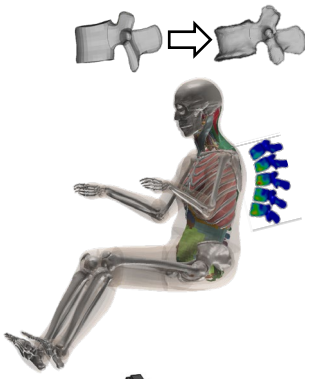
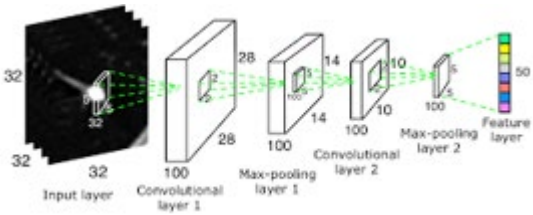
Wake Forest University
School of Medicine

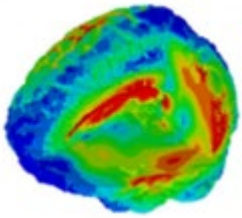
2027 Research Project Descriptions

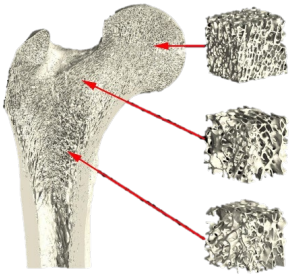
Summer Research Internship Program

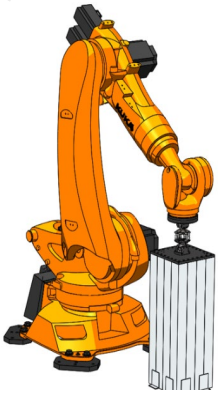
for Undergraduate & MS Graduate Students

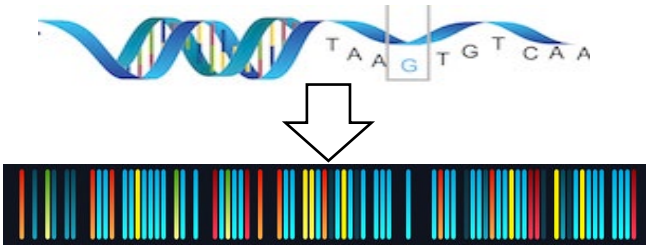












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Projects in Biomedical Engineering, Biomedical Informatics, AI, & more!

2027 Summer Research Project Descriptions

Proj. #	Advisor(s)	Summer Research Project Titles	BME	Informatics
1	Kristen Beavers & Ashley Weaver	Intervening to Mitigate Weight Loss Associated Bone Loss	✓	
2	Philip Brown	In-Situ Minimally Invasive Surgical Robotic Bioprinting	✓	
3	Philip Brown	Telemedicine System for Upper Extremity Evaluation and Rehabilitation of Parkinson's Disease	✓	
4	Philip Brown	Development of an Abdominal Hemorrhage Phantom for Ultrasound Training	✓	
5	Karan Devane	Assessment of Pedestrian Crash Protection Systems using Real-World Pedestrian Crash Data in CARLA	✓	
6	Karan Devane	Development of Machine Learning Model for Predicting Pedestrian Injuries using Real-World Crash Databases	✓	
7	Karan Devane	Guardian Vision: Development of an AI-Driven Computer Vision Tool for Detection of Child Restraint System Misuse	✓	
8	Scott Gayzik	Human Body Model Development for Trauma Research	✓	
9	Scott Gayzik	Standardizing Methods for Virtual Assessment in Human Body Models	✓	
10	Scott Gayzik	Physics-based Finite Element Analysis for Injury Criteria Using Human Surrogates	✓	
11	Scott Gayzik	Development of Signal Analysis Tools for a National Crash Database	✓	
12	Adam Hall	Molecular Detection and Analysis of Trauma Bioindicators	✓	
13	Ryan McGinnis	Balance and Mobility Phenotypes of Fall Risk in Persons with Multiple Sclerosis	✓	✓
14	R. McGinnis & E. McGinnis	Predicting Panic Attacks in the Wild	✓	✓
15	R. McGinnis & E. McGinnis	Detecting Anxiety and Depression in Young Children	✓	✓
16	Kristen Nicholson	Understanding Pitching Efficiency	✓	
17	Joel Stitzel	Crash Injury Research and Engineering Network [CIREN]	✓	✓
18	Joel Stitzel	Head Impact Exposure Quantification and Mitigation in Motorsports	✓	
19	Joel Stitzel	Subconcussive Head Impact Analysis using Instrumented Mouthpiece Data	✓	✓
20	Jill Urban	Evidence-Based Intervention for Improved Head Impact Safety in Youth Sports	✓	✓
21	Ashley Weaver	High-Resolution Peripheral Quantitative Computed Tomography (HR-pQCT) Scanning in Clinical Trial Interventions	✓	
22	Ashley Weaver	Muscle Quality/Radiomics Features and Muscle-Bone Crosstalk	✓	
23	Jared Weis	Predicting Cancer Treatment-Related Cardiotoxicity by Imaging Cardiac Mechanical Stiffness	✓	

2027 Summer Research Project Descriptions

Proj. #	Advisor(s)	Summer Research Project Titles	BME	Informatics
24	Jared Weis	Photoacoustic Imaging for Biophysical Physiological Indicators of Infant Intestinal Health and Necrotizing Enterocolitis	✓	
25	Jeff Willey	Preventing Cancer Therapy-Induced Pain and Bone Loss	✓	
26	Hannah Zlotnick	Stimuli-Responsive Materials to Treat Osteoarthritis-Related Joint Pain	✓	
27	Oguz Akbilgic	Electrocardiographic Long-Term Simulation for Future Rhythm Disorder Detection		✓
28	Metin Gurcan & Onur Koyun	Linking Histopathologic Morphology to Diagnostic Concepts Using Artificial Intelligence		✓
29	Metin Gurcan & Mohammad Hasan	Tracking What Changed: Evidence-Based Detection of Medication Errors in AI-Generated Clinical Summaries		✓
30	Metin Gurcan & Abbas Alili	AI-Assisted Research Award Data Reporting		✓
31	Metin Gurcan & Hao Lu	Characterizing Failure Modes of AI-Based Otoscopy Video Diagnosis		✓
32	Da Ma & Michael Horvath	Language-based AI Model on Genomic Data to Understand and Predict Risk of Alzheimer Disease and Multimorbidity		✓
33	Ibrahim Karabayir	Intervention-Aware AI Based Risk Modeling & Counterfactual Simulation for Cardiovascular Outcomes		✓
34	Ibrahim Karabayir	Multimodal AI Grounded in ECG & Clinical Text: A Dynamical View of Cardiovascular Outcomes		✓
35	Arezoo Movaghar	AI-Assisted Pre-screening for Neurological Disorders		✓
36	Ellen Quillen	Analysis of Entropy in Multi-omic Datasets Associated with Cognitive Decline in Older Adults with Vascular Disease		✓
37	Daniel Sprockett	AI-Enabled Prediction of Infant Gut Microbiome Development: Linking Early Feeding Patterns to Short-Chain Fatty Acid Production Across Diverse Populations		✓
38	Umit Topaloglu	Protocol2Agent: Prototyping a Validated, Machine-Actionable Interface for Clinical Trial Protocol Eligibility Criteria		✓
39	Metin Gurcan & U.C. Nwaozuru	AI Future Self Simulator: Evidence-Grounded Health Narratives to Motivate Cancer Prevention in Young Adults		✓

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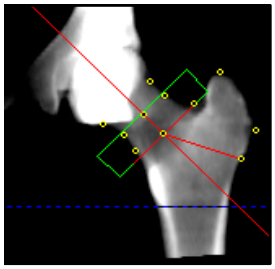
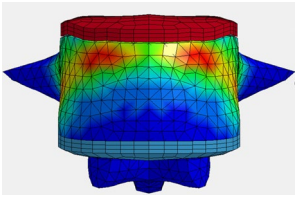
Project 1 - Summer 2027

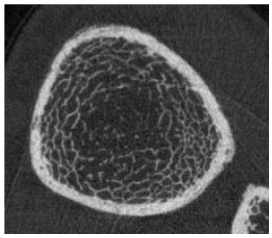
Intervening to Mitigate Weight Loss Associated Bone Loss

Identification of intervention strategies to minimize weight loss associated bone loss among middle-aged and older adults is needed. Two 12-month NIH clinical trials are funded to: 1) test whether bisphosphonate therapy can minimize bone and muscle loss associated with bariatric surgery among sleeve gastrectomy patients, and 2) compare the independent and combined effects of progressive resistance training plus bone loading exercises and bisphosphonate use on measures of bone density, quality, and turnover in older adults who are undergoing a dietary weight loss intervention. Studies incorporate a range of musculoskeletal methods, including quantitative computed tomography (QCT) of the hip and spine, and high-resolution peripheral quantitative computed tomography (HRpQCT) of the ankle and wrist.

The student will: 1) review the literature on weight loss associated bone loss and techniques for measuring bone health using QCT and HRpQCT, 2) form a hypothesis to test the effect of skeletal loading and bisphosphonate interventions on CT-derived bone outcome such as bone mineral density (BMD), cortical thickness, bone strength, or fracture risk, and 3) experimentally test the hypothesis by applying learned CT analysis and finite element (FE) modeling techniques to collect, analyze, and draw conclusions from the resulting bone outcome data.







