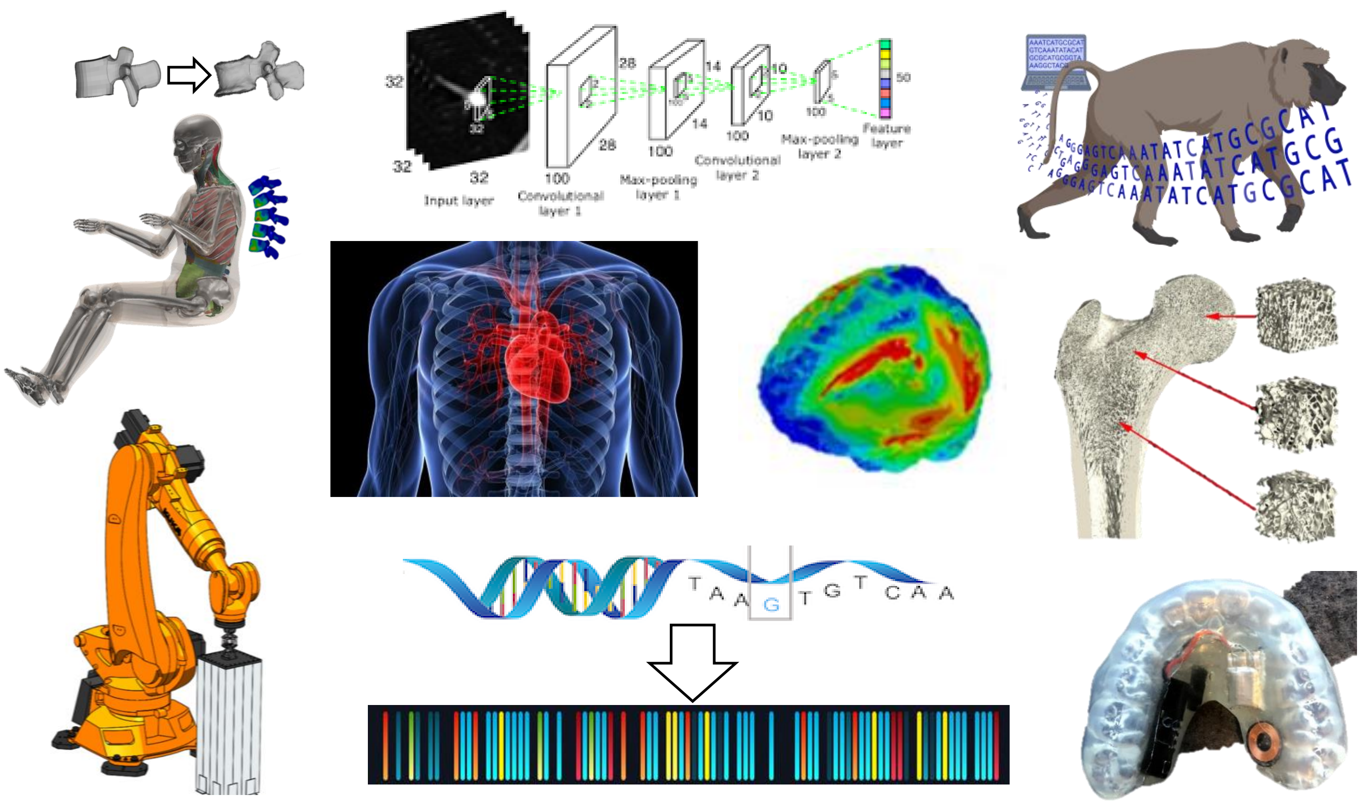
Wake Forest University
School of Medicine

2026 Research Project Descriptions

Summer Research Internship Program

for Undergraduate & MS Graduate Students



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2026 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	Mechanically Matched Patient Specific Bone Surrogates	✓	
4	Philip Brown	Full Field Spinal Characterization Methodology Development	✓	
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	Scott Gayzik	Human Body Model Development for Trauma Research	✓	
8	Scott Gayzik	Standardizing Methods for Virtual Assessment in Human Body Models	✓	
9	Scott Gayzik	Physics-based Finite Element Analysis for Injury Criteria Using Human Surrogates	✓	
10	Scott Gayzik	Development of Signal Analysis Tools for a National Crash Database	✓	
11	Adam Hall	Molecular Detection and Analysis of Trauma Bioindicators	✓	✓
12	Ryan McGinnis	Balance and Mobility Phenotypes of Fall Risk in Persons with Multiple Sclerosis	✓	✓
13	Ryan McGinnis & Ellen McGinnis	Digital Health Measures of Postpartum PTSD	✓	✓
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 & Karan Devane	Neck & Lumbar Spine Injury Risk Curve Development for Spaceflight Applications	✓	✓
22	Ashley Weaver	High-Resolution Peripheral Quantitative Computed Tomography (HR-pQCT) Scanning in Clinical Trial Interventions	✓	
23	Ashley Weaver	Muscle Quality/Radiomics Features and Muscle-Bone Crosstalk	✓	

2026 Summer Research Project Descriptions

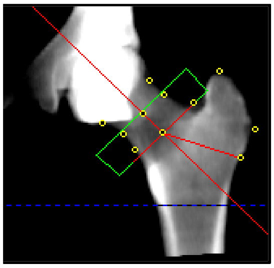
Proj. #	Advisor(s)	Summer Research Project Titles	BME	Informatics
24	Jared Weis	Predicting Cancer Treatment-Related Cardiotoxicity by Imaging Cardiac Mechanical Stiffness	✓	
25	Jared Weis	Photoacoustic Imaging for Biophysical Physiological Indicators of Infant Intestinal Health and Necrotizing Enterocolitis	✓	
26	Jeff Willey	The Mouse Housing Unit-8 Mission to the International Space Station: Prevention of Skeletal Complications	✓	
27	Tanner Filben & Zach Hostetler	Rapid Design and Optimization of Personal Protective Equipment to Mitigate Warfighter Injury Risk	✓	
28	Oguz Akbilgic	Medical Image Generation from Physiological Signals		✓
29	Nicholette Allred	Investigating the Genetic Architecture of the Metabolome to Provide Insight into Cardiometabolic Disease Risk		✓
30	Metin Gurcan	Anomaly Detection in Lung X-rays		✓
31	Metin Gurcan	Otoscopy Assistant Diagnosis System with Integrated Classification and Out-of-Distribution Detection		✓
32	Metin Gurcan	Structuring and Standardizing Patient Discharge Notes		✓
33	Metin Gurcan	Predicting Breast Cancer Recurrence From H&E-Stained Whole Slide Images		✓
34	Metin Gurcan	Nuclei and Tissue Segmentation in Whole Slide Histology Images		✓
35	Ibrahim Karabayir	Novel Deep learning Algorithms and Explainable AI on ECG		✓
36	Da Ma & Michael Horvath	Language-based AI Model on Genomic Data to Understand and Predict risk of Alzheimer Disease and Multimorbidity		✓
37	Mohammad Moghimi	Multimodal System for Early Identification of Cardiovascular Diseases	✓	✓
38	Mohammad Moghimi	Wearable Flexible Patch for Early Identification of Melanoma	✓	✓
39	Arezoo Movaghar	AI-Assisted Pre-screening for Neurological Disorders		✓
40	Ellen Quillen	Genetic Analysis of Machine Learning-Based Rate of Aging Metrics		✓
41	Mostafa Rezapour	Multi-Modal Fusion of Histopathology and Omics Data for Precision Cancer Diagnosis		✓
42	Daniel Sprockett	Computer Vision Analysis of Maternal Behavior in Vervet Monkeys for Understanding Early Life Microbiome Transmission		✓
43	Daniel Sprockett	AI-Enabled Metagenomic Binning: Integrating Long-Read and Short-Read Data for Improved Microbial Genome Reconstruction		✓
44	Atalie Thompson	Exploring Vision and Mobility in BNET-EYE		✓

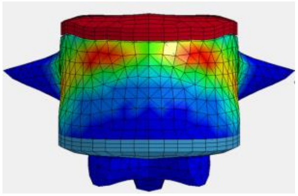
Project 1 - Summer 2026

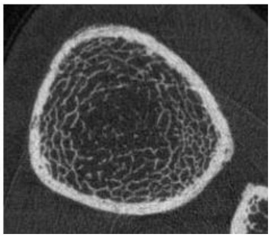
Intervening to Mitigate Weight Loss Associated Bone Loss

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 were recently funded to: 1) test whether bisphosphonate therapy can minimize bone and muscle loss associated with bariatric surgery among 120 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 308 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.







