licheniformis* is a relatively difficult organism to manipulate genetically and has relatively few tools described for such a purpose. The Wilson Lab at Georgia Tech has made strides to implement biomolecular tools in this important strain chassis in order to improve our control over its behavior.

In this talk, I will first outline the design of the biomolecular components of the transcriptional programming toolkit that will allow us to control biological behavior at the genetic level. Next, I will discuss the practical methods we use to build our modified *Bacillus licheniformis* strains in the lab. Then, I will show the results of testing these built strains for functional activity, demonstrating the efficacy of transcriptional programming to control cellular behavior. Finally, I will summarize what we have learned from the results of this study so far and how this could inform future designs for applications in biomanufacturing.



## Research Talk Session II: 12:30 – 1:25 p.m.

### 11. Extension requests and student autonomy: Fostering help seeking behaviors in historically marginalized student populations

*Franziska Tsufim\** and *Micheal Rumore\**

This presentation will focus on an ongoing study that investigates how college instructors can foster students' help-seeking behaviors via inclusive extension policies. The existing literature, that primarily studies student help seeking in relationship to on-campus mental health services, suggests that students historically marginalized in higher education (such as BIPOC or LGBTQIA+ identifying students) tend to seek help less frequently than their traditionally empowered counterparts (Glickman et. al. 2021, Stewart and Gonzalez 2023, Whillans et al. 2021). Despite those disparities, little research exists on how to promote help seeking in the classroom via targeted interventions. Our study seeks to fill this gap. Specifically, we assess if an extension hour log, that grants every student in a class a set amount of extension hours to use on projects of their choice and to document this usage in a logbook, can empower students, in particular historically marginalized students, to seek help more readily in future classes. The study utilizes a pre- and post-course survey that is currently being administered to approximately 200 students enrolled across 14 sections in Georgia Tech's first year-writing program. Our presentation will focus on the initial results of the pre-course survey that assessed students' attitudes toward extension seeking. Our initial data suggests that, while students overwhelmingly agree that college students sometimes need more time to complete their work at a high level, the vast majority associate extension seeking with negative emotions such as guilt and shame. We will use these findings to cement our claim that instructors need to consider how to develop policies that dissociate extension seeking from a rhetoric of failure to ensure that all students will go on to readily request help. We will discuss this as a matter of equity in the classroom and close with presenting the extension log policy as a possible intervention.



## 12. Bifunctional antibacterial properties of nanotextured steel modified with copper

Anuja Tripathi\* and Julie A. Champion

Bacteria can cause a wide range of disease, including infections, food poisoning, and even death. Around 8 million people die from bacterial infection every year. Several methods are available for eradicating bacteria, such as antibiotics and bleach, which can either terminate bacterial life or impede their growth. Nonetheless, the frequent use of these chemicals induces chemical resistance in bacteria, diminishing the efficacy of conventional treatment options. This issue is particularly alarming for old people and children with weakened immune systems, as it can result in elevated mortality rates.

Physical method of bacteria killing offer a promising alternative, which has the capacity to target a broad spectrum of bacteria, including those that have developed resistance to drugs, without the need for specific chemical agents. Recent research has explored the use of materials like Ag, Cu, and Au. These materials possess inherent antibacterial properties which were further enhanced by incorporating nanostructures onto these metals. However, the scalability of cleanroom-based nanostructure fabrication methods is limited due to the long fabrication time and high cost. Herein, we have demonstrated Cu-coated nanotextured stainless steel (nSS) fabrication using inexpensive electrochemical technique and its potential as an antibiotic-free biocidal surface against *E. coli* and *S. epidermidis*. As nanotexture and Cu combine for dual methods of killing, this material does not contribute to drug resistant bacteria, and can demonstrate their antibacterial activity within 30 minutes. We have performed surface characterization of the surface revealing that the Cu coating consists of metallic Cu and oxidized states ( $\text{Cu}^{2+}$  and  $\text{Cu}^+$ ) which may depolarize the bacterial membrane. Cu-coated nSS induces a remarkable reduction of 97% in *E. coli* and 99% *S. epidermidis* bacteria. Overall, the Cu modified nanostructured steel has potential to be used for effective, scalable, and sustainable solutions to prevent bacterial infections without contributing to antibiotic resistance.