Kristen Beavers, PhD

Professor
Gerontology & Geriatric Medicine
Wake Forest School of Medicine
Winston-Salem, NC

https://school.wakehealth.edu/faculty/b/kristen-marie-beavers

Ashley Weaver, PhD

Professor
Biomedical Engineering
Wake Forest School of Medicine
Winston-Salem, NC

Ashley Anne Weaver, PhD | Wake Forest University School of Medicine

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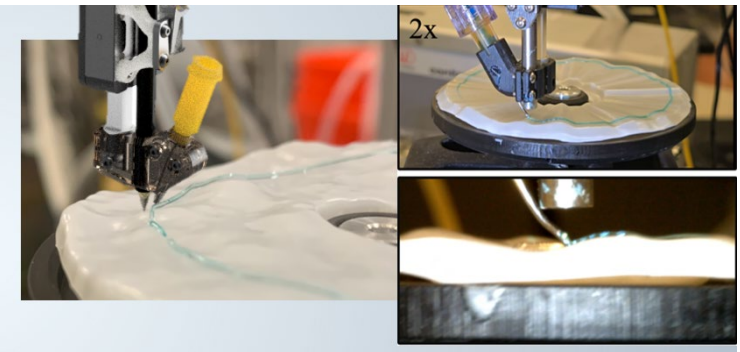
School of Medicine

Project 2 - Summer 2027

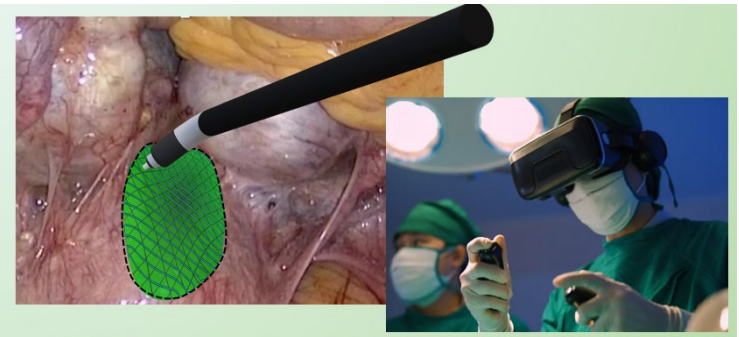
In-Situ Minimally Invasive Surgical Robotic Bioprinting

Bioprinting has been well established as a method of developing biomimetic structures for tissue engineering to create scaffolds, constructs, and organoids. The process of bioprinting using Cartesian and multi-axis additive manufacturing allows for a synergistic pairing with surgical robotics. This project aims to develop an in-situ laparoscopic bioprinting system through the research of supporting technologies in real-time scanning and sensing, motion compensation mechatronics, and augmented reality surgical planning and control.

We are creating a printing platform that can scan organic surfaces and adapt the extruder height and flow rate within acceptable tolerances is needed to overcome in-situ printing challenges. We are looking for help in control systems, tool design, biomaterials, software and augmented reality.



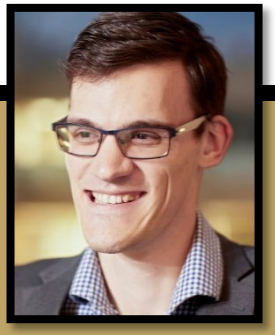
Precision Robotic Surgical Bioprinting



In-Situ Bioprinting Path Planning in Augmented Reality

Philip Brown, PhD

Associate Professor, Biomedical Engineering
Director, Translational Engineering and Design Core
Office: 336-716-0945
phibrown@wakehealth.edu
www.linkedin.com/in/philip-brown-71a24553



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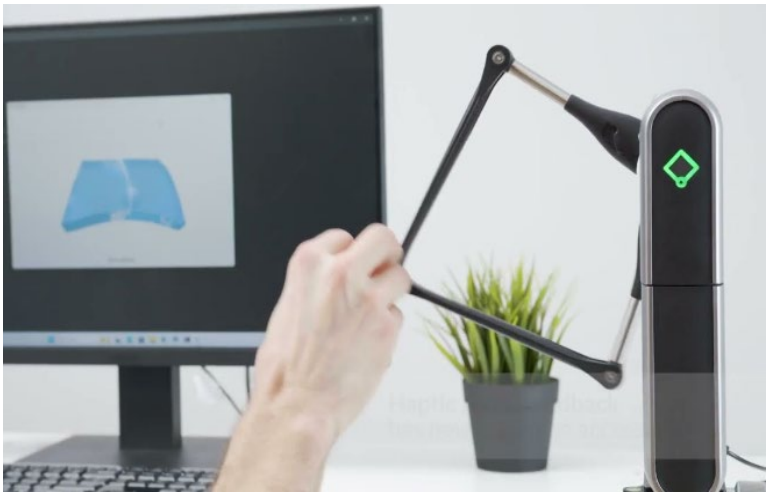
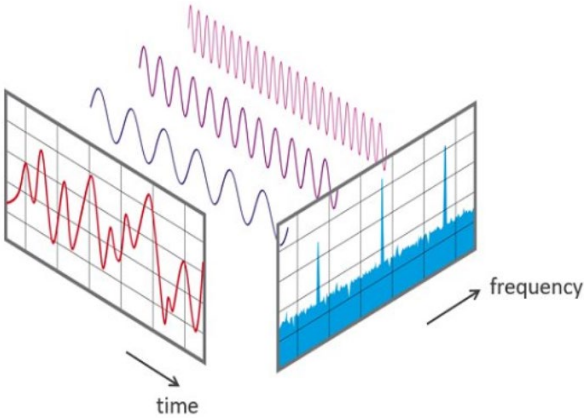
Project 3 - Summer 2027

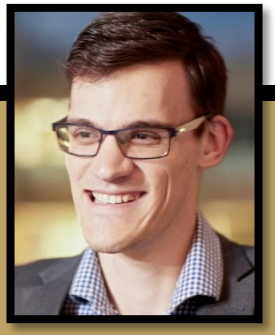
Telemedicine System for Upper Extremity Evaluation and Rehabilitation of Parkinson's Disease

Parkinsons's Disease is the second most common neurodegenerative disorder affecting about 1 million people in the US. The disease causes tremors which can effect the quality of life of the patient. Physical therapy has been shown to be effective in reducing the effects of tremors. Therapy can be expensive and not accessible to many populations. We are working on a automated diagnostic and treatment system. This system uses a haptic controller and real-time evaluation of the treatment to modify the exercises and inform the patients care team of the quality of improvement.





Philip Brown, PhD



Associate Professor, Biomedical Engineering
Director, Translational Engineering and Design Core
Office: 336-716-0945
phibrown@wakehealth.edu
www.linkedin.com/in/philip-brown-71a24553

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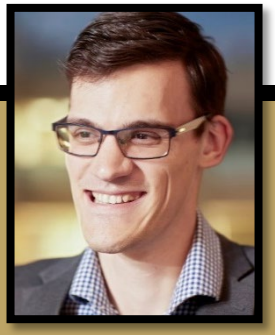
Project 4 - Summer 2027

Development of an Abdominal Hemorrhage Phantom for Ultrasound Training

Abdominal hemorrhage is a life-threatening condition caused by active internal bleeding from ruptured abdominal organs or major vessels, and rapid detection is essential for improving outcomes in trauma care. Ultrasound is widely used for hemorrhage localization and assessment and can be used to drive autonomous robotic intervention. There is a lack of physiologically accurate active hemorrhaging training phantoms for both clinical training and robotic autonomous training. There is a need for phantoms that reliably simulate rupture events with anatomically accurate structures and ultrasound properties. To address this gap, we are developing a controlled and repeatable abdominal hemorrhage ultrasound phantom to mimic using advanced silicone 3d printing techniques.

Philip Brown, PhD



Associate Professor, Biomedical Engineering
Director, Translational Engineering and Design Core
Office: 336-716-0945
phibrown@wakehealth.edu
www.linkedin.com/in/philip-brown-71a24553

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Project 5 - Summer 2027

Assessment of Pedestrian Crash Protection Systems using Real-World Pedestrian Crash Data in CARLA

- Modern vehicles are equipped with advanced safety features including pedestrian crash avoidance but there are still numerous scenarios where these systems fail to avoid crashes.
- CARLA is an open-source tool developed to support the development, training, and validation of autonomous driving systems.
- The project objective is to use this tool to assess existing and new safety systems by reconstructing real-world pedestrian crashes.
- The student will help create pedestrian crash scenarios and test different sensor suites in a virtual environment.
- Student will build skills in python-programming, crash data analysis, biomechanics, and injury analysis.

Karan Devane, PhD

Assistant Professor, Biomedical Engineering
VT-WFU Center for Injury Biomechanics
School of Biomedical Engineering and Sciences
575 N. Patterson Ave
Winston-Salem, NC 27101
https://school.wakehealth.edu/faculty/d/karan-shamrao-devane

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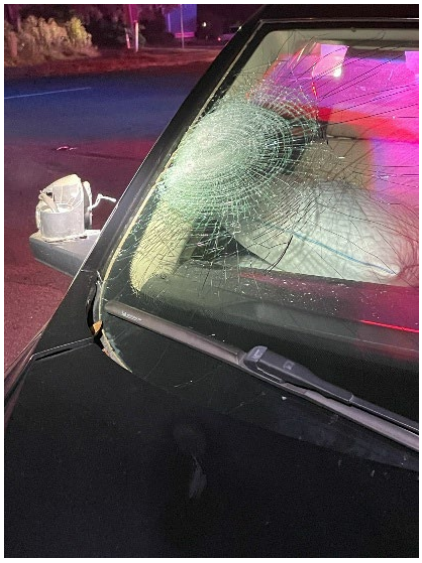
Project 6 - Summer 2027

Development of Machine Learning Model for Predicting Pedestrian Injuries using Real-World Crash Databases

- Images, vehicle parameters, crash details, and pedestrian injury data from the crash databases will be used to train and test a machine learning model that will be used to predict pedestrian injuries.
- Student will be parsing the databases to collect all the required data, preprocess it, and build an injury prediction model.
- Student will build skills in python-programming, crash data analysis, biomechanics, and injury analysis.
- Student will get to interact with multidisciplinary team of experts.