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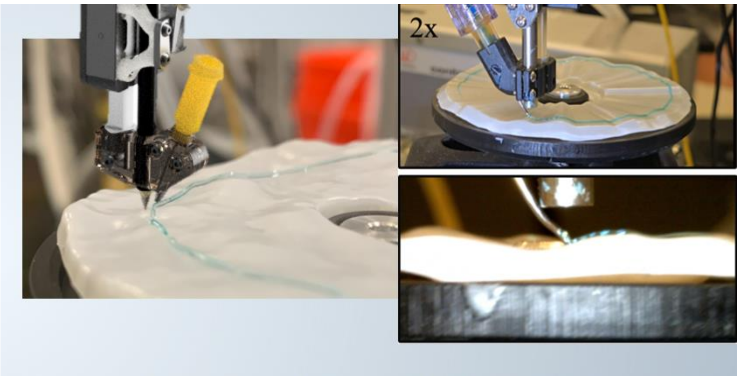
Project 2 - Summer 2026

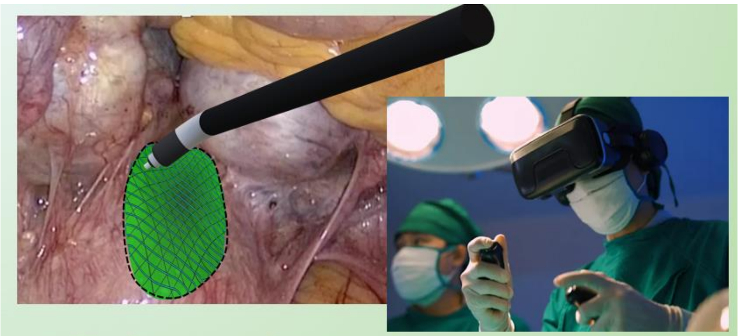
In-Situ Minimally Invasive Surgical Robotic Bioprinting

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

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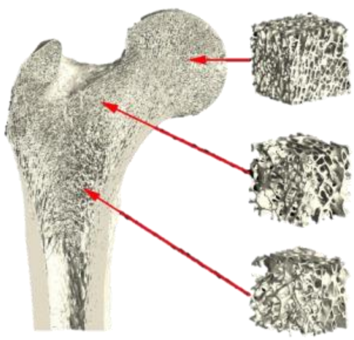
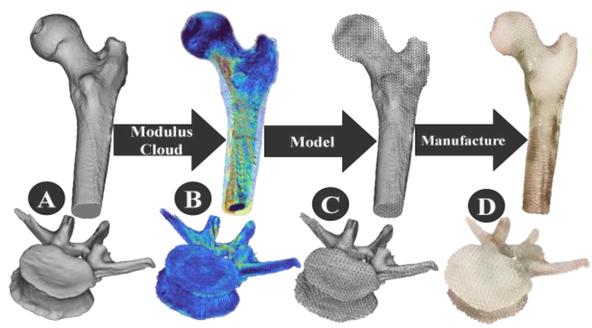
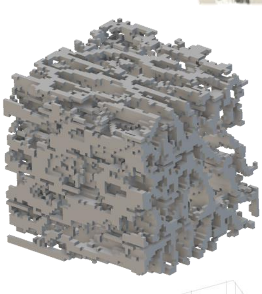
Project 3 - Summer 2026

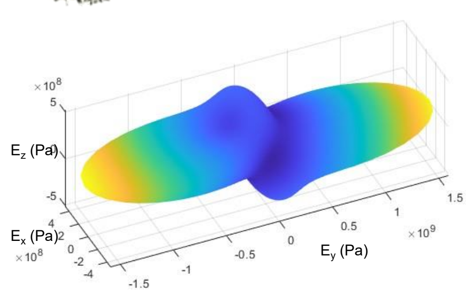
Mechanically Matched Patient Specific Bone Surrogates

Recent advancements in super resolution artificial intelligence, additive manufacturing, and high-performance computing present unique opportunities in the space of medical device design for patient specific implants and patient/population specific mechanical surrogate bones. We are working to create biomechanically accurate subject specific 3D-printed bone surrogates from clinical resolution CT scans. We are working to create and validate workflows for image analysis, mechanical analysis and interpretations, design from mechanical properties for additive manufacturing, and production through a variety of material and printing technologies.









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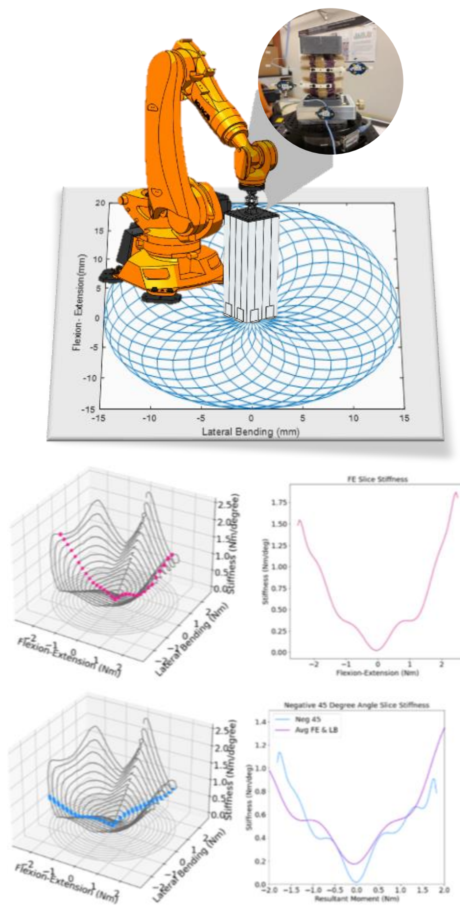
Project 4 - Summer 2026

Full Field Spinal Characterization Methodology Development

The widely accepted method for evaluating spinal biomechanics developed by Panjabi et al has been adopted into standards such as ASTM F2077-22 to validate spinal implants. This method involves applying a pure Cartesian moment to a spinal segment or a functional spinal unit (FSU) in each physiologic plane, then measuring the resulting range of motion (ROM), loading and unloading stiffness, hysteresis, and neutral zone (NZ) behavior. While planar moment testing is a standardized and powerful tool, it leaves the spinal motion-loading space in- between planes untested and unknown. Adding more simultaneous dimensions of loading in a full-field multi-planar methodology will lead to deeper insight into the complex physiological behavior of the spine in various surgical interventions.



To address this gap, we propose a novel testing protocol that uses six-degree-of-freedom trajectories to produce complex motion paths which mapping the spine’s full-field multi-planar behavior. This exploration enables multidimensional visualization of the spine’s bending stiffness in all directions within its physiological limits. The objective of this study was to debut complex multi-planar spinal testing, explore visualization strategies, and identify spinal behavior insights gained relative to traditional testing.

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Project 5 - Summer 2026

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.

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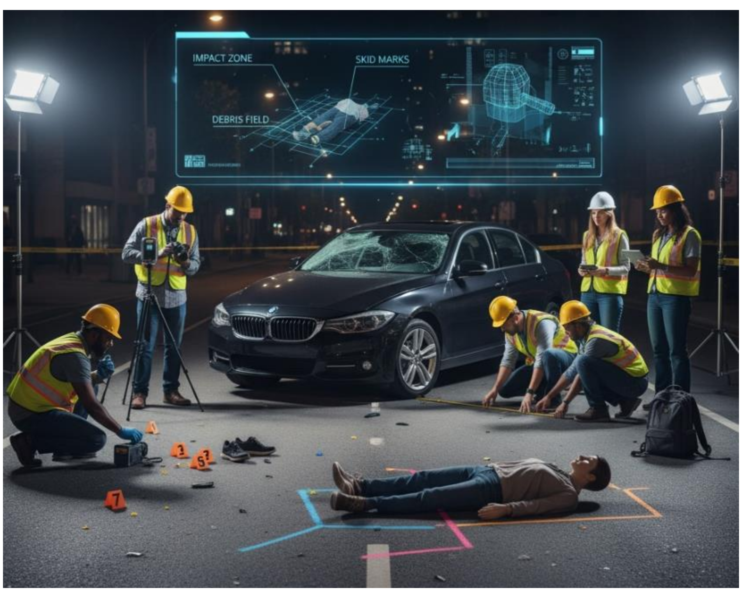
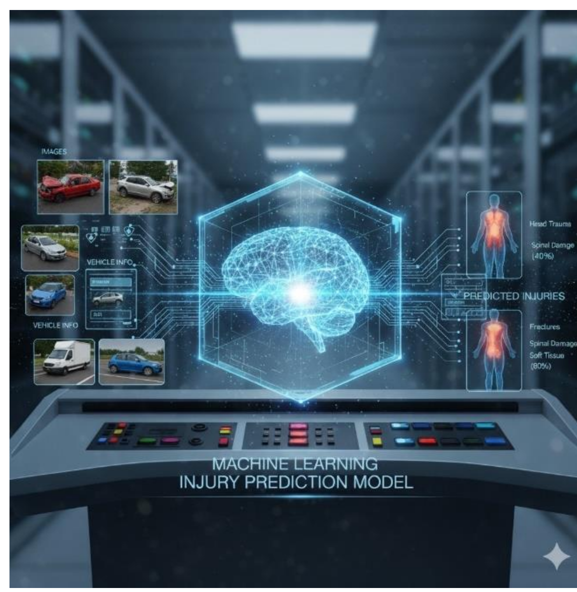
Project 6 - Summer 2026