### 13. Exploring coral reefs resilience, connectivity, and biodiversity in the Coral Triangle through machine learning and complex networks

*Lyuba Novi\** and Annalisa Bracco

*Abstract cannot be shared publicly.*

### 14. Manufacturing of renewable barrier thin films for packaging applications using a multiscale modeling approach

*Samuel Fagbemi\** and Tequila Harris

Packaging is a vital component of the consumer product industry and serves as a means for preserving the product and isolating it from the immediate environment. The most widely used packaging materials are petroleum-based which do pose dangers to the environment. Paper is viewed as the ideal packaging material because it is highly recyclable, compostable and completely biodegradable. However, several factors such as its porous structure, poor mechanical properties and hydrophilic nature have hampered its implementation in the packaging industry. In this work we study, computationally, how the pore structure, wettability and permeability of paper can affect the effectiveness of the coated substrate using a micro-continuum approach. We model the effect of injecting biopolymers that resulted in excellent mechanical and barrier properties from previous experiment using slot die manufacturing, onto the surface of glassine paper to form a uniform single layer coating. We found that super-calendering effects yielded less fluid penetration into the pores of the paper while maintaining a uniform wet thickness under stable operating conditions. An increase in permeability resulted in a higher level of penetration of the fluid phase, while large amounts of air pockets were observed for systems with higher void fractions which could bring about delamination of the dried coated films.

## 15. Taming bandits with heavy tails

*Shubhada Agrawal\**, Sandeep Juneja, Wouter M. Koolen

Imagine you are in a casino with a bunch of slot machines, each with its own secret pattern for giving out prizes. Your goal is to win as many prizes as possible over time. But you don't know which machine is the best. So, every time you pull a lever on a machine, you get a random reward. Your job is to figure out which machine to play at each time, to win the most prizes. This is the classical regret-minimisation problem. Here, regret is the difference between what you could have won if you always played the (unknown) best machine, and what you actually won.

Researchers have studied this problem for a long time, but they usually assume certain things about how the machines work, which might not be true in real life. For example, they assume that the machines follow simple rules, like having normal (Gaussian) rewards. But in real-world applications, like investing in stocks or managing internet traffic, the rules are often much more complicated.

In our research, we came up with a way to tackle this problem without making too many assumptions about how the machines behave. Using mathematical tools, we found a method that works well in a wide range of situations, and prove that our method is the best you can do in these uncertain situations. Practically, what this means is that we can help people make better decisions in complex scenarios. For instance, if you're an investor, we can guide you on where to put your money for the best returns, even when the market is unpredictable. Or if you're managing a network, we can help you route data efficiently, even when the network is crowded. And we can do all of this while considering different goals, like maximizing rewards while keeping risks in check.

## Lightning Talk Session II: 1:30 – 2:00 p.m.

### 16. Narrative-based learning in quantum physics

*Michael David Measel\**

The School of Literature, Media, and Communication and the School of Materials Science and Engineering have enacted an interdisciplinary project involving myself and one another Brittain Fellow. Initiated by Dr. Faisal Alamgir of MSE, the overall goal of this project is to bridge the gap narrative theory and practice and quantum science. In this presentation I will highlight the theory behind narrative-based learning (teaching and learning with narrative and persuasive story elements) and examples of its implementation. My focus and the connection to our assignments will be on the work of W. B. Mott, et al. and Steve Schmidt, with explanation of how the latter's principles of "sticky" learning are applied to the assignments we produce. I will enumerate the benefits of narrative-based learning as well as discuss two examples of group assignments that require students (both undergraduate and graduate) to dramatize highly technical information a way that makes it highly palatable to non-technical audiences – in this case, making the study of quantum physics easy to understand for a lay audience. I will explain with examples how these assignments, including a podcast episode and a dramatic skit, require students to doubly practice analysis and synthesis, increasing their understanding of the material and their ability to communicate it efficiently to expert and lay audiences.