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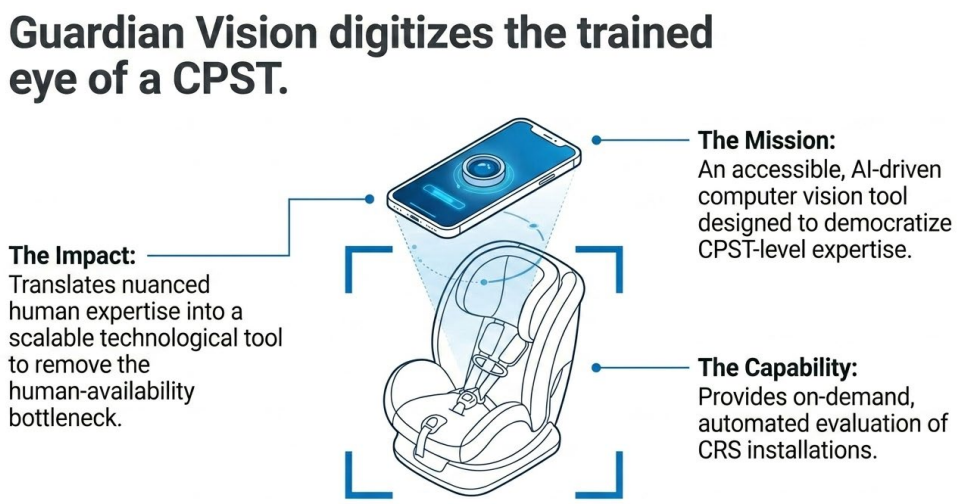
Project 7 - Summer 2027

Guardian Vision: Development of an AI-Driven Computer Vision Tool for Detection of Child Restraint System Misuse

- Development of a computer vision tool for caregivers to use on-demand to check their kid's car seat installation and restraint fit.
- Student will work on data preparation, video annotation and training computer vision model.
- Student will build skills in python-programming, machine learning, biomechanics, and child occupant safety.
- Student will get to interact with multidisciplinary team of experts in biomechanics, machine learning, and occupant safety.



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School of Biomedical Engineering and Sciences
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https://school.wakehealth.edu/faculty/d/karan-shamrao-devane

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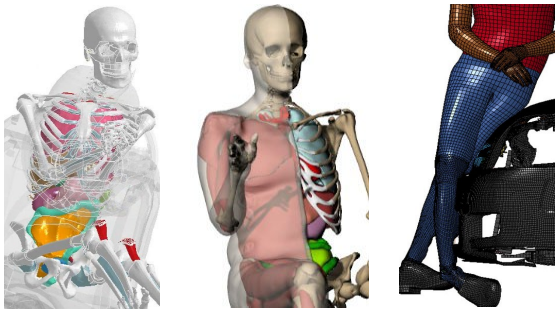
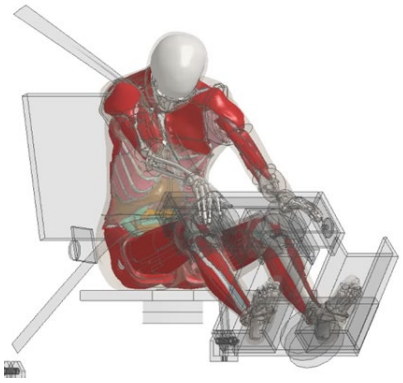
Project 8 - Summer 2027

Human Body Model Development for Trauma Research

Computational modeling is a growing component of injury biomechanics and trauma research. This project is a multi-center effort developing a next generation set of human body finite element models for enhanced injury prediction and prevention systems. The student will be responsible for assisting in model development tasks including scaling, postural adjustment, meshing, and contact algorithm development. Responsibilities will also include reporting FEA model analysis and results, running analyses on distributed computing environments, simulating validation procedures, performing literature reviews, and reporting related research efforts through written and oral status updates. The student(s) will gain valuable experience in fields of trauma research, computer modeling, and injury biomechanics.





This research effort will be in the Center for Injury Biomechanics (CIB) and you will have the opportunity to work on a range of projects centered around safety. The human is at the center of all the research we do. We operate in the fields of mobility safety, data analytics including database and medical image analysis, military countermeasures, and sports biomechanics. The research at the CIB combines experimental testing, computational modeling, and analytics to investigate human injury biomechanics

Scott Gayzik, PhD

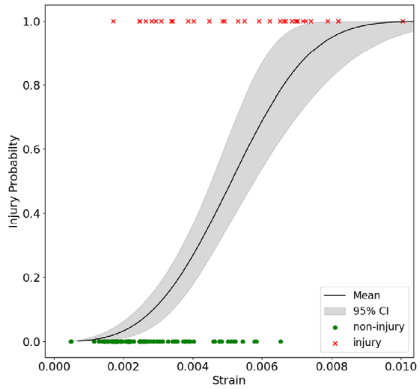
Professor, Biomedical Engineering
VT-WFU Center for Injury Biomechanics
School of Biomedical Engineering and Sciences
575 N. Patterson Ave
Winston-Salem, NC 27101
www.CIB.vt.edu

Wake Forest University
School of Medicine

Project 9 - Summer 2027

Standardizing Methods for Virtual Assessment in Human Body Models

Human body models (HBMs) have gained prominence in biomechanics literature over the last two decades, but there is little information available regarding the standardization of model positioning and injury assessment. It is well understood that deviations in initial positioning of human models can lead to deviations in outcomes for otherwise identical crash simulations, yet this effect is not well quantified. This project focuses on developing best practices (BPs) for simulation-based repositioning, gravity- settling, belting, pre-test posture reporting and injury prediction using computational human body models. Your research will be on the cutting edge of this digital transformation of the regulatory space!



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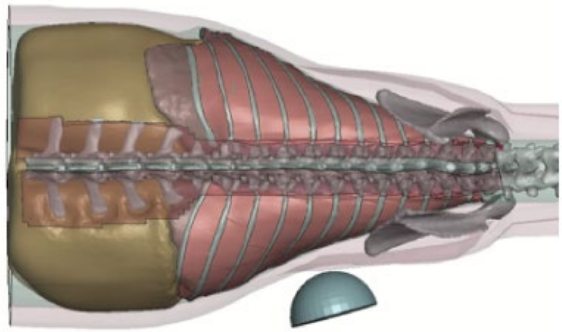
Project 10 - Summer 2027

Physics-based Finite Element Analysis for Injury Criteria Using Human Surrogates

The objective of this research is to develop and validate a physics-based finite element model(s) (ovine and caprine) to study behind armor blunt trauma (BABT). These models will be an important tool for evaluating countermeasures and developing computational injury criteria to better protect service members. The models will be used to provide insight and guidance on the risk of skeletal and soft tissue injuries including the development of injury criteria for rib, pulmonary and limited vascular and peripheral organ injury from BABT. The proposed project is the first of its kind to develop ovine and caprine FEA models for use in the study of BABT. Specifically, the models will be used to develop finite element based BABT injury criteria.



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Winston-Salem, NC 27101
www.CIB.vt.edu

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Project 11 - Summer 2027

Development of Signal Analysis Tools for a National Crash Database

The key objective of this effort is to modernize the United States federal government's Vehicle Safety Research Signal Analysis Tools. Our fundamental motivation for this work is to 1. Modernize the code offered by creating a fully web-based tool and 2. Update the existing code to interact with a Crash Test Database that already exists online. The approach we will take involves a ground up reconstruction of the underlying code. The student will assist by helping build the code and running calculations of fundamental biomechanical measures used in kinematic, kinetic and injury assessments. The project is sponsored by the National Highway Traffic Safety Administration. This is an opportunity to see your work be used by hundreds or even thousands of users worldwide.

The project will marry the fields of web-based software development and biomechanics and represents an exciting opportunity for engineers interested in both domains. The skills and training a student will develop on for this project will be highly translatable for careers in biomechanics or software development.

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Winston-Salem, NC 27101
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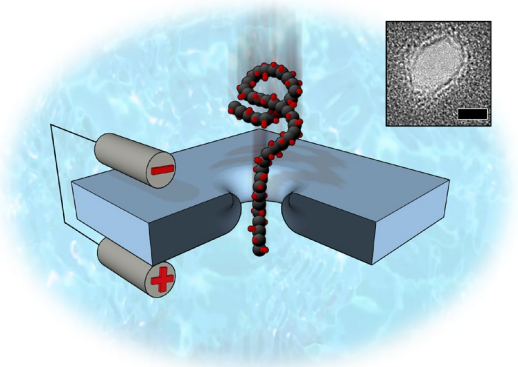
Project 12 - Summer 2027

Molecular Detection and Analysis of Trauma Bioindicators

Hyaluronan (or hyaluronic acid, HA) is a key linear sugar that is found in all physiological fluids and tissues, where variation in its composition can either result from or be a direct cause of disease emergence. While changes in net HA abundance in biofluids can be probed conventionally, this metric ignores a critical size-function relationship in which high- and low-molecular weight (MW) HA exhibit contrasting effects on inflammation, angiogenesis, cell motility, and more. Consequently, determination of both HA abundance *and* size distribution is essential. However, many important physiological systems contain small total amounts of HA and technologies for comprehensive assessment have critical limitations in sensitivity as well as challenges in dynamic range, cost, ease of implementation, and/or delivery of quantitative results.

In response, our laboratory has applied a molecular detection strategy using the solid-state nanopore platform, which is able to detect and size HA electrically and with tremendous sensitivity. Here, we will apply our assay to probe the HA content of plasma derived from trauma patients. As a central goal of this project, we aim to investigate HA MW as a bioindicator of outcomes for patients presenting with similar trauma severities.