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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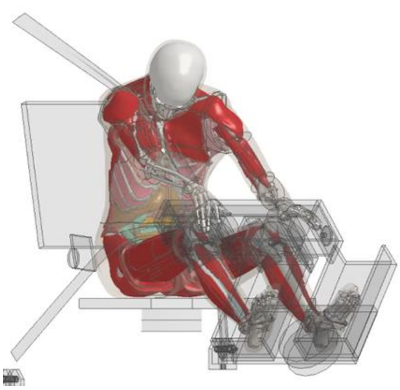
Project 7 - Summer 2026

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

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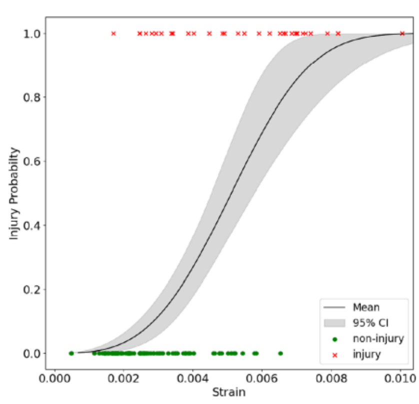
Project 8 - Summer 2026

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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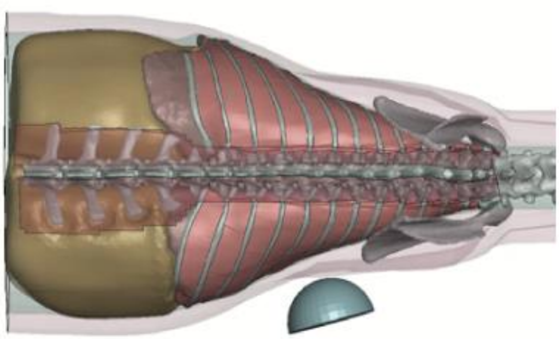
Project 9 - Summer 2026

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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Project 10 - Summer 2026

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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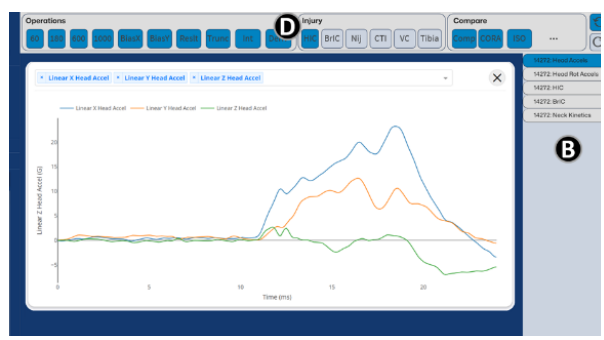

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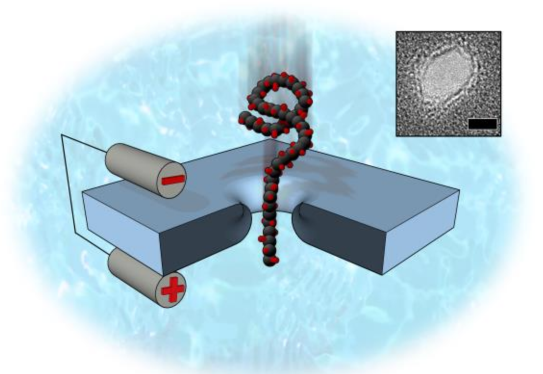
Project 11 - Summer 2026

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

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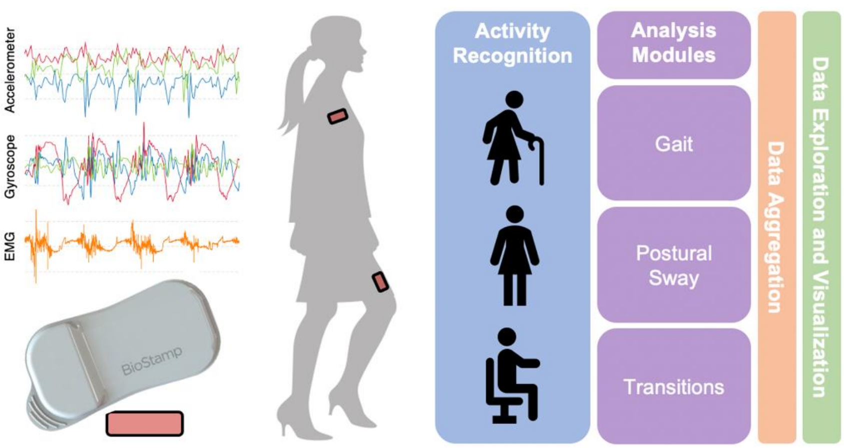
Project 12 - Summer 2026

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

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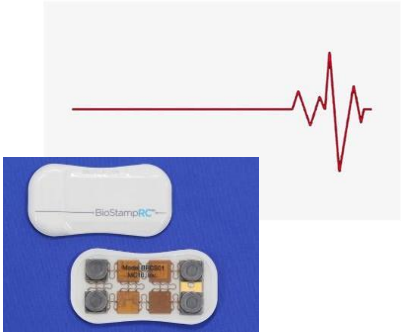
Project 13 - Summer 2026

Digital Health Measures of Postpartum PTSD

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 post-traumatic stress disorder (PTSD).

One in 15 pregnancies result in postpartum PTSD, which has direct bearing on child bonding and familial relationships. Early postpartum is a sensitive period for risk to transmit from one generation to the next, and early intervention could improve child outcomes. We need destigmatized approaches to alert new mothers about PTSD symptoms and get them directed to care early, when intervention can make the largest impact on them and their maternal-infant bonding.

The student will: 1) review literature 2) help to collect and manage data from a pilot cohort of postpartum women, and 3) leverage machine learning to identify potential predictors of PTSD.



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Project 14 - Summer 2026

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.

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Project 15 - Summer 2026

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

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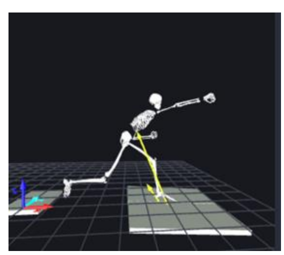
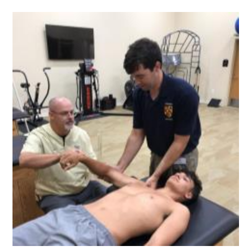
Project 16 - Summer 2026

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

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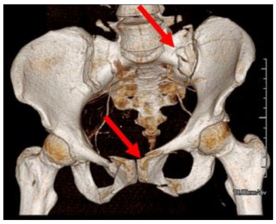
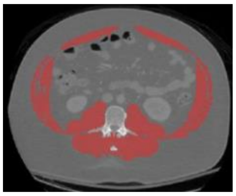
Project 17 - Summer 2026

Crash Injury Research and Engineering Network (CIREN)

CIREN is a research catalyst that can be used to conduct a wide range of motor vehicle trauma studies. It has been an ongoing project at WFUBMC since 2005.





The student will: 1) conduct detailed investigations of real-world motor vehicle crashes and determine mechanism and causation of occupant injuries to improve prevention, mitigation, and treatment of motor vehicle crashes, 2) collaborate and work closely with a broad range of medical specialties, including biomedical engineers, crash investigators, radiologists, orthopedic surgeons, and trauma surgeons, and 3) conduct finite element (FE) modeling reconstructions of CIREN crashes using the simplified GHBMC human body model of a simplified vehicle model providing kinematic visualizations and injury analyses to supplement our investigations.

