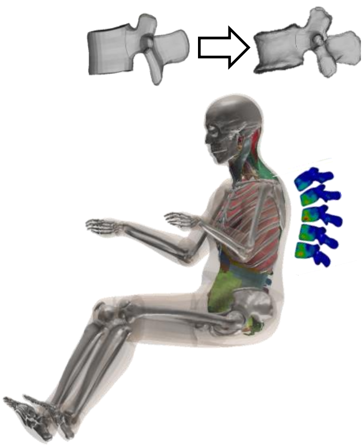
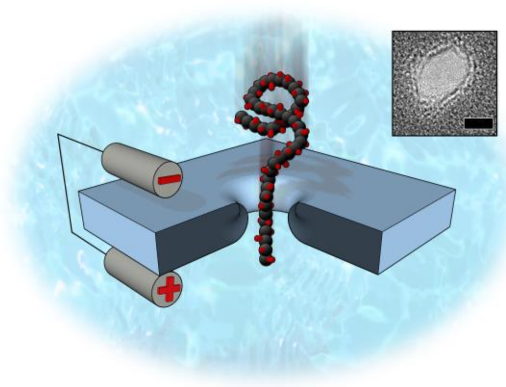
Wake Forest University School of Medicine

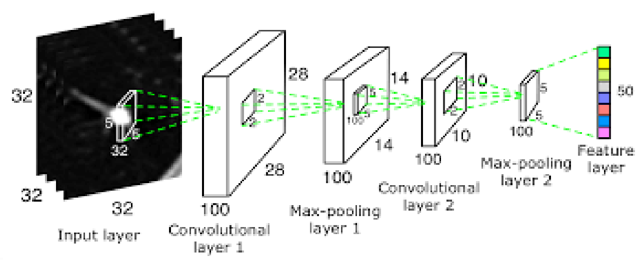
2024 Project Descriptions

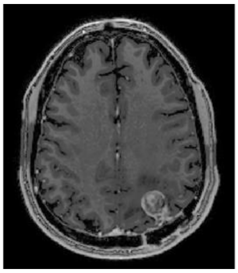
Summer Research Internship Program

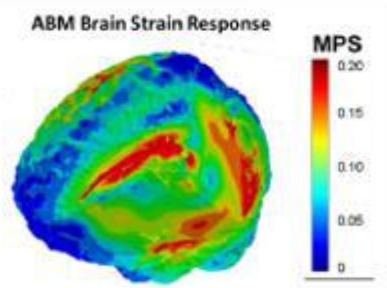
Undergraduate & Master's Level Graduate Students











40+ Projects in Biomedical Engineering & Biomedical Informatics

2024 Project Descriptions

Proj.	Advisor	Research Project Title	BME	Informatics
1	Beavers & Weaver	Intervening to Mitigate Weight Loss Associated Bone Loss	✓	
2	Brown	In-Situ Minimally Invasive Surgical Robotic Bioprinting	✓	
3	Brown	Mechanically Matched Patient Specific Bone Surrogates	✓	
4	Brown	Full Field Spinal Characterization Methodology Development	✓	
5	Gayzik	Human Body Model Development for Trauma Research	✓	
6	Gayzik	Standardizing Methods for Virtual Assessment in Human Body Models	✓	
7	Gayzik	Physics-based Finite Element Analysis for Injury Criteria Using Human Surrogates	✓	
8	Gayzik	Development of Signal Analysis Tools for a National Crash Database	✓	
9	Gayzik	Instrumented Human Surrogate for Blast and Ballistic PPE Testing	✓	
10	Hall	Molecular Detection and Analysis of Trauma Bioindicators	✓	
11	Lipford	Neuro Image Processing and Analysis	✓	✓
12	R. McGinnis	Balance and Mobility Phenotypes of Fall Risk in Persons with Multiple Sclerosis	✓	✓
13	R. McGinnis & E. 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	Nicholson	Understanding Pitching Efficiency	✓	
17	Stitzel	Crash Injury Research and Engineering Network [CIREN]	✓	✓
18	Stitzel	Head Impact Exposure Quantification and Mitigation in Motorsports	✓	✓
19	Stitzel	Subconcussive Head Impact Analysis using Instrumented Mouthpiece Data	✓	✓
20	Urban	Evidence-Based Intervention for Improved Head Impact Safety in Youth Sports	✓	
21	Weaver	Vertebral Strength and Injury Risk Following Long-Duration Spaceflight	✓	
22	Weaver	High-Resolution Peripheral Quantitative Computed Tomography (HR-pQCT) Scanning in Clinical Trial Interventions	✓	✓
23	Weaver	Muscle Quality/Radiomics Features and Muscle-Bone Crosstalk	✓	✓
24	Weaver	Vulnerable Road User In-Depth Crash Investigation Study (VICIS): Pedestrian Injury and Causation Assessment	✓	
25	Weis	Image-based Biophysical Modeling to Differentiate Radiation-induced Injury from Tumor Recurrence Following Stereotactic Radiosurgery	✓	✓
26	Weis	Spatial histopathological image analysis of gastrointestinal tissue	✓	✓
27	Willey	Translational Studies to Improve Lung Cancer Treatment Outcomes	✓	
28	Zhao	Biomedical imaging of the brain tumor microenvironment	✓	✓

2024 Project Descriptions

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29	Allred	Investigating the Genetic Architecture of the Metabolome to Provide Insight into Cardiometabolic Disease Risk		✓
30	Downs	CHICA Decision Support Development		✓
31	Gurcan	Developing Artificial Intelligence to Detect Ear Infections		✓
32	Gurcan	Machine Learning Methods for Maternal Health		✓
33	Niazi	Improving Colorectal Cancer Prognosis through Artificial Intelligence		✓
34	Ma & Horvath	Language-based AI Model on genomic data to predict multimorbidity		✓
35	Ostasiewski	Digital Fingerprinting		✓
36	Ostasiewski	Data-Driven Strategies for Trial Recruitment		✓
37	Ostasiewski	Standards Mapping and Interoperability		✓
38	Speiser & Bullock	Professional North American Sport Data Scraping		✓
39	Speiser & Jaeger	Standardized, HArmonized REpository of longitudinal aging data (SHARE data)		✓
40	Speiser & O'Connell	Cross validation methods for prediction modeling of small and imbalanced data		✓
41	Thompson	Exploring Vision and Mobility in BNET-EYE		✓
42	Quillen	Admixture Mapping of Genes Related to Tanning Response		✓
43	Karabayir	Novel Deep learning Algorithms and Explainable AI on ECG		✓
44	Akbilgic	Deep Survival Learning for Signal Type Data		✓
45	Movaghar	AI-Assisted Pre-screening for Fragile X Syndrome		✓
46	Movaghar	Health Characteristics of Patients with Profound Autism		✓
47	Ma	Identify neuroimaging-based Alzheimer's subtypes using machine-learning-based data-driven approaches		✓