The student who joins our team will learn and/or perform one or more of the following activities:

- Biochemical extraction of hyaluronan from physiological samples
- Molecular detection with the solid-state nanopore platform
- Data analysis & reporting

Adam Hall, PhD

Associate Professor, Biomedical Engineering
VT-WFU School of Biomedical Engineering and Sciences
Wake Forest University School of Medicine
575 N Patterson Ave.
Winston-Salem, NC 27101
https://thehalllab.org

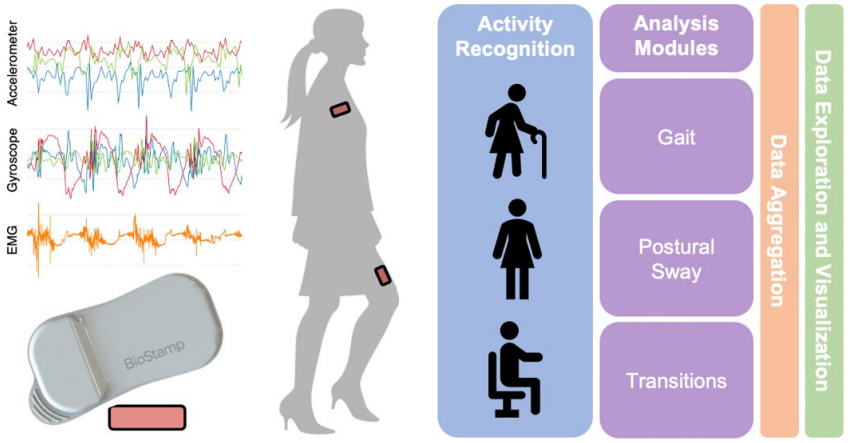
Wake Forest University
School of Medicine

Project 13 - Summer 2027

Balance and Mobility Phenotypes of Fall Risk in Persons with Multiple Sclerosis

This project will leverage digital health technologies (i.e., wearables, mobile apps) and AI-based informatics to identify potential biomechanical, physiological, and behavioral markers of fall risk in persons with multiple sclerosis (PwMS).

Falls are a significant healthcare problem without a clear solution. Fifty percent of PwMS will fall in any three-month period with nearly half of those falls resulting in injury. Techniques that can detect when a PwMS is at risk for falling could enable the development of new preventative interventions. We have collected multimodal wearable sensor data during daily life from more than 50 PwMS, capturing thousands of balance challenging activities that could be used to detect fall risk. We aim to explore how these data can be used to inform AI-based phenotypes of fall risk.



The student will: 1) review literature 2) manage thousands of daily life observations of balance challenging activities, and 3) leverage machine learning and statistical analysis techniques to identify indicators of fall risk

Ryan McGinnis, PhD

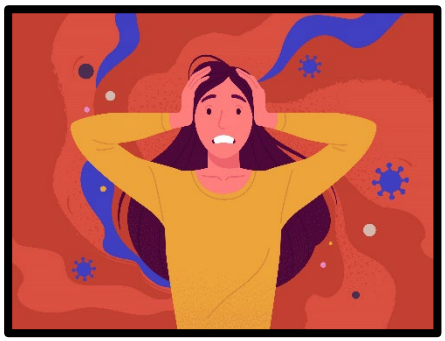
Associate Professor
Department of Biomedical Engineering
Center for Remote Health Monitoring
Wake Forest University School of Medicine

Wake Forest University
School of Medicine

Project 14 - Summer 2027

Predicting Panic Attacks in the Wild

This project will leverage digital health technologies (i.e., wearables, mobile apps) and AI-based informatics to identify potential biomechanical, physiological, and behavioral markers of panic attacks.



One in 10 people have experienced a panic attack, a debilitating psycho-physiological state wherein people experience heart palpitations, shortness of breath, and feel out of control of their own bodies. We have daily Apple Watch data on 90 individuals who regularly suffer from panic attacks. We will develop models to predict when panics attacks will occur to ultimately inform digital interventions to warn folks and engage them in prevention strategies.

The student will: 1) review literature 2) manage data from a study including more than 300 panic attacks, and 3) leverage machine learning to identify predictors of next-day panic attacks.

Ryan McGinnis, PhD

Associate Professor
Department of Biomedical Engineering
Center for Remote Health Monitoring
Wake Forest University School of Medicine

Ellen McGinnis, PhD

Assistant Professor
Division of Public Health Sciences
Center for Remote Health Monitoring
Wake Forest University School of Medicine

Wake Forest University
School of Medicine

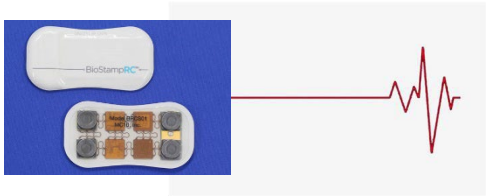
Project 15 - Summer 2027

Detecting Anxiety and Depression in Young Children

This project will leverage digital health technologies (i.e., wearables, mobile apps) and AI-based informatics to identify potential biomechanical, physiological, and behavioral markers of anxiety and depression in young children.

It has just been recommended that children be screened for anxiety at pediatric well visits. However, we currently do not have brief, accurate, objective screening tools to detect mental health disorders in young children. We have multimodal wearable sensor data during 3 brief laboratory tasks from 100 preschoolers with and without mental health diagnoses. We aim to develop models to detect disorders from sensor data and to examine parent and child factors that may moderate accuracy.

The student will: 1) review literature 2) manage data from a 100-child study 3) leverage machine learning to identify indicators of diagnoses and 4) conduct statistical tests to identify survey and IQ data that may moderate models



Ryan McGinnis, PhD

Associate Professor
Department of Biomedical Engineering
Center for Remote Health Monitoring
Wake Forest University School of Medicine

Ellen McGinnis, PhD

Assistant Professor
Division of Public Health Sciences
Center for Remote Health Monitoring
Wake Forest University School of Medicine

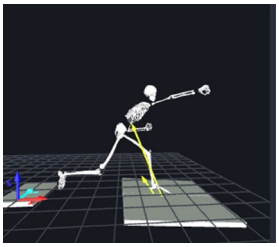
Wake Forest University
School of Medicine

Project 16 - Summer 2027

Understanding Pitching Efficiency

Baseball throwing and pitching is a multifaceted, intricate movement pattern that results in high forces and torques throughout the body. During the pitching motion, the body is considered a kinetic chain. The lower extremities generate force that is transferred through the trunk, arm, and ultimately to the hand to propel the baseball. Disruption or inefficiency within this chain increases arm stress and injury risk. It is well known that pitching velocity is related to arm stress. Therefore, the faster a pitcher throws the greater their risk of injury. However, there are also pitching biomechanics and other variables that influence arm stress, pitch velocity, and ball metrics. The goal of the Wake Forest Pitching Laboratory is to find this balance between minimized injury risk and maximized performance – deemed pitching efficiency.

The student will: 1) review literature on pitching biomechanics 2) collect 3D motion capture data of baseball pitchers, and 3) analyze the influence of kinematics, fatigue, strength, and/or functional movement on arm kinetics, ball velocity, and ball metrics. The student will apply skills they learn in human subjects' research, experimental design, data collection and processing, biomechanics and human movement, and statistical analysis to better understand pitching efficiency.



Kristen Nicholson, PhD

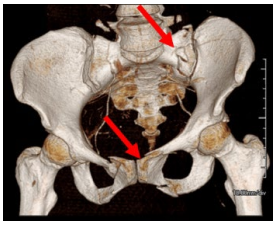
Associate Professor, Orthopedic Surgery
Wake Forest Baptist Health
Medical Center Boulevard
Winston-Salem, NC 27157

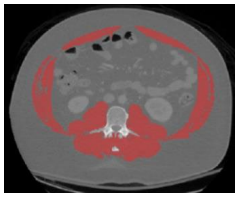
Wake Forest University
School of Medicine

Project 17 - Summer 2027

Crash Injury Research and Engineering Network (CIREN)

A NHTSA CIREN Medical and Engineering Center at Wake Forest since 2005. Real-world crashes enrolled in Winston-Salem and Charlotte are studied with clinicians to explain injury causation and improve prevention and care.





Join our CIREN team and work side-by-side with engineers and clinicians. You will: 1) investigate real-world crashes—linking scene, vehicle, imaging, and medical data to determine injury mechanism and causation; 2) collaborate in multidisciplinary case reviews with trauma and orthopedic surgeons, radiologists, crash investigators, and biomedical engineers; and 3) reconstruct selected cases with GHBMC human body models to visualize occupant kinematics and supplement injury analysis. Interns leave with rare, hands-on experience in trauma biomechanics, team science, and computational modeling.

Joel Stitzel, PhD

Professor, Biomedical Engineering
575 N. Patterson Ave, Suite 530
Winston-Salem, NC 27101
CIB at WFU

Wake Forest University
School of Medicine

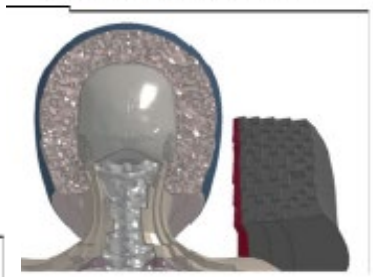
Project 18 - Summer 2027

Head Impact Exposure Quantification and Mitigation in Motorsports

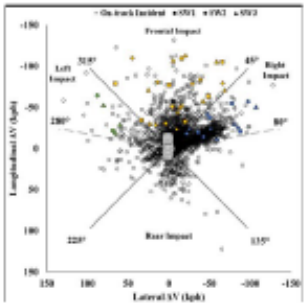
Custom instrumented mouthpieces are worn by NASCAR Cup Series drivers and grassroots / High Limit Racing athletes. Use on-track data and computational models to quantify head exposure and help optimize safety.