Joel Stitzel, PhD

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Project 18 - Summer 2026

Head Impact Exposure Quantification and Mitigation in Motorsports

The Pilot testing of individualized mouthpiece deployment in motorsports involving injury risk assessment for the optimization of safety measures

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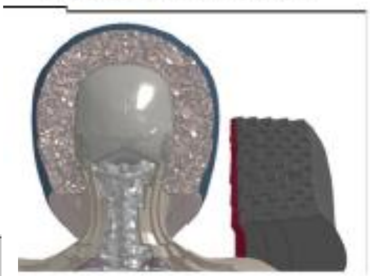
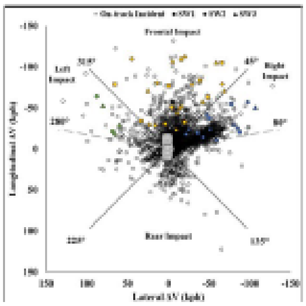
Driver FE Model

FE Simulation for Driver Safety Optimization



Example On-Track Impacts



The student will: 1) conduct analysis to quantify environmental and crash head kinematics, 2) utilize finite element (FE) modeling for injury risk assessment for drivers in crash scenarios, and, 3) FE simulation to optimize safety measures and driver comfort.

Joel Stitzel, PhD

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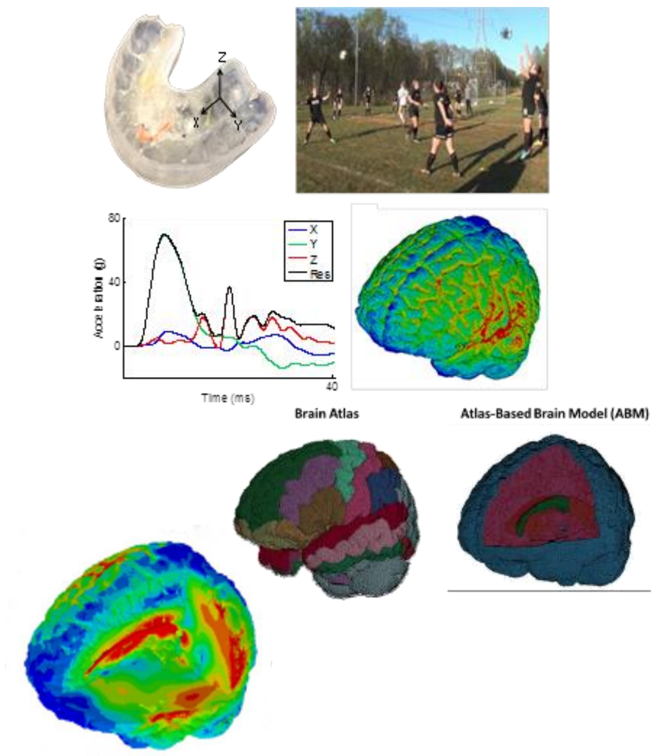
Project 19 - Summer 2026

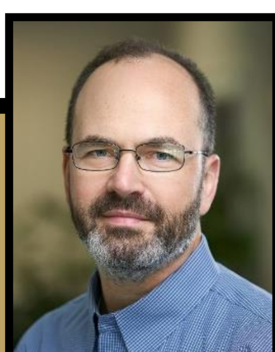
Subconcussive Head Impact Analysis using Instrumented Mouthpiece Data

Sensor technology offers researchers and consumers the ability to collect head impact data in the real-world; however, the accuracy of such sensors has been limited. This project involves development, testing, and field deployment of a novel instrumented mouthpiece in contact sports (e.g. football, gymnastics, soccer, hockey) and everyday activities (e.g. sitting, running).



The student will: 1) review literature on head kinematics in athletic and everyday activities, and 2) work on a project to evaluate kinematic data collected from the mouthpiece. The student will apply skills they learn in human subjects' research, experimental testing, data collection and processing, statistical analysis, and FE modeling with a brain model to derive conclusions and a better understanding of head kinematics and TBI risk in sports and everyday activities.

Joel Stitzel, PhD



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Project 20 - Summer 2026

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

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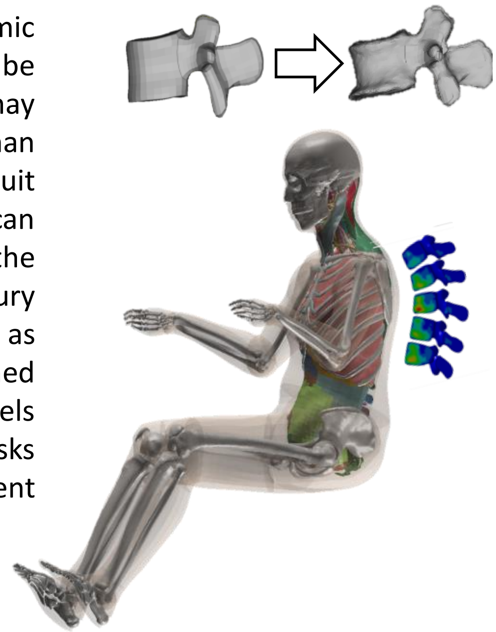
Project 21 - Summer 2026

Neck & Lumbar Spine Injury Risk Curve Development for Spaceflight Applications

Injury prediction and prevention in domains analogous to spaceflight dynamic events commonly rely on the use of anthropomorphic test devices (ATD), also known as crash test dummies. While ATDs have been effective in reducing injury in several domains, their use is limited in spaceflight as the dynamic events often involve the use of a seat or space suit that may not be compatible with the ATDs, and the dynamic events themselves may not be reproducible in a laboratory setting. Finite element human body models, on the other hand, can be outfitted with a space suit and fit into any seat design that may be used. These models can then predict the loads, accelerations, etc., of the body during the dynamic phases of flight. However, the acceptable level of injury risk in spaceflight is much lower than in analogous domains such as the automotive industry. There are currently no established thresholds for which loads on these human body models correspond to these lower levels of injury probability. These tasks seek to identify these thresholds, also known as injury assessment reference values (IARVs), for the neck and lumbar spine.



Karan Devane, PhD

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Ashley Weaver, PhD

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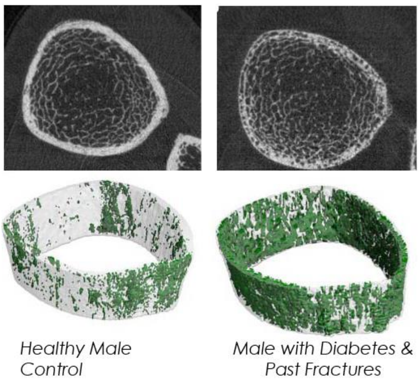
School of Medicine

Project 22 - Summer 2026

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.

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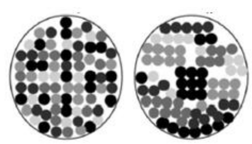
Project 23 - Summer 2026

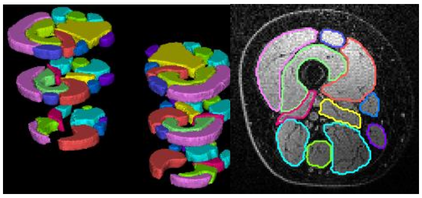
Muscle Quality/Radiomics Features and Muscle-Bone Crosstalk

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.

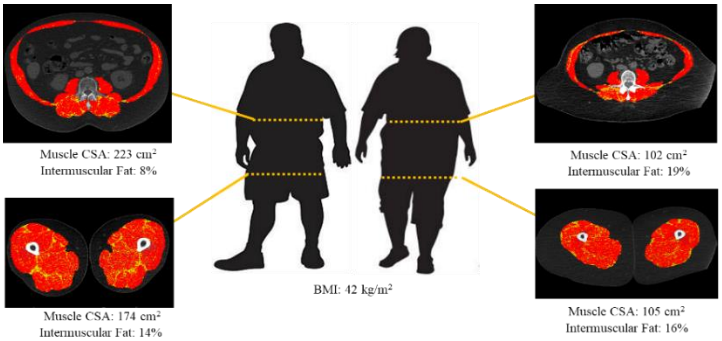
We also use automated radiomics analysis to extract high-dimensional muscle quality measures, such as uniformity, heterogeneity, randomness, and repetitive patterns from CT. These muscle properties can be correlated to bone mineral density and bone strength, which we derive from imaging. These analyses 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.

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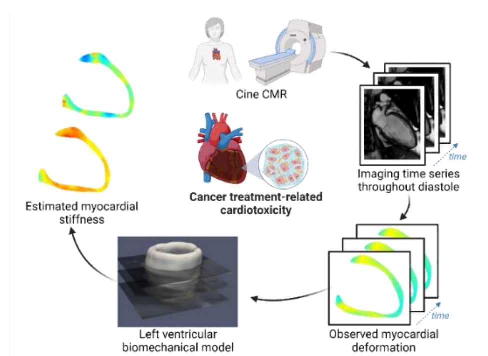
Project 24 - Summer 2026

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.