## 17. Engineering intelligent physical human-robot interactions

*Keya Ghonasgi\**, Reuth Mirsky, Adrian M. Haith, Peter Stone, Ashish D. Deshpande

Technology for human use capitalizes on our ability to learn from interactions with the environment. Robotics technology has advanced significantly in the past few decades, enabling physical human-robot interaction (HRI) to become a safe and promising new mode through which humans can act upon and learn from their environment. At the same time, advances in artificial intelligence (AI) have provided us with frameworks for how robotic devices can control their behavior at a high level. As a result, we can now harness both human learning and robot learning abilities to engineer meaningful physical interactions that go beyond conventional technological solutions. In this talk, I will explore how physical HRI can be interpreted through the lens of neuroscience and translated into engineering solutions that can intelligently affect the human-robot system's behavior. Specifically, I consider motor learning in the context of human-exoskeleton interaction. I begin by discussing the challenges of dynamic human behavior assessment and interpretation. Exoskeleton sensing and actuation capabilities offer the potential to address these challenges. I use hypothesis-driven human-subject experiments to demonstrate the potential for this approach. The results of this research showcase exoskeletons' ability to measure, probe, and affect human behavior through physical interactions. Based on these findings, I motivate a framework to modulate human-robot interaction resulting in adaptive training curricula that target improvement in skill across individuals. I will also examine these results in the context of other physical HRI applications. My goal through this talk is to make a case for bi-directional communication and co-adaptation of the human-robot system in the design of intelligent physical HRI.

## 18. Generative machine learning-assisted functional phosphopeptide design

*Vardhan Satalkar\**, Aanushka Mehjabin, Julie Mitchell, Matthew Torres

*Abstract cannot be shared publicly.*

## 19. Biochemical characterization of pseudoexfoliation glaucoma-related protein LOXL1

*Hannah Youngblood\**, Hailee Scelsi, Raquel Lieberman

Glaucoma is the leading cause of irreversible blindness worldwide. Pseudoexfoliation glaucoma (XFG) is the most common form of secondary open-angle glaucoma. The strongest genetic link to XFG is lysyl oxidase 1 (LOXL1), a protein responsible for the cross-linking of tropoelastin into elastin microfibers. LOXL1 is comprised of a signal peptide, a disordered N-terminal domain, and a C-terminal copper oxidase domain. The copper oxidase domain contains the copper-containing active site and lysyl-tyrosylquinone (LTQ) cofactor necessary for cross-linking activity. Aside from its role in elastin crosslinking, little is known about LOXL1. Currently, the structure of LOXL1 has not been solved, biophysical characterization of human LOXL1 is lacking, and the role of XFG-associated variants in LOXL1 is not well understood. This project sought to express and purify LOXL1 for future structural, biophysical, and biochemical characterization using two different expression systems: a mammalian ExpiCHO expression system and BL21 E. coli. Stable full-length LOXL1 protein (~67kDa) is obtainable from the soluble intracellular fraction of ExpiCHO cells, while a naturally proteolytically cleaved product (~35kDa) containing the copper oxidase domain may be obtained from ExpiCHO spent media. Meanwhile, E. coli provides an excellent system for a divide-and-conquer approach to separately examine the N- and C-terminal domains of LOXL1. Characterization by circular dichroism suggests that the C-terminal end of LOXL1 is predominantly comprised of beta-sheets, while full-length LOXL1 exhibits a strong alpha helix signature. Metal analysis has shown that supplementing growth media with copper is necessary for LOXL1 incorporation of enzymatically critical Cu(II). Taken together, this work has laid the foundation for future biochemical characterization of LOXL1 in both its wild-type and XFG-associated variant forms.

## 20. Leveraging data in sequential decision-making: Performance guarantees via robust approaches

*Sivaramakrishnan Ramani\**, Archis Ghate

*Abstract cannot be shared publicly.*