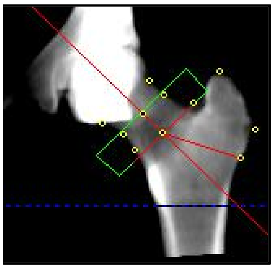
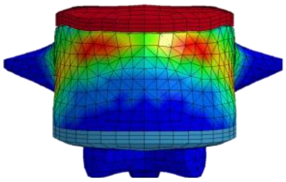
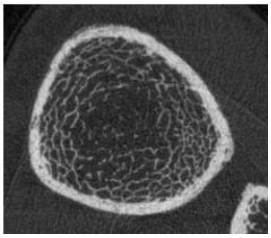
Wake Forest University School of Medicine

Project 1 - Summer 2024

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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Kristen Beavers, PhD

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wakeforestinnovations.com/experts/ashley-weaver-phd/

http://hes.wfu.edu/beavers.htm

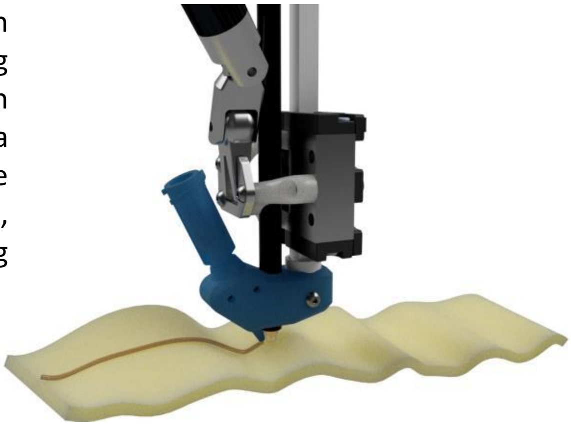
Wake Forest University
School of Medicine

Project 2 - Summer 2024

In-Situ Minimally Invasive Surgical Robotic Bioprinting

In-situ bioprinting has been performed with robotic arms and gantry systems in open surgery, however few systems have attempted minimally invasive approach constraints. There are several technical hurdles to overcome to print on in-situ soft tissue during surgery. Extrusion bioprinting is very sensitive to tool head height from the substrate and extrusion rate. Relatively small inconsistencies in tool height and extrusion rate can result in large boluses of material and/or the bioink missing adhering to the substrate of the printed construct. Additionally, soft tissue can deform on a macro and micro scale due to blood circulation, breathing, and random movement like peristalsis and muscular contraction.

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 will modify a robotic surgical tools with magnetic position sensing, optical distance sensing, and a lightweight high speed micro linear actuator to compensate for errors in the robotic control, texture of the tissue substrate, and low frequency motion of the tissue surface during printing.



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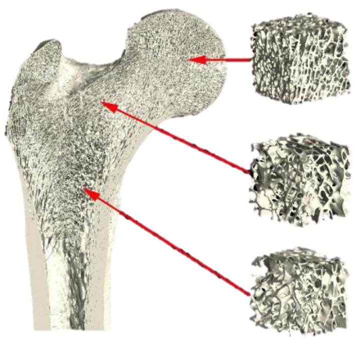
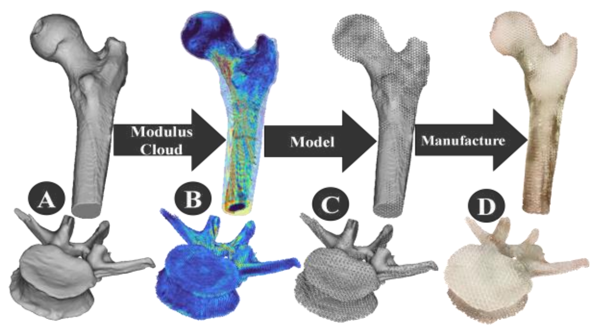
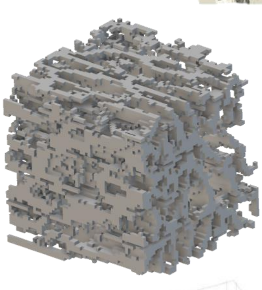
Project 3 - Summer 2024

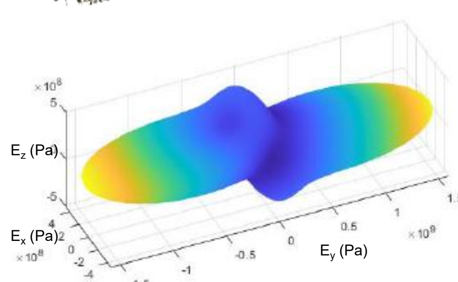
Mechanically Matched Patient Specific Bone Surrogates

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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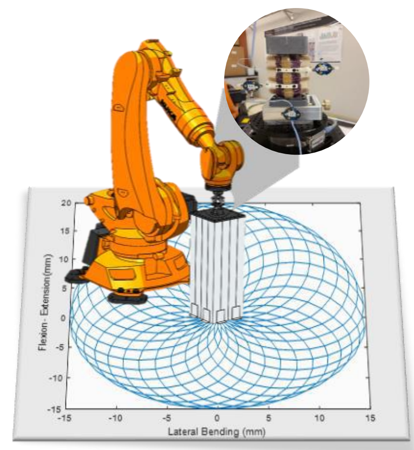
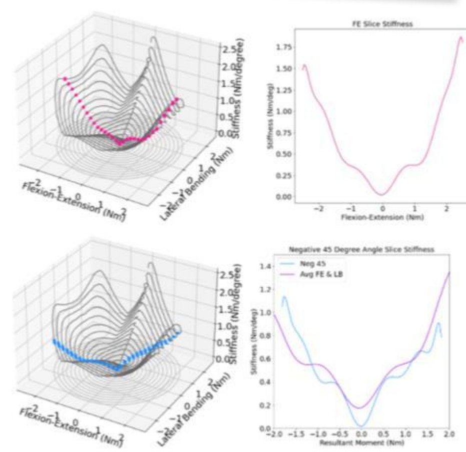
Project 4 - Summer 2024

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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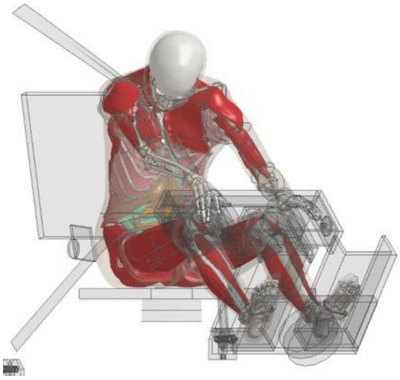
Project 5 - Summer 2024