Jared Weis, PhD

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Wake Forest University School of Medicine

Project 25 - Summer 2026

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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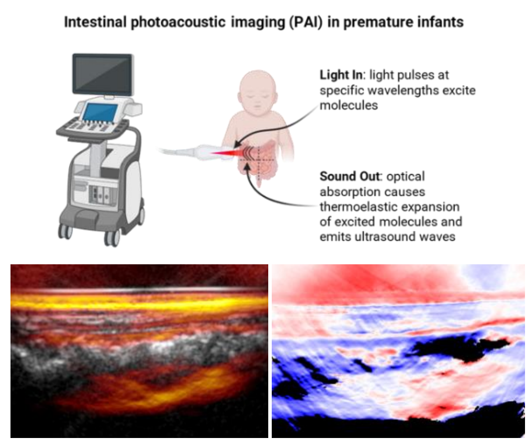
This project is a highly collaborative team science effort to advance a promising and translationally relevant diagnostic imaging tool with collaborators across the departments/sections of Biomedical Engineering, Regenerative Medicine, Neonatology, Pediatric Surgery, Pediatric Radiology, Comparative 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.



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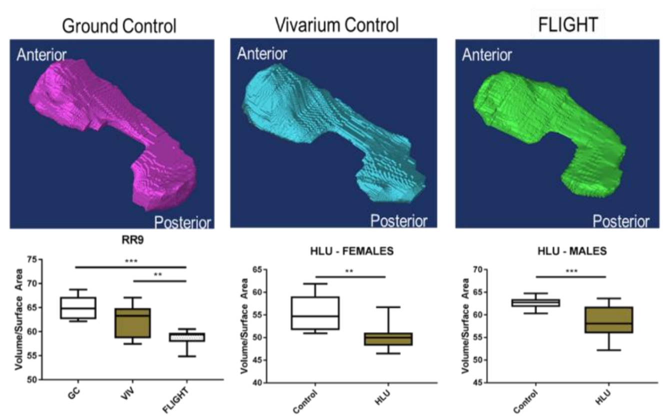
Project 26 - Summer 2026

The Mouse Housing Unit-8 Mission to the International Space Station: Prevention of Skeletal Complications

Loss of bone, cartilage, and muscle during periods of microgravity in space serves as a challenge to astronaut health during and after the mission. Our previous spaceflight data (from the International Space Station and Space Shuttle) identified damage to soft (cartilage, menisci) and hard (bone) joint tissues. Our group is again part of a team of investigators examining spaceflight affects on musculoskeletal health. Our team is examining if artificial gravity and/or spaceflight-relevant radiation exposure can protects against spaceflight environment-induced damage to bone and joint tissues.

This spaceflight mission for our REU team member involved sending mice to the International Space Station in March, 2023, and also that were exposed to spaceflight radiation at the NASA Space Radiation Lab. For the spaceflight study, we exposed the mice to continuous artificial gravity as via centrifugation aboard the ISS, as part of a joint study between NASA and the Japanese Space Agency. Mice received different gravitational levels, including near 0G, 0.67G, 0.33G (Martian), and 1G, to see if artificial gravity could project against skeletal damage. Likewise, rodents were exposed to spaceflight radiation and / or simulated microgravity.

The REU student will have the opportunity to perform skeletal-related analyses across tissues. We are interested in a team member who can help establish mechanical testing (e.g., using AFM or other approaches) to identify whether cartilage mechanics are altered during/after spaceflight, with/without artificial gravity, and/or after exposure to spaceflight radiation, although we can be flexible with engineering and biologic approaches.



**p<0.01; ***p<0.001

Jeffrey Willey, PhD

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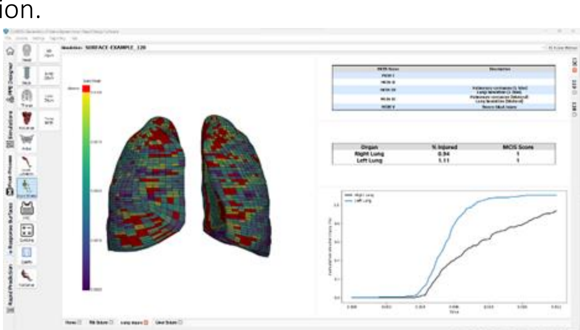
Project 27 - Summer 2026

Rapid Design and Optimization of Personal Protective Equipment to Mitigate Warfighter Injury Risk

Background: The modern United States warfighter is equipped with a sophisticated suite of personal protective equipment (PPE). However, the complexity of modern PPE and the variety of design criteria, certification requirements, and performance considerations require a labor intensive and experimentally demanding design process. Adding to these difficulties are the lack of suitable and accessible human surrogates for translating the effectiveness of PPE in testing to prediction of real-world performance for military personnel in theater. Advanced digital engineering tools are poised to fill gaps in the current PPE design process and facilitate both expedited and more comprehensive design analyses. One key tool available in the digital design space to serve this purpose is the computational Finite Element (FE) Human Body Model (HBM). Another key tool is probabilistic methodologies to facilitate uncertainty quantification and optimization. The objective of this project is to develop a digital design tool capable of rapid design exploration of PPE through the coupling of state-of-the-art HBMs with advanced probabilistic and optimization techniques. The proposed software solution will provide manufacturers with a tool to accelerate the PPE design cycle while also making performance more focused on relevant real world injury reduction.



Student Activities: The student will gain experience in…

- Developing desktop applications, including interactive 3D visualizations of human body models and PPE designs
- Post-processing finite element simulations of human body models and calculating relevant biomechanical metrics for injury risk analysis
- Utilizing machine learning models and optimization algorithms for real world PPE applications

Location: Elemance

Tanner Filben, PhD

Research Engineer
Elemance, LLC
Winston-Salem, NC

Zach Hostetler, PhD

Senior Engineer
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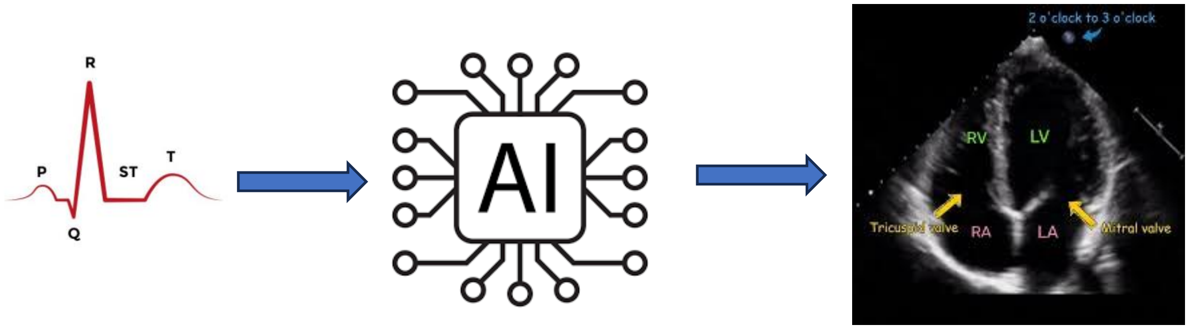
CAIR
CENTER FOR ARTIFICIAL INTELLIGENCE RESEARCH

Project 28 - Summer 2026

Medical Image Generation from Physiological Signals

Medical imaging modalities, such as echocardiogram, computed tomography, or cardiac magnetic resonance, typically forms the gold standard diagnostics for most cardiovascular diseases. However, such images are associated with high cost and low accessibility limiting their utility in cardiovascular diseases screening purposes. On the other hand, electrocardiogram is significantly more frequently recorded and widely accessible, yet, it is not satisfactory for gold standard diagnosis of most diseases. Hence, there is a need for artificial intelligence tools to convert information in ECG signals into rich information gathered from these cardiac imaging modalities.



This research effort will be in the Department of Cardiovascular Medicine and the Center for Artificial Intelligence. The intern will be provided with data and computational resources to develop AI models that can 1) estimate imaging parameters from ECG and 2) to construct images from ECG signals.