Driver FE Model

FE Simulation for
Driver Safety Optimization

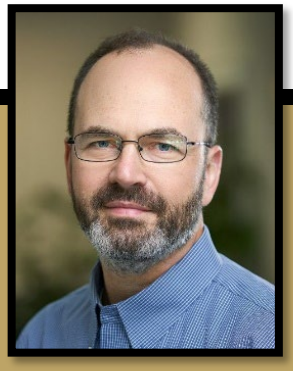


Example On-Track Impacts



Work with CIB engineers, NASCAR safety partners, and the motorsports team. You will: 1) analyze on-track and crash head kinematics from instrumented mouthpieces; 2) use finite element (FE) models to estimate brain injury risk in real crash scenarios; and 3) evaluate safety countermeasures and driver comfort with simulation and field data. This is translational motorsports safety—analysis that can inform how drivers, teams, and sanctioning bodies protect the brain.

Joel Stitzel, PhD



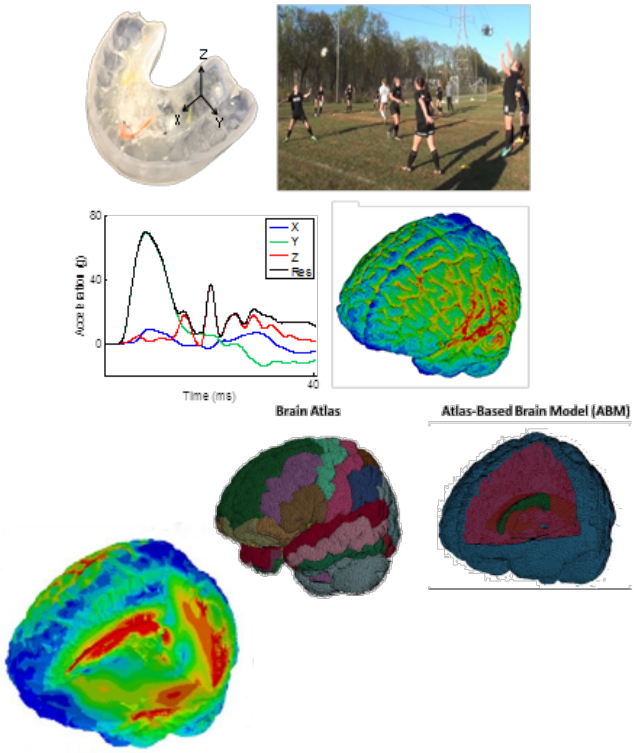
Professor, Biomedical Engineering
575 N. Patterson Ave, Suite 530
Winston-Salem, NC 27101
CIB at WFU

Wake Forest University
School of Medicine

Project 19 - Summer 2027

Subconcussive Head Impact Analysis using Instrumented Mouthpiece Data

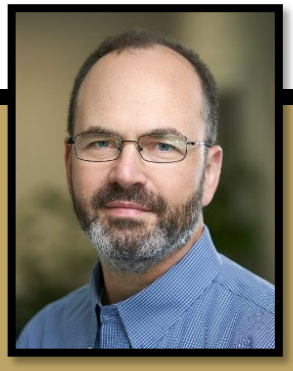
Our custom-fit instrumented mouthpiece couples to the upper jaw to measure six-degree-of-freedom head kinematics in the field. It is used in youth and high school sports, motorsports, and everyday activities, and supports NIH-funded studies of subconcussive exposure and brain health.



Join a collaborative team of engineers, clinicians, and sports partners. You will: 1) review current evidence on head kinematics in sport and daily life; 2) process and analyze mouthpiece data from ongoing field studies, including video-synced events; and 3) apply statistics and brain finite element modeling to interpret exposure and TBI risk. Interns gain skills in human-subjects research, sensor data pipelines, statistical analysis, and computational brain modeling.

Joel Stitzel, PhD

Professor, Biomedical Engineering
575 N. Patterson Ave, Suite 530
Winston-Salem, NC 27101
CIB at WFU



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Project 20 - Summer 2027

Evidence-Based Intervention for Improved Head Impact Safety in Youth Sports

Due to rising concern of head impact exposure and concussion in the 21 million children involved in team sports, this project aims to examine the sub-concussive and concussive head impact exposure in adolescent athletes instrumented with mouthpiece sensors and evaluate the effectiveness of evidence-based intervention programs in youth sports.

The student will: 1) review literature focused on cumulative exposure of sub-concussive and concussive head impacts and factors influencing exposure (e.g. coaching techniques; practice and game guidelines/rules; community-based interventions; athlete age, size, experience, and position), and 2) design a hypothesis-driven experiment to examine metrics of head impact exposure using on-field video analysis, biomechanical data processing, and statistical approaches learned from mentored training. The student will directly contribute to the broader research goal of reducing sub-concussive and concussive head impact exposure to improve sport safety in adolescents

Jillian Urban, PhD, MPH

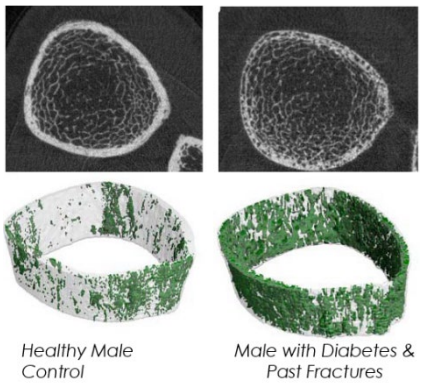
Associate Professor, Biomedical Engineering
VT-WFU Center for Injury Biomechanics
School of Biomedical Engineering and Sciences
575 N. Patterson Ave
Winston-Salem, NC 27101
http://www.wakehealth.edu/CIB/CIB-People.htm

Wake Forest University
School of Medicine

Project 21 - Summer 2027

High-Resolution Peripheral Quantitative Computed Tomography (HR-pQCT) Scanning in Clinical Trial Interventions

The XtremeCT II HR-pQCT scanner provides highly specialized CT scans at the distal radius and tibia. These images can be used to quantify changes in volumetric bone mineral density (BMD) as well as structural changes by providing detailed resolution of the bone microarchitecture.



Burghardt et al. – JCEM 2010

These data are being used by our group in the clinical setting as part of interventional trials designed to evaluate the outcome of varying weight loss modalities (dietary, exercise, surgical) on metrics of bone health. The ability to see microarchitecture remodeling may lead to an increased understanding of how bones are affected by weight loss, particularly among older adults.

The student will: develop HR-pQCT scanning and analysis protocols, assist with HR-pQCT scanning of participants, and analyze HR-pQCT scan to extract bone microstructure properties (e.g., trabecular spacing, cortical porosity, trabecular and cortical BMD, finite element estimated failure load and bone stiffness) to explore how clinical trial interventions alter the skeleton.

Location: Wake Forest University School of Medicine

Ashley Weaver, PhD

Professor, Biomedical Engineering
VT-WFU Center for Injury Biomechanics
School of Biomedical Engineering and Sciences
575 N. Patterson Ave
Winston-Salem, NC 27101
Ashley Anne Weaver, PhD | Wake Forest University School of Medicine

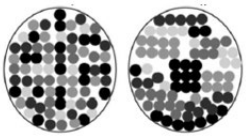
Wake Forest University
School of Medicine

Project 22 - Summer 2027

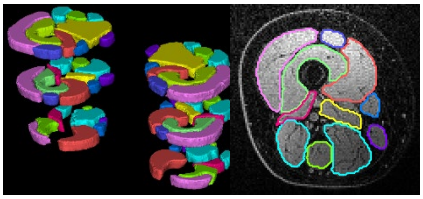
Muscle Quality/Radiomics Features and Muscle-Bone Crosstalk

Loss of muscle mass and strength can lead to mobility disability and increase risk of osteoporosis and fracture as muscle acts both mechanically and biochemically on bone. We are conducting studies utilizing computed tomography (CT) and magnetic resonance (MR) imaging to assess muscle changes with weight loss (diet/exercise-based or bariatric surgery), disease (e.g. myotonic dystrophy; heart failure), or normal aging. We apply automated machine-learning and semi-automated methods to assess changes in muscle area, volume, quality, and intermuscular fat in CT and MR scans.

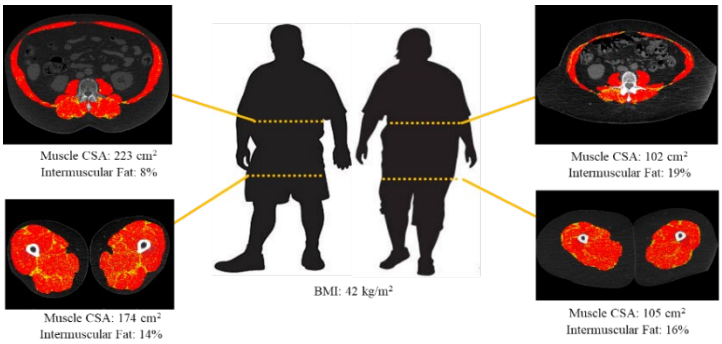
We also use automated radiomics analysis to extract high-dimensional muscle quality measures, such as uniformity, heterogeneity, randomness, and repetitive patterns from CT. These muscle properties can be correlated to bone mineral density and bone strength, which we derive from imaging. These analyses assess effectiveness of interventions, characterize mechanisms of disease, identify therapeutic targets, and will help establish imaging biomarkers to predict musculoskeletal decline.



Radiomic Textures



Myotonic Dystrophy



The student on this project will be trained in image segmentation and pipelines for quantifying muscle properties from radiology. The student will examine muscle quality/radiomics features in a human subject population and explore how these features are affected by a clinical trial intervention or disease such as myotonic dystrophy.