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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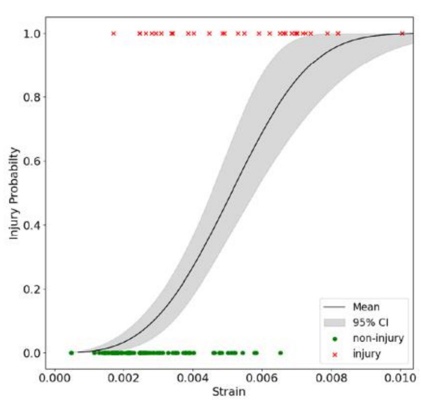
Project 6 - Summer 2024

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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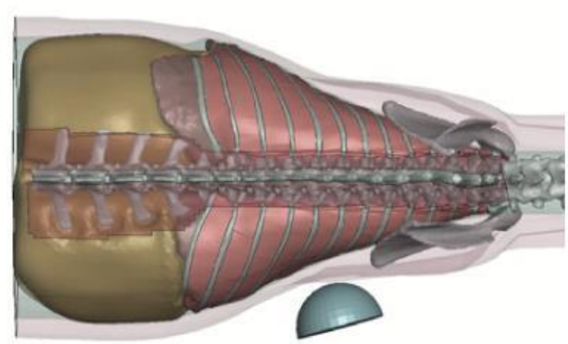
Project 7 - Summer 2024

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 8 - Summer 2024

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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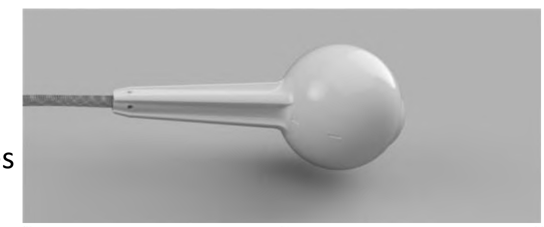
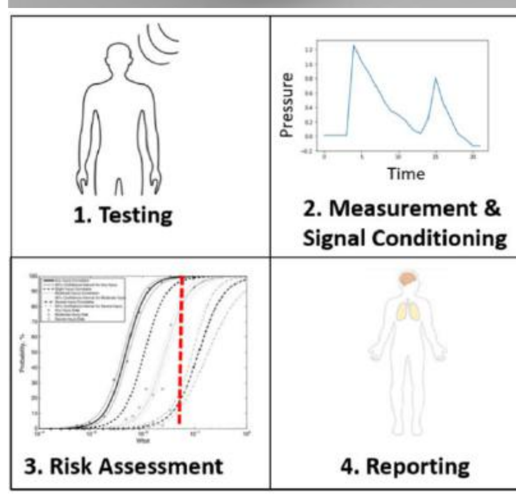
Project 9 - Summer 2024

Instrumented Human Surrogate for Blast and Ballistic PPE Testing

Injury from primary and secondary blast continues to be a major source of morbidity and mortality for the modern warfighter. The WFU CIB will support the design, fabrication and testing of a low-cost and efficient human surrogate for field-based blast and ballistic PPE testing. The model will be based on human anatomy and team members will gain valuable experience in the development of injury risk assessment methods based on computational modeling and physical testing. Knowledge of signal analysis, finite element analysis, physical and computational modeling as well as device fabrication will be gained through work on this project. Travel opportunities for off-site physical testing are included. Join this exciting project to gain real-world and broad experience in all relevant aspects of contemporary biomechanics.





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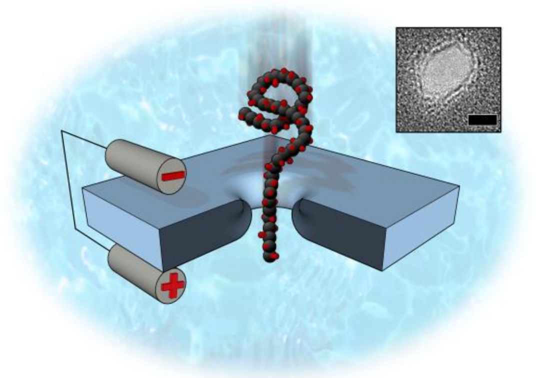
Project 10 - Summer 2024

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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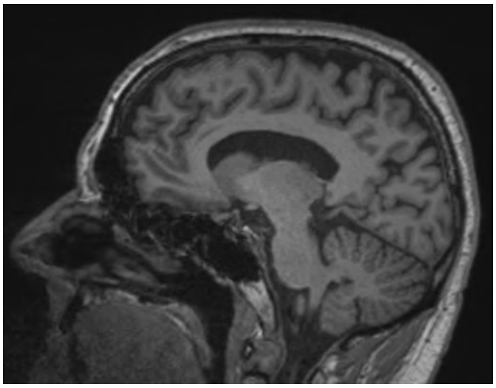
Project 11 - Summer 2024

Neuro Image Processing and Analysis

Acquisition of MRI images of the brain is just the beginning of the process of using neuro MRI images for research. Subsequent steps include normalization to brain templates and atlases, segmentation by tissue type, and tissue volume estimations. There is also a wide array of other MRI modalities such as diffusion tensor imaging (DTI), functional MRI, susceptibility weighted imaging (SWI), and perfusion imaging with arterial spin labeling (ASL). A multitude of metrics can be extracted from each of these modalities. The student will learn the basics of each of these modalities, and then focus in on one modality in order to perform advanced analysis. There are several neuro imaging dataset available for analysis including application in sports-related head impact exposure in youth athletes, older adults at risk for and with dementia, Parkinson's disease patients, and non-human primates.

The student will: 1) be trained in multimodal imaging acquisition and analysis (structural MRI, DTI, functional MRI, SWI, ASL). 2) Review literature on the neuro MRI results in the application of choice. 3) Develop a hypothesis-driven project to correlate neuroimaging measures with applicable meta data including demographics, metabolic data, cognitive data, clinical measurements, and functional assessments, as available in each project dataset.



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Megan E. Lipford, PhD

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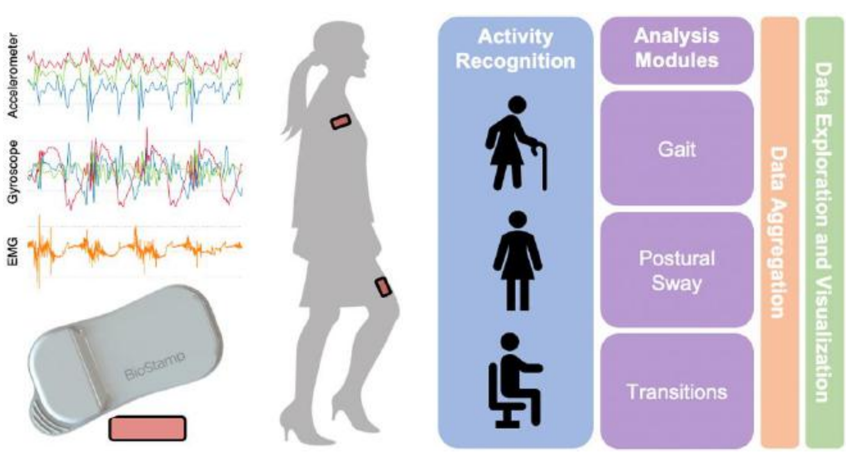
Project 12 - Summer 2024

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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School of Medicine

Project 13 - Summer 2024

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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Wake Forest University School of Medicine

Project 14 - Summer 2024

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 2024

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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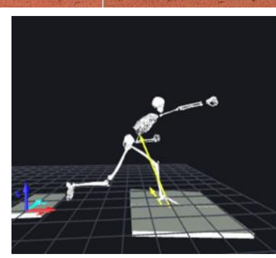
Project 16 - Summer 2024

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.