Oguz Akbilgic, PhD

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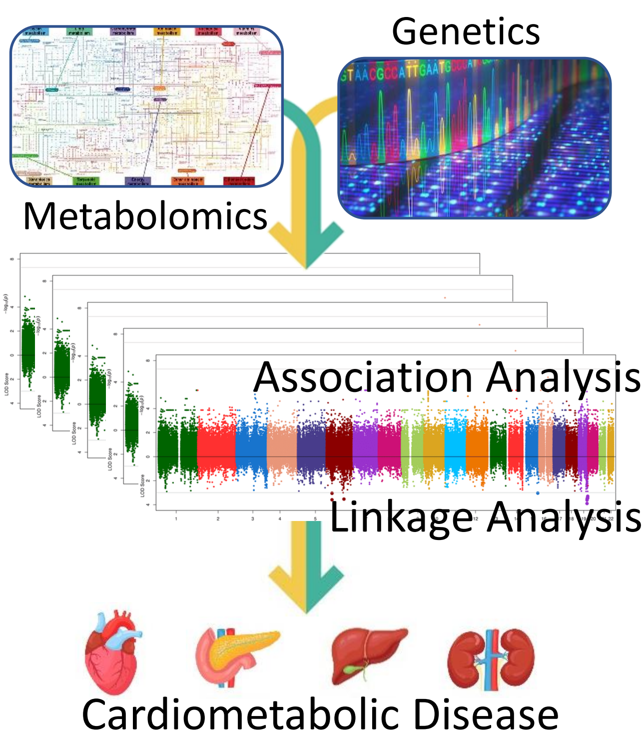
Project 29 - Summer 2026

Investigating the Genetic Architecture of the Metabolome to Provide Insight into Cardiometabolic Disease Risk

Metabolomic profiles are highly informative of an individual's functional state and capture the interaction of cellular processes and environmental exposures to promote disease. High-throughput profiling has implicated multiple metabolites in cardiometabolic disease risk, e.g. type 2 diabetes (T2D) and obesity. Minority populations experience a disproportionate burden of cardiometabolic disease; however, studies in these populations have been few in number and limited in scope.



Goal: Provide a comprehensive survey of the genetic architecture of untargeted metabolomics data. Data include 1274 plasma metabolites with genetic data drawn from genome-wide array, whole exome sequencing and whole genome sequencing. Methods to be incorporated include family-based linkage analysis and variance components models to test for association.

Expectation: The student working on this project will be trained on the implementation of statistical analysis packages relevant for linkage, association and plotting of results. Results will be contextualized using the relevant literature for implication in cardiometabolic disease states. Students interested in genetics, statistics and cardiometabolic disease should consider applying.

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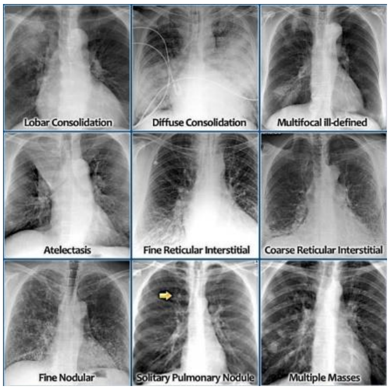
Project 30 - Summer 2026

Anomaly Detection in Lung X-rays

The timely and accurate diagnosis of lung abnormalities from chest X-rays is a critical factor in patient outcomes. Chest X-rays are one of the most common diagnostic imaging tests, capable of revealing a wide range of conditions including cancer, pneumonia, and collapsed lungs. However, the interpretation of these images can be challenging and subject to human error, with missed lung nodules being a predominant cause of malpractice claims in chest imaging.



Deep learning has emerged as a powerful tool in medical image analysis, with the potential to improve the accuracy and efficiency of diagnoses. This project aims to develop a robust and interpretable deep learning framework to automatically detect and classify various anomalies in chest X-ray images. By automating this detection process, we can create a low-cost, scalable tool to assist radiologists, prioritize urgent cases, and ultimately improve patient care.

Learning Objectives:

Gain hands-on experience with deep learning for medical image analysis.

Learn and apply computer vision techniques on lung pathologies.

Work with large-scale, real-world chest X-ray datasets and address challenges such as class imbalance and data variability.

Develop skills in model validation and interpretation in a clinical context.

Expectation: Good programming skills in python, familiarity with PyTorch and basic knowledge of Machine learning/Deep learning.

Metin Gurcan, Ph.D.

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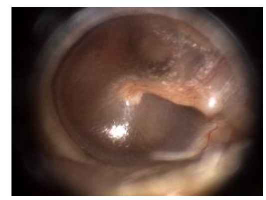
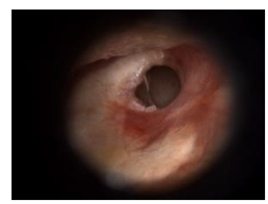
Project 31 - Summer 2026

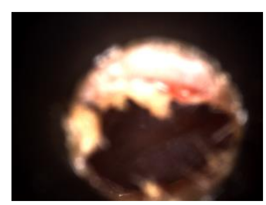
Otoscopy Assistant Diagnosis System with Integrated Classification and Out-of-Distribution Detection

Ear diseases are highly prevalent worldwide and often require expert evaluation of otoscopic images and videos for accurate diagnosis. However, variations in image quality, patient anatomy, and disease presentation make automated analysis challenging. This project focuses on developing an advanced assistant diagnostic system for otoscopy by combining disease classification with out-of-distribution (OOD) detection.

The classification component aims to train state-of-the-art deep learning models to accurately identify common otologic conditions such as effusion, perforation, and infection. Simultaneously, the OOD detection module will identify samples that fall outside the distribution of the training dataset, such as images of rare diseases, poor-quality frames, or ambiguous cases that are difficult even for clinicians to diagnose. This dual approach ensures that the system can not only provide reliable predictions for known conditions but also flag uncertain or novel cases for further expert review, thereby increasing safety and trustworthiness in clinical applications.


Normal


Perforation


Low quality (normal)

Learning Objectives:
Gain hands-on experience with deep learning for medical image and video analysis. Learn techniques for out-of-distribution detection, uncertainty quantification, and trustworthy AI. Work with real-world otoscopy datasets and experience challenges such as image quality variability and dataset imbalance.
Expectation: Good programming skills in python, familiarity with PyTorch or TensorFlow and basic knowledge of Machine learning.

Metin Gurcan, Ph.D.

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Wake Forest University
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CAIR
CENTER FOR ARTIFICIAL INTELLIGENCE RESEARCH

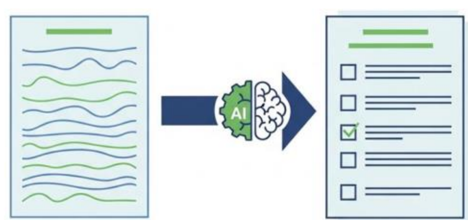
Project 32 - Summer 2026

Structuring and Standardizing Patient Discharge Notes

Patient discharge summaries and notes often vary depending on the hospital, region, and the individual physician's documentation style. These differences can make it difficult to quickly capture key information when a patient is transferred to another department or hospital. This project aims to create a more systematic, standardized structure for patient notes to ensure critical information is easier to find and interpret across different settings.

Significance

Inconsistent documentation formats across hospitals and regions can lead to missed critical information, delayed care, and unnecessary repetition of tests. By standardizing the structure of discharge and anamnesis notes, this project will improve continuity of care, prevent oversight of life-saving details, and make patient follow-up more systematic and efficient.



Learning Objectives:

To develop and validate a Natural Language Processing (NLP) model capable of accurately identifying and extracting key clinical entities from unstructured, free-text discharge notes. These entities include diagnoses, medications, procedures, allergies, lab results, and follow-up plans To evaluate the effectiveness of the AI-generated standardized notes by measuring reductions in documentation time for physicians and improvements in information retrieval accuracy by receiving clinicians. To assess the impact of the standardized notes on patient safety metrics, such as medication errors and hospital readmission rates.

Expectation: Good programming skills in python, familiarity with PyTorch and basic knowledge of Machine learning/Deep learning.

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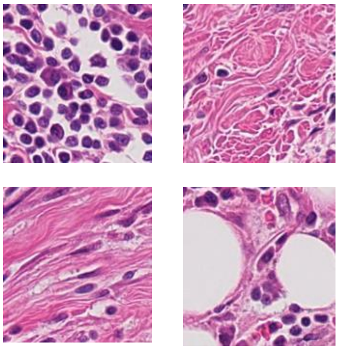
Project 33 - Summer 2026

Predicting Breast Cancer Recurrence From H&E-Stained Whole Slide Images

The risk of disease recurrence is a critical factor in determining the course of treatment for breast cancer patients. While genomic assays like Oncotype DX provide recurrence risk scores, they are expensive and not universally available. Histopathological examination of H&E-stained tissue slides remains the cornerstone of diagnosis, and these images contain a wealth of morphological information that correlates with tumor aggression and, ultimately, recurrence risk.