Location: Wake Forest University School of Medicine

Ashley Weaver, PhD

Professor, Biomedical Engineering
VT-WFU Center for Injury Biomechanics
School of Biomedical Engineering and Sciences
575 N. Patterson Ave
Winston-Salem, NC 27101
Ashley Anne Weaver, PhD | Wake Forest University School of Medicine

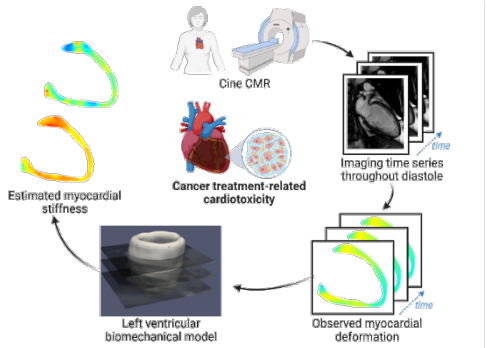
Wake Forest University
School of Medicine

Project 23 - Summer 2027

Predicting Cancer Treatment-Related Cardiotoxicity by Imaging Cardiac Mechanical Stiffness

Cancer treatment-related cardiotoxicity is a significant concern for cancer survivors. Increased survival rates along with a younger demographic shift makes patient survivorship issues, particularly cardiovascular disease, a forefront of clinical concern in an important patient group with decades of life to protect. Cardiotoxicity concerns limit therapeutic options and offset expected therapeutic benefits. Current clinical detection paradigms are based on semi-quantitative and subjective assessments that are only able to detect late-stage irreversible cardiac decline. There is a compelling need for new methods to assess early cardiac dysfunction to allow for interventional opportunities to minimize cancer therapy-induced cardiotoxicity while maximizing cancer treatment effect. We have recently shown the development of novel myocardial mechanical stiffness phenotyping tools. This project seeks to further develop and optimize biomechanical model-embedded cardiovascular magnetic resonance imaging (CMR) assessment of myocardial mechanical elasticity to accurately and non-invasively detect cancer treatment-related changes in left ventricular stiffness as an early indicator of cardiac dysfunction to inform therapeutic management strategies for breast cancer patients prior to irreversible cardiovascular damage.

The student will gain experience with medical image processing (segmentation, registration) and biophysical finite element modeling based on MRI data. The student will develop and deploy computational analysis pipelines and contribute to the development of computational model-based image analysis methodologies to guide interventional therapy for cancer survivors.



Location: Wake Forest University School of Medicine

Jared Weis, PhD

Associate Professor, Biomedical Engineering
School of Biomedical Engineering and Sciences
575 N. Patterson Ave
Winston-Salem, NC 27101
http://www.weislab.org/

Wake Forest University
School of Medicine

Project 24 - Summer 2027

Photoacoustic Imaging for Biophysical Physiological Indicators of Infant Intestinal Health and Necrotizing Enterocolitis

Necrotizing enterocolitis (NEC) is a devastating intestinal disease affecting the most fragile premature infants, with mortality rates that persist at 20 - 40%. Accurate and conclusive early diagnosis of NEC remains elusive, with limited diagnostic confidence complicating timely and effective medical management efforts to prevent disease progression to urgent surgical removal of necrotic intestine. We have recently pioneered the translational use of photoacoustic imaging for characterizing intestinal physiological health in infants. Our current research goals focus on developing and validating these novel in vivo photoacoustic imaging methods in both humans and animal models of intestinal diseases affecting premature infants. This is an interdisciplinary research project that integrates gastrointestinal cell biology/physiology and biomedical imaging/analysis tools to explore the mechanistic underpinnings of an emerging new diagnostic imaging method for premature infant intestinal diseases

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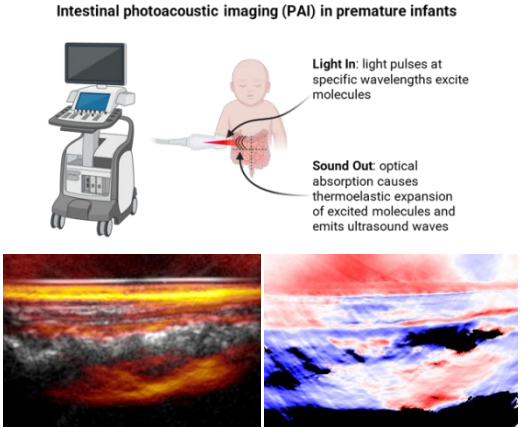
This project is a highly collaborative team science effort to advance a promising and translationally relevant diagnostic imaging tool with collaborators across the departments/sections of Biomedical Engineering, Regenerative Medicine, Neonatology, Pediatric Surgery, Pediatric Radiology, Comparative Pathology, and Biostatistics. The student will gain experience with ultrasound and photoacoustic image processing and histopathological tissue staining techniques used for validation of the cellular and molecular origins of changes in imaging signatures.



Location: Wake Forest University School of Medicine

Jared Weis, PhD

Associate Professor, Biomedical Engineering
School of Biomedical Engineering and Sciences
575 N. Patterson Ave
Winston-Salem, NC 27101
http://www.weislab.org/

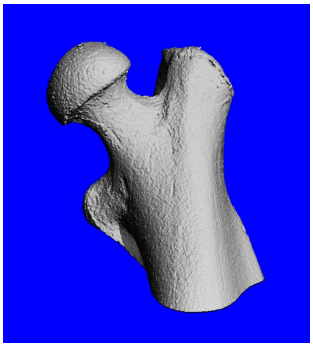
Wake Forest University
School of Medicine

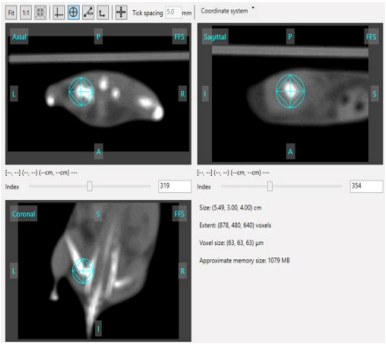
Project 25 - Summer 2027

Preventing Cancer Therapy-Induced Pain and Bone Loss

This is an opportunity to use engineering and biologic techniques to identify if two therapeutics in clinical trials have the potential to increase the quality of life for our cancer patients. Radiation therapy is an effective means of killing tumors and saving the lives of our patients. While modern radiation therapy techniques improves patient survival, an unintended consequence is morbidity in the form of substantial radiation-induced pain, bone loss, and subsequent fractures. The mechanism causing the pain is unclear, and can occur without fractures (though fractures are painful). Moreover, the 1-year mortality rate for individuals over 60 who have a pelvic fracture is ~25%, and the incidence of pelvic fractures is elevated after pelvic radiation treatment. Thus, preventing these radiation-related complications would greatly improve patient mobility, and quality of life.

The intern will work with orthopedic surgeons, radiation oncologists, bioengineers and physicists to perform quantitative analyses (e.g., microCT, FEA, gait assessment) that will determine if our therapeutics can prevent radiation-induced pain and/or bone damage. We targeted the hips of mice with simulated radiosurgery, and then delivered one of two agents with strong potential for preventing pain and bone loss – both compounds have been enrolled in clinical trials for other purposes. We will perform/train microCT assessment of bone to identify the protective potential of these therapeutics. The student can perform FEA on these images. Moreover, pain often manifests as impaired behaviors like walking ability ("gait"). The intern will analyze gait metrics using an image capture system to test if these drugs can prevent pain caused by targeted radiation therapy. Our lab follows a mentoring strategy in which the intern will be teamed with an expert in imaging and quantitative assessment to perform their research.





NOTE: There are also opportunities for the intern to perform quantitative skeletal analyses on tissues (bone, cartilage, muscle) from mice that we sent into orbit to the International Space Station to Test ways to protect skeletal health, which if desired could be the topic of the intern's research.

Jeffrey Willey, PhD

Professor, Radiation Oncology
Wake Forest University School of Medicine
Medical Center Boulevard
Winston-Salem, NC 27157
http://www.wakehealth.edu/Faculty/Willey-Jeffrey-Scott.htm

Location:

Wake Forest University
School of Medicine

Wake Forest University
School of Medicine

Project 26 - Summer 2027

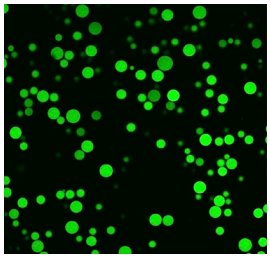
Stimuli-Responsive Materials to Treat Osteoarthritis-Related Joint Pain

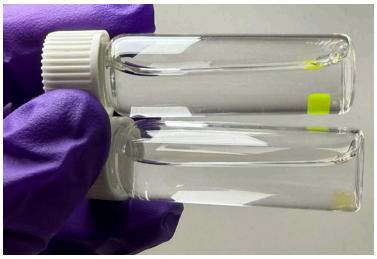
Background: Osteoarthritis (OA) is a whole-joint disease characterized by inflammation of joint tissues, vascular expansion (i.e., angiogenesis), pain, and articular cartilage degeneration. There are limited clinical options to minimally invasively treat OA. An emerging clinical strategy—synovial embolization, involves the localized occlusion of small capillaries lining the joint with injectable microbeads. This approach seeks to limit the influx of inflammatory factors through the vascular bed and prevent further vascular expansion which is hypothesized to contribute to joint pain.

Goal: We are engineering injectable materials to investigate and improve clinical outcomes for synovial embolization. Using stimuli-responsive materials, we can precisely control the time that microbeads are present within synovial capillaries. This project brings together chemistry (peptide-engineering, molarity calculations, ^{1}H NMR), physics (rheology), and biology (fluorescent imaging, joint biology). Based on interests, the student may focus on either (1) stimuli-responsive material development and characterization, or (2) the development of an in vitro model of embolization. For all lab work, the student will work alongside a trained laboratory technician and meet weekly with the PI. This work is in collaboration with Prof. Stefan Kluzek.