Location:

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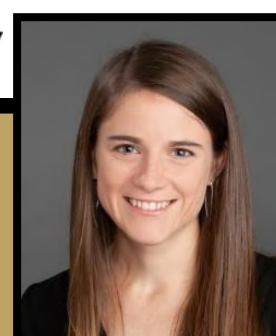

Kristen Nicholson, PhD

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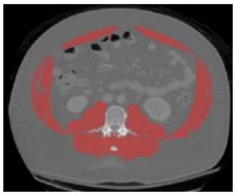
Project 17 - Summer 2024

Crash Injury Research and Engineering Network (CIREN)

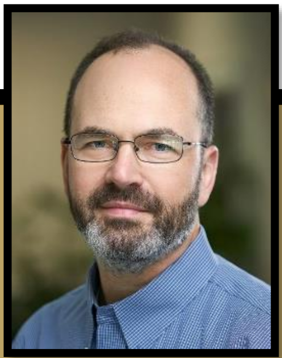
CIREN is a research catalyst that can be used to conduct a wide range of motor vehicle trauma studies. It has been an ongoing project at WFUBMC since 2005.



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.

Location: Wake Forest University School of Medicine

Joel Stitzel, PhD



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Project 18 - Summer 2024

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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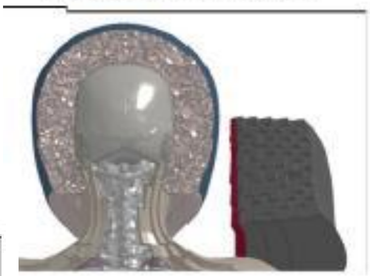
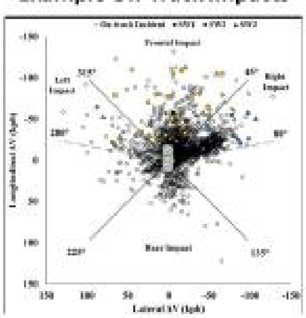
Driver FE Model

FE Simulation for Driver Safety Optimization



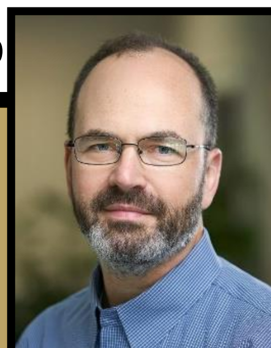
Example On-Track Impacts



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.

Location: Wake Forest University School of Medicine

Joel Stitzel, PhD



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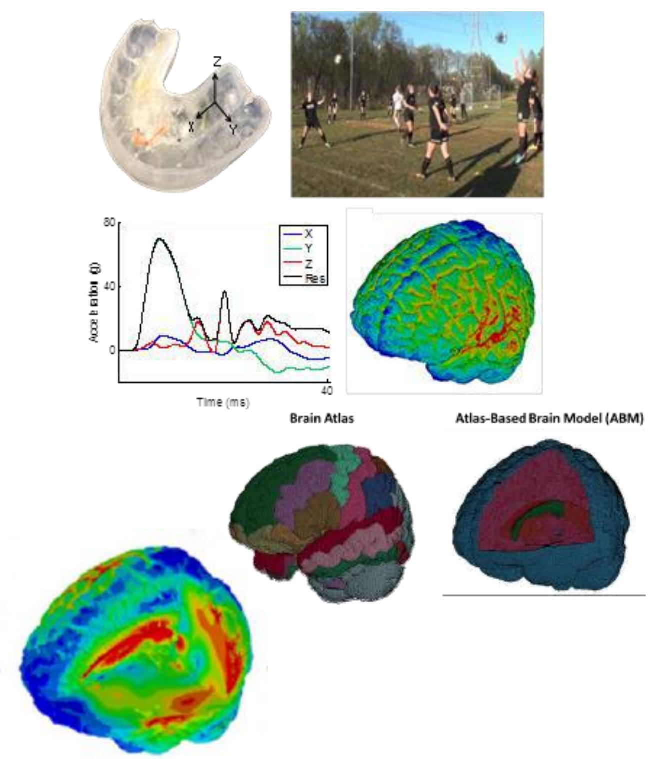
Project 19 - Summer 2024

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.

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Project 20 - Summer 2024

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

Location: Wake Forest University School of Medicine

Jillian Urban, PhD, MPH

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Project 21 - Summer 2024

Vertebral Strength and Injury Risk Following Long-Duration Spaceflight

Prolonged spaceflight can degrade the vertebrae and spinal muscles, leading to astronaut injury. This study is collecting pre- and post-flight CT and magnetic resonance imaging (MRI) scans of astronauts to quantify vertebral BMD, cortex thickness, geometry, and spinal muscle volume changes in 6-month space missions. Vertebral strength and injury risk will be quantified from simulations with a human body model altered to represent each astronaut's pre- and post-flight vertebrae and spinal muscles

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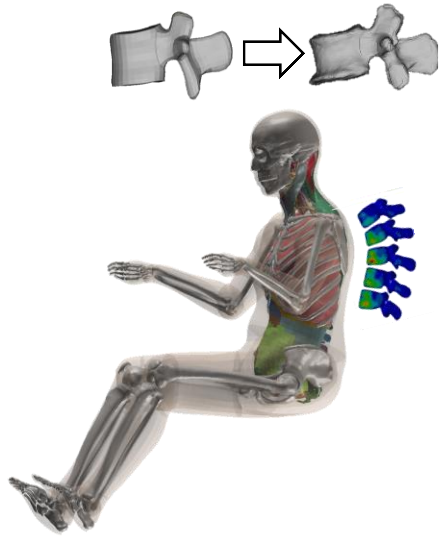
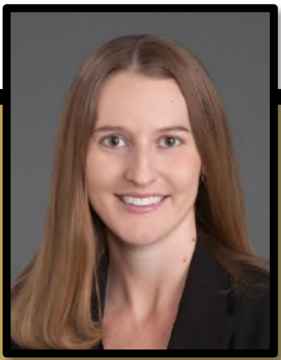
The student will: 1) review literature on astronaut musculoskeletal deconditioning and form a hypothesis to test the effect of spaceflight on a bone or muscle outcome, and 2) learn image segmentation and registration, BMD and cortical thickness algorithms, and FE modeling to analyze pre- to post-flight changes in the astronauts to improve our understanding of injury risks associated with spaceflight deconditioning



Location: Wake Forest University School of Medicine

Ashley Weaver, PhD



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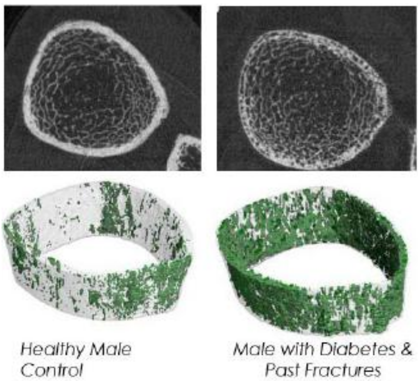
Project 22 - Summer 2024

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.