However, a pathologist's visual assessment of recurrence risk is inherently subjective and based on integrating a complex set of features like tumor grade, mitotic activity, and the nature of the tumor-immune interface. This project aims to develop a robust and interpretable deep learning framework to objectively predict breast cancer recurrence directly from standard H&E-stained Whole Slide Images (WSIs). By automating this prediction, we can create a low-cost, scalable tool to augment clinical decision-making and better stratify patients.



Breast WSI Tiles

Learning Objectives:
Gain hands-on experience with deep learning for medical image analysis. Learn techniques for object detection, segmentation, and multi-instance learning. Work with real-world histopathology datasets and experience challenges such as image stain variability and dataset imbalance.

Expectation: Good programming skills in python, familiarity with PyTorch and basic knowledge of Machine learning/Deep learning.

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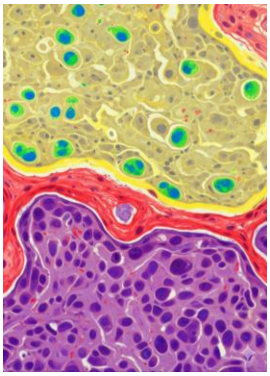
Project 34 - Summer 2026

Nuclei and Tissue Segmentation in Whole Slide Histology Images

Pathology slides contain a wealth of information that is essential for accurate diagnosis. This project focuses on developing a model that can automatically detect whether a slide contains pathological findings, even spotting abnormalities that the human eye might miss. In places where pathologists are not available, diagnosis can be delayed, which affects treatment decisions and patient outcomes. This project aims to support healthcare teams by providing a reliable, AI-powered screening tool that speeds up the process and helps ensure no critical findings are overlooked.



Our Approach:
We will use a dataset of H&E-stained Whole Slide Images (WSIs) and apply deep learning based segmentation algorithms to identify nuclei and tissue regions. These segmented regions will then be analyzed with classification models to determine whether the slide shows any pathological features.

Learning Objectives: Key learning objectives include implementing segmentation models to identify nuclei and tissue regions and developing classification models to detect pathological features. The primary expectation is to build, train, and quantitatively evaluate a complete AI pipeline for automated slide analysis, culminating in a functional and well-documented system.

Expectation: The participant is expected to gain hands-on experience in digital pathology by applying deep learning algorithms to H&E-stained Whole Slide Images (WSIs).

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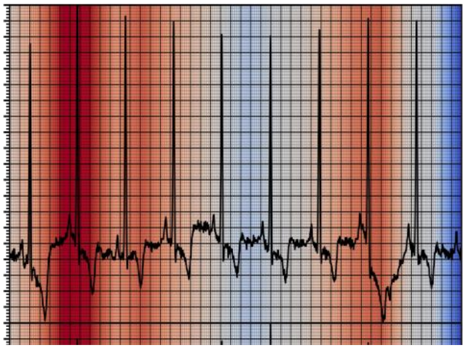
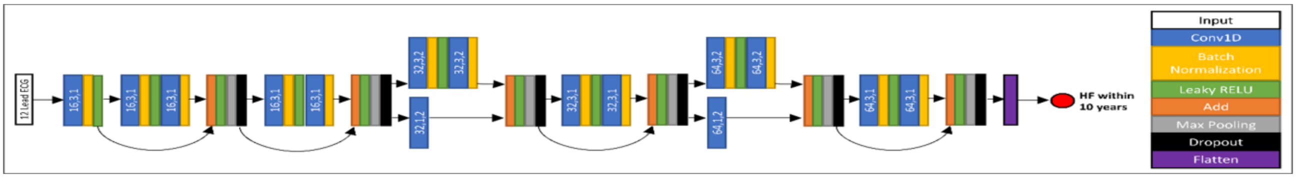
Project 35 - Summer 2026

Novel Deep learning Algorithms and Explainable AI on ECG



Background: In Deep Learning (DL), there are various types of layers that are specialized for specific tasks. For example, the convolutional layers slides over the input (image or its representation) spatially to extract features. However, there is still a gap in the literature to design a DL layer for ECG specific. And the black-box side of the DL is still an open-research area, specifically for ECG based models.

Goal: The goal of this project is to build ECG inputted novel DL algorithms (layers, activation functions, or architecture based) for prediction/classification of cardiovascular diseases. And the other goal is to uncover the black-box side of ECG fed DL models by spatial perspectives of the input data (ECG).



Expectation: The student in this project will is expected to have Python programming skill and work on 1) building novel DL algorithms fed by ECG 2) design infrastructure to uncover the black-box of ECG fed DL models, 3) compare results with state-of-the art algorithms

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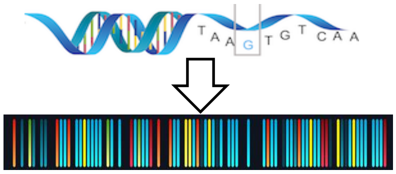
Project 36 - Summer 2026

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

Background: 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.

Goal: The goal of this project is to 1) develop novel NLP-based deep learning models on genomic data to predict the composite risk for multiple diseases.



Expectation: 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.

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Project 37 - Summer 2026

Multimodal System for Early Identification of Cardiovascular Diseases

Cardiovascular diseases (CVDs) are the leading cause of death globally. Many forms of CVDs are progressive and develop over time. Early identification and guided treatment may assist to manage the disease and reduce the burden. In this project, we will collect data from patients and analyze data to identify early signs of CVDs. We will develop a multimodal system to record different signals such as temperature, blood pressure and ECGs from patients and healthy subjects. We will analyze data to find abnormalities associated with CVDs.

The student will: 1) review literature on vital signs analysis, 2) develop a multimodal system, 3) collect data from patients and healthy subject, and 4) analyze data to find abnormalities.

Background in electronic circuits, statistical analysis and hands-on-experience with electronic equipment will be essential for this project.

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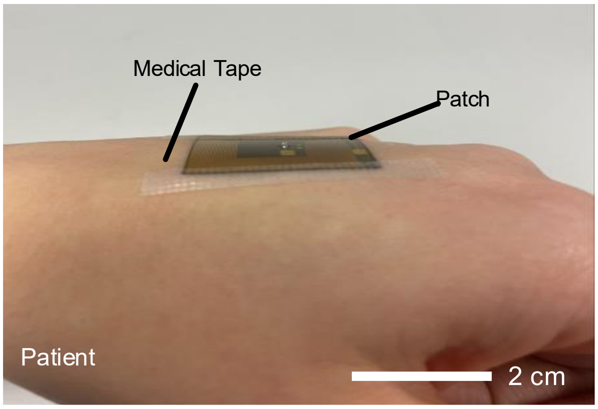
Project 38 - Summer 2026

Wearable Flexible Patch for Early Identification of Melanoma

Melanoma is the most malicious type of skin cancer, and the incidence was on rise in the last decades. In the United States alone, 97,610 new cases of melanoma were diagnosed in 2023, and mortality rate was 7,9901. Melanoma may leave marks on skin and cause cosmetic issues for the patients. As the tumor grows, melanoma may metastasize and result in death. Early identification and timely management increase the chance of successful treatment and reduce the burden. In this project, we will develop a wearable patch that can be used by individuals out of clinical setting to evaluate the risk of melanoma on decolored parts of skin and lesions.

The student will: 1) review literature on melanoma detection, 2) optimize the flexible patch, 3) collect data from lesions, and 4) analyze data from benign and malignant tumors.

Background in electronic circuits, statistical analysis and hands-on-experience with electronic equipment will be essential for this project.



Wearable patch placed on a lesions

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Project 39 - Summer 2026

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.

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Project 40 - Summer 2026

Genetic Analysis of Machine Learning-Based Rate of Aging Metrics

Understanding the difference between biological aging and chronological aging is at the crux of geroscience and our ability to target interventions that reduce disease and improve quality of life for older adults. This project is developing rate of aging (RoA) metrics using machine learning and AI-based tools across a range of non-human primate (NHP) species based on routinely collected clinical data. We will use these RoA to identify shared and species-specific patterns of biological aging across 15,000 NHPs to test if longer lifespans within and between species are associated with increased physiological disruption later in life and a slower pace of biological aging. We will then identify genetic variants that differentiate exceptionally fast and slow agers to characterize pathways mediating health and lifespan differences within and between species. This will leverage existing sequence data in >3,000 NHPs to identify rare and common genetic variants associated with lifespan, healthspan, and pace of aging within species. This data will be used to identify the underlying biology driving differences in longevity within and between species which will highlight biological pathways for potential interventions in human patients.