Prior coursework preferred:
- Chemistry, Biology, Physics

The student will gain experience with:
- Hydrogel synthesis
- Rheology and NMR
- Peptide engineering
- Fluorescent imaging
- In vitro models of embolization





Location: Wake Forest University School of Medicine

Hannah Zlotnick, PhD

Assistant Professor, Orthopaedic Surgery
School of Medicine
1 Medical Center Blvd
Winston-Salem, NC 27157
https://www.zlotnicklab.com/

Wake Forest University
School of Medicine

Project 27 - Summer 2027

Electrocardiographic Long-Term Simulation for Future Rhythm Disorder Detection

Project Overview:

Electrocardiograms are used to detect a wide range of arrhythmias. Yet, may of the rhythm disorders have paroxysmal nature not easy to detect within a single 10 second standard electrocardiogram. This project aims to develop models to simulate future behavior of short them ECGs to identify of arrhythmia development from a given normal sinus rhythm ECG

Developing a code library to execute analysis, translating findings into scientific presentation and abstract. Student should have Python programming experience. Also, experience with LLMs is preferred.

Location: Wake Forest University School of Medicine

Oguz Akbilgic PhD

Professor, Cardiovascular Medicine
Department of Cardiovascular Medicine
Center for Artificial Intelligence Research
Wake Forest School of Medicine
E. oguz.akbigic@advocatehealth.org

Wake Forest University
School of Medicine

Project 28 - Summer 2027

Linking Histopathologic Morphology to Diagnostic Concepts Using Artificial Intelligence

Project Overview:

Modern computational pathology foundation models can encode histology images into high-dimensional representations that capture tissue morphology, but these representations are difficult to interpret biologically. This project will investigate whether visual features extracted from a pretrained pathology foundation model, such as UNI, can be organized into interpretable morphology prototypes and linked to natural-language descriptions of histologic patterns. The primary objective is to develop a lightweight framework that groups histopathology image patches according to their foundation-model representations and associates the resulting visual prototypes with pathology-related text concepts. Examples may include gland formation, lymphocytic infiltration, necrosis, fibrosis, nuclear pleomorphism, and stromal patterns. The project will evaluate whether these text-grounded prototypes form a meaningful and reusable vocabulary for describing tissue morphology across different patients and cancer types.

- Gain familiarity with digital pathology images and modern vision foundation models.
- Use pretrained UNI features to perform dimensionality reduction, clustering, and morphology prototype discovery.
- Develop or curate pathology morphology descriptions from image-caption datasets and pathology terminology sources.
- Embed pathology text using pretrained vision-language or language models and link visual clusters to relevant textual descriptions.
- Visualize representative image patches for identified morphology prototypes and evaluate their consistency and interpretability.
- Assess prototype quality using quantitative metrics such as:
  - Cluster stability
  - Patient diversity
  - Cancer-type distribution
  - Image-text similarity
- Compare visual-only prototypes with text-grounded prototypes to determine whether language supervision improves biological interpretability.

Basic programming experience in Python is preferred. Familiarity with machine learning, computer vision, data science, or deep learning is helpful but not required. Experience with PyTorch, NumPy, pandas, scikit-learn, or visualization tools is a plus. The student should be comfortable learning new computational methods and have an interest in artificial intelligence, biomedical imaging, or computational biology.

Metin Gurcan PhD

Onur Koyun PhD
Staff Scientist

Metin N. Gurcan, Ph.D., FSPIE, FACMI
Senior Associate Dean for Artificial Intelligence
Director, Center for Artificial Intelligence Research
Professor, Department of Internal Medicine,
Professor, Pathology, BME, Regenerative Medicine
Wake Forest University School of Medicine

E. Metin.Gurcan@wfusm.edu

Wake Forest University
School of Medicine

Project 29 - Summer 2027

Tracking What Changed: Evidence-Based Detection of Medication Errors in AI-Generated Clinical Summaries

Project Overview:

Clinical summaries must accurately communicate changes in a patient's treatment. When information is distributed across multiple notes, an AI-generated summary may omit a medication change, retain an outdated instruction, or confuse a temporary hold with permanent discontinuation. This project will investigate whether explicitly tracking medication changes over time improves automated detection of these discrepancies. The trainee will develop a research prototype that compares a clinical handoff summary with its source notes. The system will extract documented medication events, organize them chronologically, and identify summary statements that contradict or omit the latest explicit treatment plan. Each flag will include supporting text from the source documentation. Cases with conflicting or insufficient evidence will be marked for review. Our central hypothesis is that verification using a structured medication timeline will detect errors more accurately than asking a language model to review the same documents without this structure. The summer project will pursue three objectives:

- 1. Develop a focused evaluation dataset of synthetic clinical cases containing medication starts, discontinuations, temporary holds, resumptions, and dose changes.
- 2. Implement a timeline-based verification method and compare it with a direct language model review baseline.
- 3. Evaluate error detection, false alerts, and the accuracy of supporting evidence, and present the results through a simple review interface.

The proof of concept will use clinician-reviewed synthetic cases to avoid dependence on institutional patient data access. Expected outputs include an annotated evaluation dataset, reproducible code, a working demonstration, and a research presentation. These results will inform subsequent evaluation using approved clinical data.

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- Participate in all stages of a clinical AI research project, from literature review to evaluation.
- Create and analyze clinical note summaries, including cases with medication discrepancies.
- Use language models and Python tools to extract and compare medication information.
- Evaluate model performance using accuracy and error-detection metrics.
- Gain experience in clinical NLP, information extraction, experimental design, and AI evaluation.
- Work closely with mentors through weekly meetings and present findings in a prototype, poster, or oral presentation.

Metin Gurcan PhD

Metin N. Gurcan, Ph.D., FSPIE, FACMI
Senior Associate Dean for Artificial Intelligence
Director, Center for Artificial Intelligence Research
Professor, Department of Internal Medicine,
Professor, Pathology, BME, Regenerative Medicine,
Wake Forest University School of Medicine
E. Metin.Gurcan@wfusm.edu

Mohammad Hasan MS
AI Analyst, AIMS
Center for Artificial Intelligence Research
Wake Forest University School of Medicine
E. mohammad.hasan@advocatehealth.org

This project will explore the use of data science and AI methods to improve the efficiency and accuracy of research award reporting. The goal is to develop and evaluate approaches for identifying and classifying records that may require additional review, helping streamline existing reporting workflows.

Wake Forest University
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Project 30 - Summer 2027

AI-Assisted Research Award Data Reporting

Project Overview:

This project will explore the use of data science and AI methods to improve the efficiency and accuracy of research award reporting. The goal is to develop and evaluate approaches for identifying and classifying records that may require additional review, helping streamline existing reporting workflows.

- Gain hands-on experience working with real-world structured datasets.
- Prepare and clean data to support analysis and modeling efforts.
- Conduct exploratory data analysis (EDA) to identify patterns, trends, and insights.
- Develop and apply classification methods to solve practical data-driven problems.
- Evaluate model performance and analyze results to determine effectiveness.
- Learn how data science techniques can be translated into real-world operational solutions.
- Build skills in data analytics, predictive modeling, and workflow optimization.
- Develop an understanding of how data-driven approaches can improve organizational decision-making and processes.

Metin Gurcan PhD

Metin N. Gurcan, Ph.D., FSPIE, FACMI
Senior Associate Dean for Artificial Intelligence
Director, Center for Artificial Intelligence Research
Professor, Department of Internal Medicine,
Professor, Pathology, BME, Regenerative Medicine,
Wake Forest University School of Medicine
E. Metin.Gurcan@wfusm.edu

Interest in AI, data science, or analytics
Basic programming experience with Python or R
Familiarity with Excel or structured data
Strong analytical thinking and willingness to learn

Abbas Alili PhD

AI Analyst, AIMS Center for Artificial Intelligence Research
abbas.alili@advocatehealth.org

Wake Forest University
School of Medicine

Project 31 - Summer 2027

Characterizing Failure Modes of AI-Based Otoscopy Video Diagnosis

Project Overview:

This project will characterize failure modes of AI-based otoscopy video diagnosis. The student will investigate factors associated with incorrect or unreliable predictions, such as poor visualization, motion blur, cerumen/occlusion, subtle pathology, multiple findings, and clinician disagreement. The goal is to better understand when AI predictions are more or less reliable.

- Review otoscopy videos alongside AI-generated predictions
- Identify and categorize model error cases to better understand performance limitations
- Organize and manage annotations for analysis and evaluation.
- Conduct basic statistical analyses and create visualizations of findings.
- Gain hands-on experience in:
    - Clinical AI research
    - Medical imaging
    - AI model evaluation
    - Scientific communication
- Contribute to research dissemination through potential posters, abstracts, or manuscripts.

Metin Gurcan PhD

Metin N. Gurcan, Ph.D., FSPIE, FACMI
Senior Associate Dean for Artificial Intelligence
Director, Center for Artificial Intelligence Research
Professor, Department of Internal Medicine,
Professor, Pathology, BME, Regenerative Medicine,
Wake Forest University School of Medicine
E. Metin.Gurcan@wfusm.edu

Interest in AI, medical imaging, otolaryngology, or clinical research is preferred. Attention to detail is important. Basic experience with Excel, Python, R, or statistics is helpful but not required.

Hao Lu, PhD
Staff Scientist Associate

Wake Forest University
School of Medicine

Wake Forest University
School of Medicine

Project 32 - Summer 2027

Language-based AI Model on Genomic Data to Understand and Predict Risk of Alzheimer Disease and Multimorbidity

Project Overview:

Our Genomes such as DNA encode molecular-level information about disease risk. Traditional methods using polygenic risk scores only explore the risk of a single disease for every single gene, omitting the high-level genetic interaction of genomic sequences that are associated with multiple diseases. The recent development of the Natural Language Processing (NLP) model has shown success in the comprehension of high-level context in sequence data such as sentences. Similarly, NLP models can also be applied to genomic sequences to extract high-level genotype information for multiple related diseases. However, studies in this field is still limited despite the strong potential.
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The goal of this project is to lean and develop novel NLP-based deep learning models on genomic data to predict the composite risk for multiple diseases.

The student in this project will be expected to have Python programming skills and work on 1) developing representation learning models to extract high-level genomic features 2) predicting multi-disease risk factors and identifying high-level genomic associations.