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.

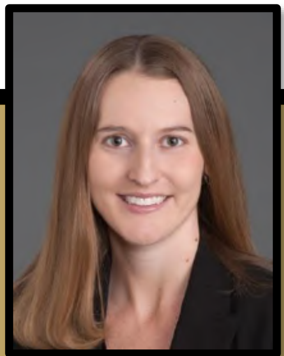


Burghardt et al. – JCEM 2010

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



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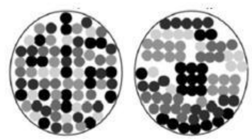
Project 23 - Summer 2024

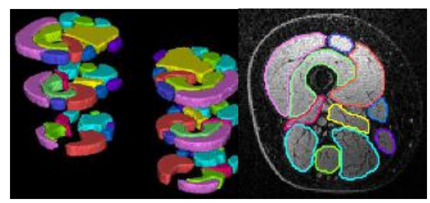
Muscle Quality/Radiomics Features and Muscle-Bone Crosstalk

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.

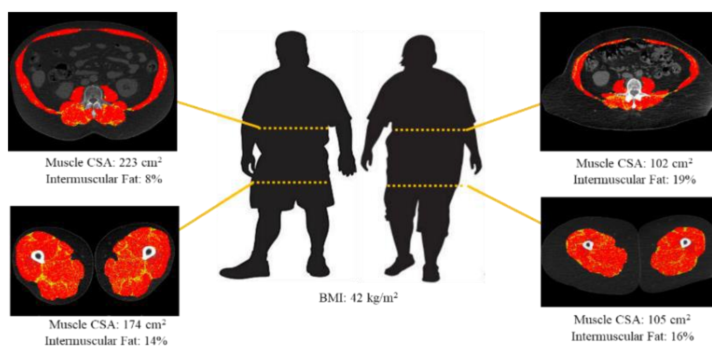
We also use automated radiomics analysis to extract high-dimensional muscle quality measures, such as uniformity, heterogeneity, randomness, and repetitive patterns from CT. These muscle properties can be correlated to bone mineral density and bone strength, which we derive from imaging. These analyses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

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Project 24 - Summer 2024

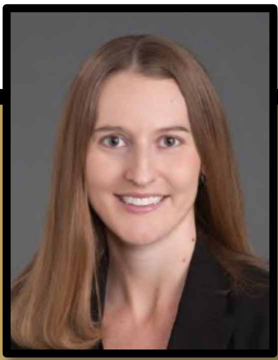
Vulnerable Road User In-Depth Crash Investigation Study (VICIS): Pedestrian Injury and Causation Assessment

- VICIS is a study focused on reviewing and analyzing vulnerable pedestrian crash data for injury causation and crash causation factors.
- The study conducts detailed investigations of real-world pedestrian crashes and determines the mechanism and causation of pedestrian injuries to improve prevention, mitigation, and treatment of motor vehicle crash injuries.
- The project involves collaboration and working closely with a broad range of medical specialties, including biomedical engineers, crash investigators, radiologists, orthopedic surgeons, and trauma surgeons.
- We also use finite element (FE) modeling reconstructions of pedestrian crashes using the simplified GHBMC human body model and a simplified vehicle model. These reconstructions provide kinematic visualizations and injury analyses to supplement our investigations.

The student on this project will be trained in: Abbreviated Injury Scale (AIS) based coding of injuries sustained by pedestrians struck by a motor vehicle, gathering medical record data, radiology, and crash investigation evidence for pedestrian crashes, engineering analysis of the evidence data to determine the cause and biomechanical mechanism of each pedestrian injury.

Location: Wake Forest® School of Medicine

Ashley Weaver, PhD



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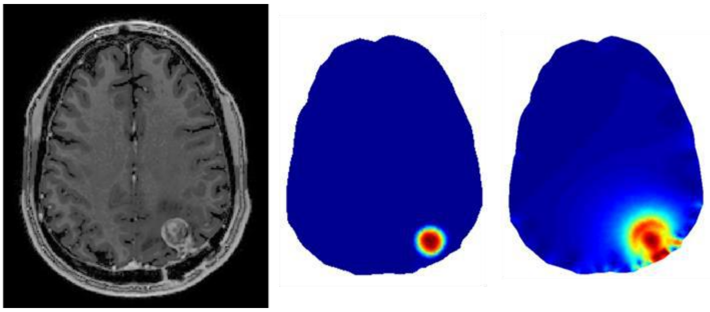
Wake Forest University
School of Medicine

Project 25 - Summer 2024

Image-based Biophysical Modeling to Differentiate Radiation-induced Injury from Tumor Recurrence Following Stereotactic Radiosurgery

Patients with intracranial metastasis treated with stereotactic radiosurgery (SRS) are evaluated for local control using serial MR imaging. Lesions can often be seen during these follow-up imaging sessions with expanding areas of contrast enhancement and surrounding tissue abnormality. Determining the underlying pathology of the lesion presents enormous clinical challenges as tumor recurrence and radiation-induced injury appear radiographically similar. Lesions are often classified as indeterminate and monitored with additional and costly serial follow-up imaging, at the risk of letting a potential recurrent tumor progress. New methods are desperately needed to guide therapeutic intervention decision-making in this important patient group. This project investigates the development of computational modeling methods that are driven by clinical imaging data. As the underlying physiology of the two conditions is fundamentally different, biophysical models may allow parameterization of lesion properties as a model-based biomarker to determine post-SRS enhancing lesion etiology, reducing costs due to unnecessary imaging or missed diagnosis.

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 patients.