The student will gain experience in training and fine-tuning neural network algorithms, handling large-scale datasets, and performing genetic and bioinformatics analyses. They will also learn how to perform phylogenetic analyses across non-human primate species to interpret the evolution of longevity in humans and the translational potential of non-human primate data.

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Project 41 - Summer 2026

Multi-Modal Fusion of Histopathology and Omics Data for Precision Cancer Diagnosis

The goal of this project is to enhance cancer diagnosis by integrating histopathology images and multi-omics molecular data, which are publicly available from datasets such as The Cancer Genome Atlas (TCGA). This project will guide students through the process of analyzing these large and diverse datasets. Initially, the project will address the processing of gigapixel-sized whole slide images (WSIs), which are essential for assessing the morphological characteristics of cancerous tissues. Due to their enormity and complexity, WSIs cannot be analyzed in their entirety efficiently. Instead, they will be broken down into smaller, manageable sections known as patches. Each patch will be encoded as a vector, creating a matrix where each column represents the embedding for a patch, and the entire matrix encapsulates the comprehensive information of the WSI. To manage and interpret this vast amount of data effectively, linear algebra tools such as various matrix decompositions will be employed to reduce the dimensionality of these matrices. Alongside the imaging data, molecular data from multi-omics sources provides deep insights into the genetic and molecular bases of cancer. This data includes detailed genomic, transcriptomic, and proteomic information that, when analyzed in conjunction with WSIs, can reveal comprehensive insights into the biological behavior of tumors. The project will explore how the integration of these two distinct data modalities can significantly transform patient diagnosis and treatment planning by providing a more nuanced understanding of the disease.

Learning Objectives: Through this project, students will not only develop technical skills in handling and analyzing large-scale datasets using Python and its associated libraries but also deepen their understanding of the statistical challenges in data integration. The knowledge of linear algebra will be applied to real-world scenarios, enhancing the students' ability to manage and interpret complex datasets.

Prerequisites: Students interested in participating in this project should have a basic understanding of statistics and linear algebra. Additionally, proficiency in Python is important for successfully completing the project tasks.

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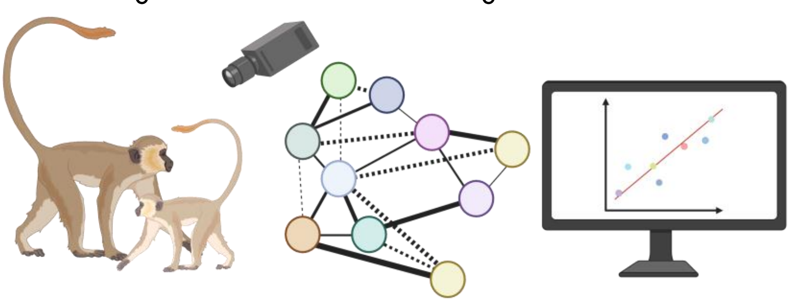
Project 42 - Summer 2026

Computer Vision Analysis of Maternal Behavior in Vervet Monkeys for Understanding Early Life Microbiome Transmission

Vervet monkeys serve as an excellent model system for studying maternal investment and microbiome transmission due to their complex social behaviors, diverse microbiomes, and developmental patterns that are similar to human. Traditional manual coding methods for quantifying maternal behaviors are time-intensive and subjective. The goal of this project is to develop an automated computer vision pipeline to analyze video recordings of vervet monkey mothers with their infants, quantifying maternal care behaviors and correlating these patterns with microbiome transmission data. This will provide insights into how specific maternal behaviors influence the establishment of the gut microbiome in early life.

The student will gain hands-on experience with computer vision techniques including object detection, tracking algorithms, and pose estimation. They will learn to work with large video datasets, develop skills in deep learning framework implementation and better understand the intersection of computational biology and animal behavior research. The student will also develop experience in data analysis and statistical methods for correlating behavioral and microbiological datasets.



The student will:

1) Review literature on computer vision applications in animal behavior analysis
2) Develop and train deep learning models for automated detection and tracking of vervet monkeys in video footage
3) Implement behavioral classification algorithms to identify and quantify specific infant care associated behaviors
4) Analyze correlations between automated behavioral measurements and microbiome data to identify key behaviors shaping microbial transmission

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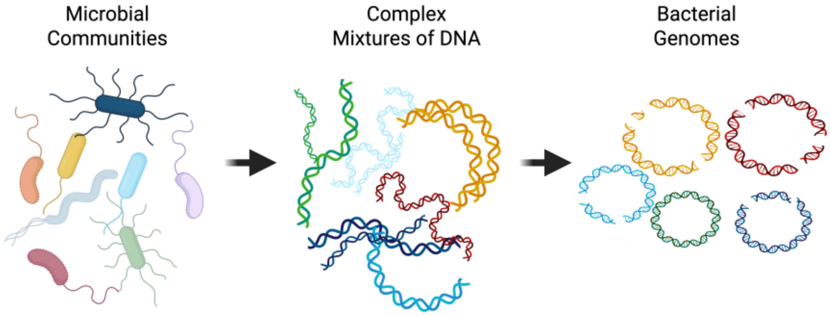
Project 43 - Summer 2026

AI-Enabled Metagenomic Binning: Integrating Long-Read and Short-Read Data for Improved Microbial Genome Reconstruction

Metagenomic sequencing allows researchers to study entire microbial communities directly from environmental samples, providing insights into microbial diversity, function, and interactions. A critical step in metagenomics analysis is "binning" - the process of grouping DNA sequences that originate from the same microbial species to reconstruct individual genomes from complex mixtures. The goal of this project is to develop novel AI-based approaches that integrate long-read sequencing data with short-read assemblies to improve the accuracy and completeness of metagenomic binning.

The student will gain experience with bioinformatics data processing, including handling large-scale sequencing datasets. They will develop skills in advanced machine learning techniques, particularly in multi-modal data integration and graph-based neural networks. The project provides exposure to metagenomics analysis pipelines and microbial genomics concepts, as well as experience in method development and computational benchmarking.



The student will:
1) Review literature on current metagenomic binning methods and hybrid sequencing approaches
2) Develop and implement machine learning models that can integrate long-read and short-read data features
3) Design training and validation frameworks using existing metagenomic datasets with known ground truth
4) Benchmark the new hybrid approach against existing state-of-the-art binning tools to demonstrate performance improvements.

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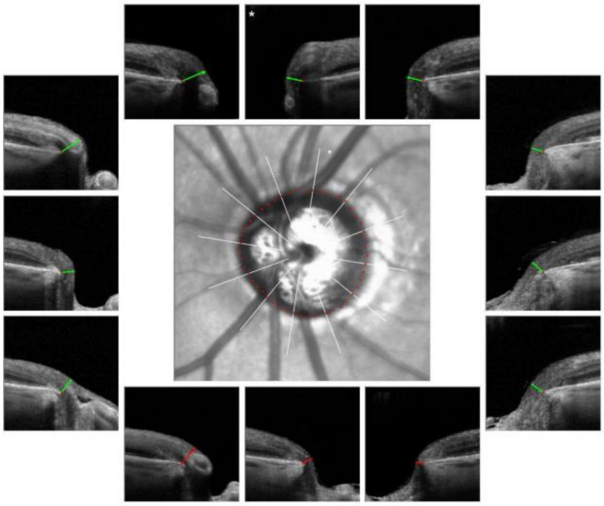
Project 44 - Summer 2026

Exploring Vision and Mobility in BNET-EYE

Older adults with poor vision are at higher risk for falls and mobility disability, but the mechanisms linking different aspects of visual function to these adverse outcomes are not well-understood. Moreover, whether microstructural differences in the retina or optic nerve may explain relationships between visual and physical function is not known. In the Brain Network and Mobility (BNET)-EYE study, we are measuring performance on the expanded short physical performance battery (eSPPB) and have collected a portfolio of traditional and novel visual function metrics as well as microstructural anatomy of the optic nerve and retina using optical coherence tomography/angiography (OCT/A) in older and younger adults.

In this project, the student will 1) learn about different tests of visual function and 2) learn to analyze OCT/A microstructural ophthalmic imaging to quantify different anatomical structures in the retina and optic nerve. This microstructural data will allow novel exploration of the relationship between visual function, ophthalmic microstructure, and physical function.



The student will develop a hypothesis-driven investigation to analyze whether a specific visual function metric is associated with mobility performance on the eSPPB, and whether ophthalmic microstructural differences may explain this relationship.

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