Michael Horvath, MS

Lead Programmer / Analyst,
Clinical and Translational
Science Institute

Da Ma, PhD

Wake Forest University
School of Medicine

Associate Professor, Gerontology and Geriatric Medicine
Center for Artificial Intelligence Research (CAIR)
Alzheimer's Disease Research Center
Wake Forest School of Medicine
https://school.wakehealth.edu/faculty/m/da-ma

Wake Forest University
School of Medicine

Project 33 - Summer 2027

Intervention-Aware AI Based Risk Modeling & Counterfactual Simulation for Cardiovascular Outcomes

Most risk models answer how likely an event is. This project asks a harder question — how would that risk change if a clinician had acted differently: starting a statin earlier, selecting a different TAVR device, tightening blood pressure control, choosing a different anticoagulant.

Focus

Simulate a patient's cardiovascular risk trajectory under interventions that never actually happened.

Approach

Causal inference and counterfactual estimation methods, layered on longitudinal EHR and survival data.

You'll build

A simulation engine that generates and compares factual vs. counterfactual risk curves for individual patients.

Location: Wake Forest University School of Medicine

Ibrahim Karabayir, PhD

Assistant Professor, Cardiovascular Medicine
Center for Artificial Intelligence Research (CAIR)
Wake Forest University Health Sciences
Wake Forest University School of Medicine
E. Ibrahim.Karabayir@wfusm.edu

Wake Forest University
School of Medicine

Project 34 - Summer 2027

Multimodal AI Grounded in ECG & Clinical Text: A Dynamical View of Cardiovascular Outcomes

A cardiologist reads a waveform and a chart note together, not separately. This project builds AI that does the same — fusing raw ECG signals with clinical narrative to track how a patient's cardiac state evolves over time.

Focus

Learn joint representations of ECG waveforms and clinical notes that capture disease dynamics, not a single snapshot.

Approach

Signal encoders for ECG paired with pre-trained clinical language models, combined through multimodal fusion and temporal modeling.

You'll build

A dynamical multimodal model that tracks and forecasts cardiovascular risk as a patient's condition changes.

Location: Wake Forest University School of Medicine

Ibrahim Karabayir, PhD

Assistant Professor, Cardiovascular Medicine
Center for Artificial Intelligence Research (CAIR)
Wake Forest University Health Sciences
Wake Forest University School of Medicine
E. Ibrahim.Karabayir@wfusm.edu

Wake Forest University
School of Medicine

CAIR
CENTER FOR ARTIFICIAL INTELLIGENCE RESEARCH

Project 35 - Summer 2027

AI-Assisted Pre-screening for Neurological Disorders

Neurological disorders (NDs) are the number one cause of disability and the second leading cause of death globally. Evidence is emerging showing that NDs are in fact multi system syndromes affecting different aspects of patients' health and well-being. Early diagnosis enables access to timely intervention and therapeutics. However, diagnosis of most NDs is challenging due to heterogeneity of disease and lack of evident physical phenotypes. The goal of this project is to use advanced artificial intelligence (AI) techniques to assist the diagnostic process and characterize the clinical risk associated with NDs.

The student will: 1) review literature on prevalence and diagnosis of different neurological disorders, 2) evaluate the previously trained model on a new dataset, 3) evaluate the model across various patient subgroups defined by race/ethnicity, sex, and co-occurrence of key diagnosis. This data will inform the development of more accurate and inclusive AI-assisted pre-screening models for neurological disorders which could lead to more equitable diagnosis and health care for patients.

Arezoo Movaghar, PhD

Assistant Professor, Department of Pediatrics
Center for Artificial Intelligence Research (CAIR)
Wake Forest University School of Medicine

Meads Hall, Queen St., Medical Center Blvd.
Winston-Salem, NC 27103

Wake Forest University
School of Medicine

Project 36 - Summer 2027

Analysis of Entropy in Multi-omic Datasets Associated with Cognitive Decline in Older Adults with Vascular Disease

Project Overview:

Epigenetic, transcriptomic, and proteomic data are available from a human cohort of aging adults. We are investigating changes in the correlation structure across these types of omic data to understand the underlying mechanisms of aging. We hypothesize that vascular disease and dementia risk increases as the integration across omic data declines.

Students will learn best practices for analyzing several types of omic data as well as interpreting the results within the context of aging biology and cognitive decline. We would like someone interested in genetics or similar fields and with R programming experience.

Location: Wake Forest University School of Medicine

We would like someone interested in genetics or similar fields and with R programming experience.

Ellen Quillen, PhD
Associate Professor
Department of Internal Medicine- Molecular Medicine
Wake Forest University School of Medicine
E. ellen.quillen@advocatehealth.org

Wake Forest University
School of Medicine

Project 37 - Summer 2027

AI-Enabled Prediction of Infant Gut Microbiome Development: Linking Early Feeding Patterns to Short-Chain Fatty Acid Production Across Diverse Populations

Project Overview:

The infant gut microbiome changes dramatically over the first year of life, especially around the introduction of complementary foods. A key product of this developing community is short-chain fatty acids (SCFAs), microbial metabolites linked to immune development and later metabolic and growth outcomes. Most infant microbiome studies are limited to a single cohort, making it unclear whether early feeding-related microbiome changes predict later microbial function across different populations and diets. This project will combine publicly available infant gut metagenomic datasets from diverse cohorts, characterize microbial community states around the onset of complementary feeding, and build models testing whether these early states predict later SCFA-producing potential.

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The student will learn to identify, evaluate, and harmonize metagenomic datasets, and apply machine learning both to find patterns in early microbiome data and to build predictive models linking those patterns to a later biological outcomes. The project will involve (1) Compiling metagenomic datasets spanning diverse populations and infant feeding practices (2) estimate feeding patterns from the metagenomic data (3) characterize microbiome function at the onset of complementary feeding and later in life (4) Build models predicting later SCFA-producing potential from these early states (5) evaluate how well these predictions generalize across independent cohorts

No prior research experience is required. Coursework in biology and/or statistics is helpful but not required.

Wake Forest University
School of Medicine

Daniel Sprockett, PhD

Assistant Professor, Department of Microbiology and Immunology
Wake Forest University Health Sciences
Wake Forest University School of Medicine
Sprockettlab.com

Wake Forest University
School of Medicine

Project 38 - Summer 2027

Protocol2Agent: Prototyping a Validated, Machine-Actionable Interface for Clinical Trial Protocol Eligibility Criteria

Project Overview:

Clinical trial protocols are distributed as static PDFs, even though they contain structured, rule-based content — like eligibility criteria — that could be computable. This project builds a small prototype: extract one trial protocol's eligibility criteria into structured, code-linked data (mapped to standard medical terminologies), write functions to test whether a sample patient meets each criterion, and validate that the extracted rules match the source text exactly. Goal: show that protocol logic can be reliably compiled into a traceable, testable computational form — not a chatbot, but a validated building block for AI-assisted trial operations.

Student will parse clinical documents using LLMs, map extracted concepts to medical terminologies (NCI Thesaurus, LOINC), build and test deterministic rule-evaluation functions, and learn core principles of provenance, auditability, and validation for AI in regulated/clinical settings. Exposure to clinical data standards

Required: Python; comfort with or willingness to learn LLM APIs. Preferred: interest in clinical/biomedical NLP, health data standards, or AI safety/validation. No clinical trials background needed.

Umit Topaloglu, PhD, FAMIA

Chief, Clinical and Translational Research Informatics Branch Center for Biomedical Informatics and Information Technology (CBIIT), National Cancer Institute (NCI), National Institutes of Health (NIH)
Lead, NIH-wide Agentic AI Governance Tiger Team
Adjunct Professor, Wake Forest University School of Medicine;
umit.topaloglu@nih.gov

Wake Forest University
School of Medicine

Wake Forest University
School of Medicine

Project 39 - Summer 2027

AI Future Self Simulator: Evidence-Grounded Health Narratives to Motivate Cancer Prevention in Young Adults

Project Overview:

Many cancers can be prevented through behaviors that take shape in adolescence and young adulthood: avoiding tobacco and vaping, limiting alcohol, staying physically active, and getting the HPV vaccine. Yet future health risks often feel distant to young people. This project will build a prototype "future self" simulator: a young adult enters current health behaviors, and an AI system generates a personalized narrative of plausible future health scenarios. To keep these narratives accurate and responsible, each scenario will be grounded in published risk evidence rather than generated freely by the language model, and will be written so that it does not overstate any individual's risk.

Summer Objectives:

1. Compile an evidence base of cancer-related risk estimates for key youth behaviors (tobacco/vaping, alcohol, physical activity, HPV vaccination, etc.) from guidelines and published literature.
2. Build a retrieval-grounded language model pipeline and a simple interface that turns a behavior profile into a personalized, evidence-linked narrative.
3. Evaluate narratives with expert reviewers for factual accuracy, readability, cultural appropriateness, and tone, comparing grounded and ungrounded generation.
4. Draft a study protocol to test whether AI-generated future-self narratives increase motivation for cancer prevention behaviors among young adults.

Student Profile:

Python programming experience is preferred. Interest in public health, cancer prevention, global health, or language models is a plus. No clinical or public health background is required.

Expected outputs: a working prototype, an expert-rated evaluation set, a draft study protocol, and a final research presentation.

Ucheoma C. Nwaozuru, PhD
Assistant Professor
Implementation Science; Social Sciences and Health Policy
Department of Public Health Sciences
Office of Global Health | Comprehensive Cancer Center
Wake Forest University School of Medicine
E. Ucheoma.Nwaozuru@wfusm.edu

Metin N. Gurcan, PhD
FSPIE, FACMI
Senior Associate Dean for Artificial Intelligence
Director, Center for Artificial Intelligence Research
Professor, Department of Internal Medicine
Wake Forest University School of Medicine
E. Metin.Gurcan@wfusm.edu