Location: Wake Forest University School of Medicine

Jared Weis, PhD

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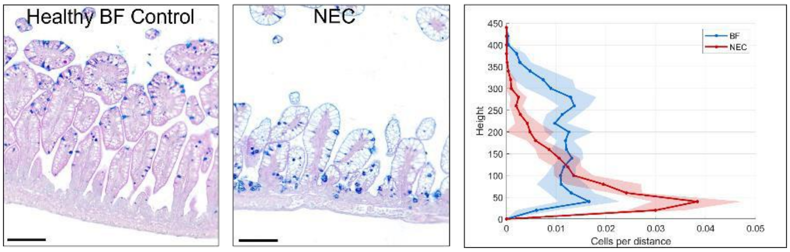
Project 26 - Summer 2024

Spatial histopathological image analysis of gastrointestinal tissue

Histological analysis is the gold standard of tissue assessment and is critical for diagnosis and understanding of disease. In the preclinical setting, tissue histology is widely used to assess the extent of disease models and the impacts of potential therapeutic approaches. However, analysis of tissue staining is primarily done through coarse and time-consuming manual scoring assessments. Further, assessment of the spatial dependence encoded within tissue staining patterns is often qualitative and lacking in non-biased quantitative assessment methods. A robust and automated histology image analysis platform for quantitative assessment of the extent and spatial dependence of tissue histology staining patterns would represent a significant improvement to research throughput and quantitative characterization methodology for regenerative medicine. We have previously performed extensive tissue histological staining in a preclinical animal model of necrotizing enterocolitis (NEC), a devastating gastrointestinal (GI) disease affecting the most fragile premature infants. In this project, the student will work alongside basic and computational sciences collaborators to develop and refine software toolboxes to perform automated spatial image analysis of histology tissue staining for GI disease.

The student will gain experience with histological staining, microscopy, and image analysis/processing. The student will develop and deploy new open-source computational software analysis pipelines in Java and MATLAB software environments for the basic science research community and contribute to the overall characterization of GI health and disease.



Location: Wake Forest University School of Medicine

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Project 27 - Summer 2024

Translational Studies to Improve Lung Cancer Treatment Outcomes

The purpose of this project is to provide the summer trainee with an opportunity to join a team of scientists, physicists, and clinicians (radiation oncologists) within the Department of Radiation Oncology and throughout the Atrium Health-Wake Forest Baptist Comprehensive Cancer Center. The trainee will help identify if a certain protein can make non-small cell lung cancer (NSCLC) resistant to treatment, and also if it can increase the aggressiveness of the tumor. We will then use these data and target this protein to increase the effectiveness of lung cancer treatment. The study will be mentored by both the PI (Dr. Willey) and a graduate student, but the trainee will spend time both in lab, and in the Radiation Oncology clinic in order to learn and apply basic, translational, and clinical Radiation Oncology treatment and research approaches (e.g., tumor imaging and dosimetry; in vitro cell culture work; histology assessment; radiation physics, etc).

Lung cancer is both the second-most diagnosed cancer and the leading cause of cancer-related death in the US. Approximately 60% of NSCLC patients receive radiation therapy as part of their treatment. Efforts to increase the radiation dose delivered to the tumor to combat radiation resistance results in worse survival due to toxicity. Understanding the mechanisms leading to radiation resistance in NSCLC are essential for effective treatment of NSCLC. Cartilage oligomeric matrix protein (COMP) is both associated with metastasis in multiple cancer types and a unique predictive biomarker for radiation-resistance in NSCLC. COMP expression has been implicated in poorer outcomes with several forms of cancers, including increased incidence of metastasis and proliferation of breast, prostate, and colorectal cancers. As COMP is expressed by NSCLC, COMP may increase metastatic potential and provides radiation resistance for lung cancer cells. COMP and its signaling intermediates thus also represent druggable targets to reduce metastatic potential and radiation resistance.

The REU student will work as part of the team, performing wet-lab based analyses from cell-culture and in vivo models (e.g., PCR, real-time proliferation imaging), and clinical assessment from imaging, outcomes, and histology, etc. We value mentoring and will work closely with the student to learn and apply all research approaches.

Jeffrey Willey, PhD

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Location:

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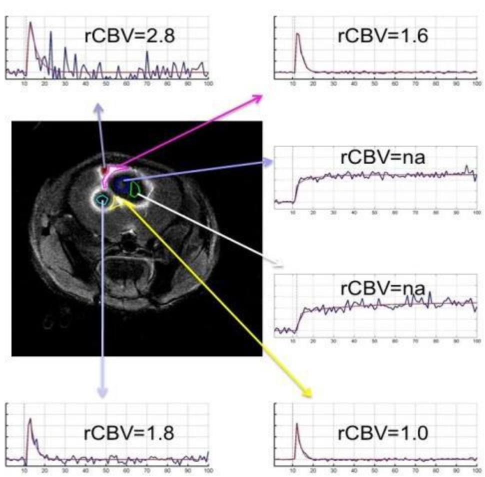
Project 28 - Summer 2024

Biomedical imaging of the brain tumor microenvironment

Malignant brain tumors that are characterized by profound angiogenesis and intratumoral hypoxia and necrosis are highly resistant to conventional multimodal therapies. Delivery of therapeutic agents to the brain tumor remains a major challenge partially due to the blood brain barrier (BBB). The BBB in brain tumor is known to be heterogeneously disrupted with tumor growth. Non-invasive MRI provides not only anatomic images, but also information about vascular function in brain tumors.



The student will: 1) review literature on cancer imaging and brain tumor pathophysiology, 2) learn post imaging processing skills with MatLab. The student will apply skills they learn in imaging segmentation of brain tumors in small animals and mathematic models-based quantitative imaging analysis of vascular perfusion and permeability parameters.

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Dawen Zhao, MD, PhD

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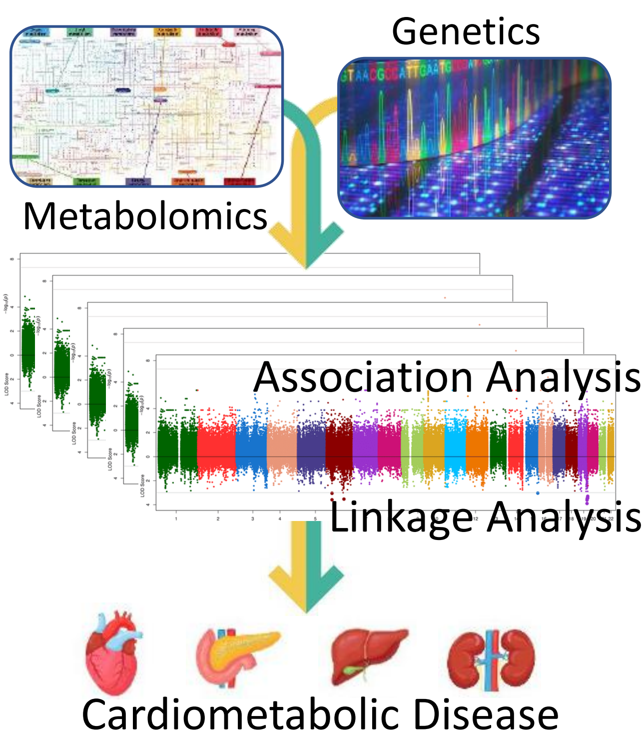
Project 29 - Summer 2024

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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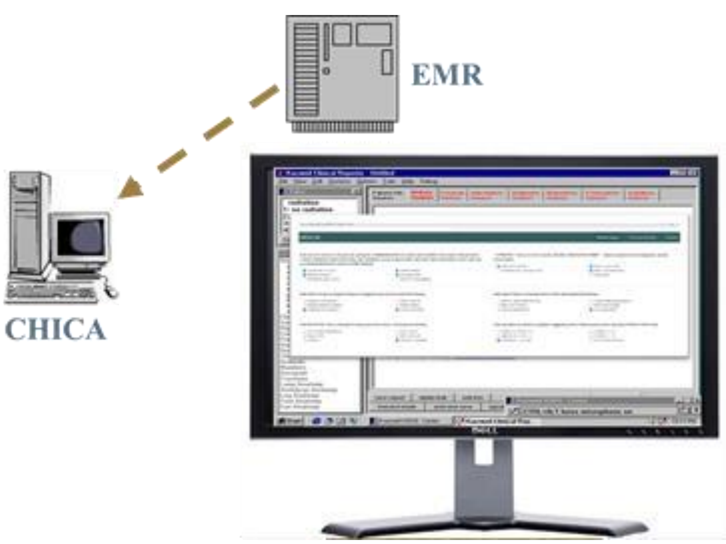
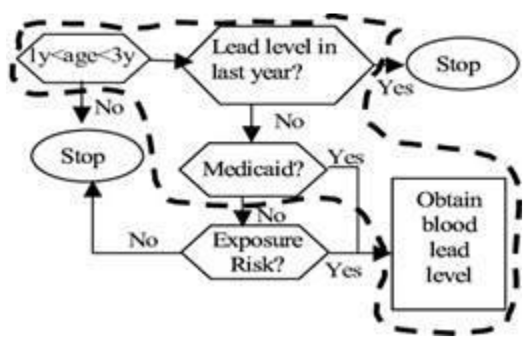
Project 30 - Summer 2024

CHICA Decision Support Development

CHICA (Child Health Improvement through Computer Automation) is a computer-based clinical decision support platform that captures health risk data directly from patients and creates a physician agenda for each clinic visit. The clinical content in CHICA is typically developed, first, by creating algorithmic flow diagrams that describe the flow of clinical care. The diagrams are then converted and encoded into Arden Syntax, a computable decision support standard.

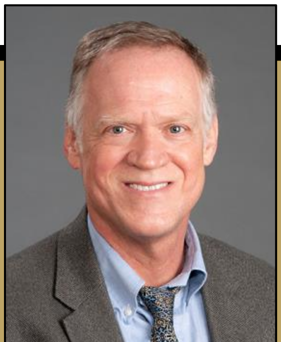
The student project will be to work with Dr. Stephen Downs, the pediatrician and informatician who first created CHICA to develop new clinical algorithms, based on authoritative guidelines, and convert them into Arden Syntax.





Stephen M Downs, MD, MS

Professor and Vice Chair, Pediatric Learning Health Systems
Associate Director, Clinical Informatics
Atrium Health Wake Forest Baptist, Brenner Children's Hospital



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Project 31 - Summer 2024

Developing Artificial Intelligence to Detect Ear Infections

Diseases of the ear, particularly acute otitis media (AOM) and middle ear effusions, are the most commonly treated childhood pathologies. The financial burden of ear disease is estimated at more than $3.2 billion per year. Because ear diseases are common, a significant problem is over-diagnosis and over-treatment

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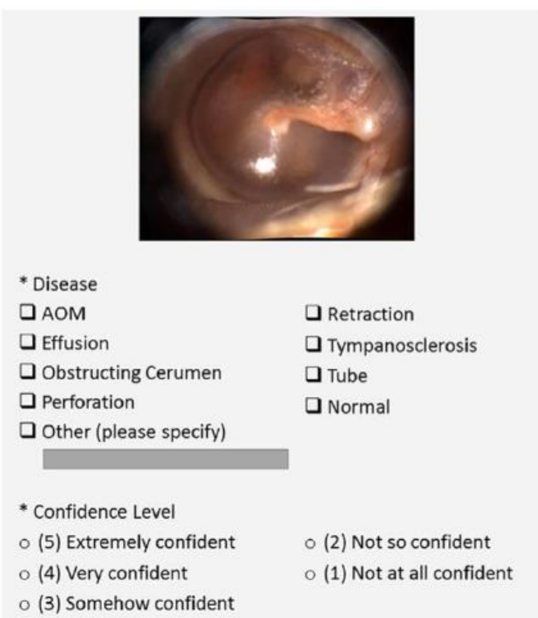


* Disease

- ❑ AOM
- ❑ Effusion
- ❑ Obstructing Cerumen
- ❑ Perforation
- ❑ Other (please specify)
- ❑ Retraction
- ❑ Tympanosclerosis
- ❑ Tube
- ❑ Normal

* Confidence Level

- ○ (5) Extremely confident
- ○ (4) Very confident
- ○ (3) Somehow confident
- ○ (2) Not so confident
- ○ (1) Not at all confident

Our group is a worldwide leader in this area. We have access to one of the largest databases in the world and several expert clinical collaborators. The student will: 1) develop, test, and validate state-of-the art machine learning methodology, 2) collaborate and work closely with ear, nose, throat (ENT) specialties 3) analyze the impact of the developed algorithm's impact on more accurate diagnosis.

Location: Wake Forest University School of Medicine

Metin Gurcan, Ph.D.

Senior Associate Dean for Artificial Intelligence
Director, Center for Artificial Intelligence
Professor, Department of Internal Medicine, Pathology, BME
Wake Forest School of Medicine
https://school.wakehealth.edu/research/labs/clinical-image-analysis-lab

Wake Forest University
School of Medicine

Project 32 - Summer 2024

Machine Learning Methods for Maternal Health

African-American women across the US experience alarmingly higher rates of maternal mortality than their white counterparts. Factors associated with social determinants of health (SDoH), including education, housing, transportation, and nutrition, are recognized as potentially contributing to this disparity in maternal health outcomes, along with clinical risk factors including hypertension and heart disease. However, the complex associations among these factors, along with the causal role they play in increased risk for maternal mortality, are not well understood, nor are there comprehensive health care interventions that take these combined factors into account to provide decision and communication support for patients, providers, and community support workers.

The student will: 1) clarify and track contributions of biological, clinical, and SDoH factors toward specific maternal morbidities associated with eventual mortality, 2) conduct efficient and accurate risk predictions to determine whether patients fall into defined target risk groups.

Location: Wake Forest University School of Medicine

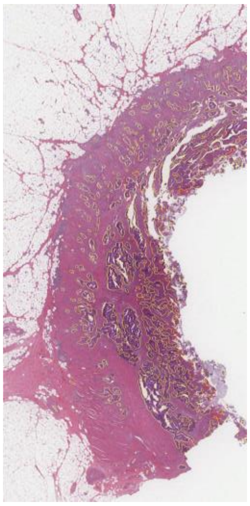
Metin Gurcan, Ph.D.

Senior Associate Dean for Artificial Intelligence
Director, Center for Artificial Intelligence
Professor, Department of Internal Medicine, Pathology, BME
Wake Forest School of Medicine
https://school.wakehealth.edu/research/labs/clinical-image-analysis-lab

Wake Forest University
School of Medicine

Project 33 - Summer 2024

Improving Colorectal Cancer Prognosis through Artificial Intelligence



This project aims to address the significant issue of colorectal cancer, which is a prevalent and deadly cancer type in the United States. Colorectal cancer is characterized by tumor budding, the presence of small groups of tumor cells at the tumor's edge, which can provide valuable prognostic information but is often challenging to identify consistently in pathology reports. To overcome this problem, the project seeks to develop a computer-aided image analysis system.

The system will employ advanced techniques, including self-supervised learning, vision transformers, and multi-modal large language models to accurately identify tumor budding in histopathology slides. Moreover, it will analyze the correlation between tumor budding and various clinical outcomes, such as microsatellite instability status, overall survival, progression-free survival, and disease-free survival.

The project will also leverage mathematical methods, such as scale-space theory and alpha-shapes, to pinpoint tumor buds and hotspots, followed by the extraction of meaningful imaging features using self-supervision, vision transformers, and multi-modal large language models. These features, along with those generated through unsupervised multiple instance learning, will be used to predict patient outcomes. Ultimately, this research aims to enhance our understanding of the role of tumor budding in colorectal cancer prognosis. The resulting software tools will contribute to more personalized cancer therapies for colorectal patients and undergo rigorous statistical analysis to ensure accuracy and reproducibility

Learning Objectives: The student will have the opportunity to work with cutting-edge deep learning models. Additionally, it will be a fantastic chance to work on a GPU cluster and learn how to distribute jobs among various nodes. Along the way, the student will also learn the fundamentals of computational pathology.

Requirements: Strong programming skills in Python and basic knowledge of machine learning.

Khalid Niazi, PhD

Assistant Professor
Center for Artificial Intelligence
Wake Forest University School of Medicine

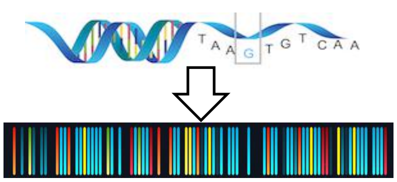
Wake Forest University
School of Medicine

Project 34 - Summer 2024

Language-based AI Model on genomic data to predict 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 huge 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.

Da Ma, PhD

Associate Professor,
Gerontology and Geriatric Medicine
Center for Artificial Intelligence
Alzheimer's Disease Research Center
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Michael Horvath, MS

Lead Programmer / Analyst,
Clinical and Translational
Science Institute

Wake Forest University
School of Medicine

Project 35 - Summer 2024

Digital Fingerprinting

Electronic Medical Records (EMRs) are leveraged in many research projects. In this realm of healthcare data analytics, protecting patient privacy is paramount. This internship opportunity offers a unique and valuable experience for a data science enthusiast to contribute to the development of cutting-edge digital fingerprinting methods. Uses of these methods will be to:

- Determine best approaches for efficient data linkage that maintains data privacy
- Develop methods for dataset review to evaluate statistically the degree of de-identification
- Innovate algorithms to shift and blur data to minimize re-identifiability of data while preserving data interrelationships

The student working on this project will be trained in data analytics and supporting data extraction programming. The student will get familiarity with national medical data standards, ontological systems, Common Data Models (CDMs), and the full-cycle process of research from cohort identification to data extraction and analysis.

Required skills: Python or R Programming. Prior experience with databases and statistics is helpful.

Brian Ostasiewski

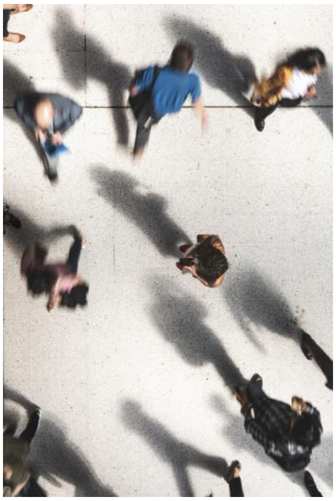
Director of Research Informatics
Clinical and Translational Science Institute
Center for Artificial Intelligence
Wake Forest School of Medicine

Wake Forest University
School of Medicine

Project 36 - Summer 2024

Data-Driven Strategies for Trial Recruitment

Clinical trial recruitment is the process of enrolling participants into clinical studies to meet predefined target numbers. Failure to recruit and accrue these target numbers can lead to delays in research, increased costs, and compromises in the validity of study outcomes. This internship in healthcare informatics focuses on analyzing patient arrival rates across clinics and providers, with a specific aim of supporting clinical trial recruitment and accrual efforts. By collecting and assessing data on patient arrival patterns, considering factors such as location, provider, and patient demographics, this project seeks to offer valuable insights to clinical trial teams looking to more accurately predict their potential to recruit participants of interest. The goal is to facilitate more effective resource allocation and scheduling, ultimately contributing to improved patient care and the success of clinical trials.



The student working on this project will be trained in data analytics and supporting application programming. The student will get familiarity with national medical data standards, ontological systems, and the full-cycle process of research from cohort identification to data extraction and analysis. Data characterization, cleaning, and visualizations may be explored.

Required skills: Python or R programming. Prior experience with databases and statistics is helpful.

Brian Ostasiewski

Director of Research Informatics
Clinical and Translational Science Institute
Center for Artificial Intelligence
Wake Forest School of Medicine

Project 37 - Summer 2024

Standards Mapping and Interoperability

Mapping local laboratory order and test data to national standards such as LOINC and SNOMED is an important task for research institutions. By using standard terminology, sites can ensure that their data is understood, interpreted, and compared correctly by other collaborating sites. This aids our participation in many Clinical Research Networks (CRNs).
One way to map local laboratory data to national standards is to develop a tool that automates part of the evaluation process, providing guidance information to aid humans in choosing the best mappings. This type of tool can help to save time and reduce mapping errors, as well as identify potential inconsistencies in the raw source data.

The student working on this project will be trained in data analytics and supporting application programming. The student will get familiarity with national medical data standards, ontological systems. Data characterization, cleaning, and visualizations will be key components to this project.

Required skills: Python or R programming. Prior experience with databases and statistics is helpful.

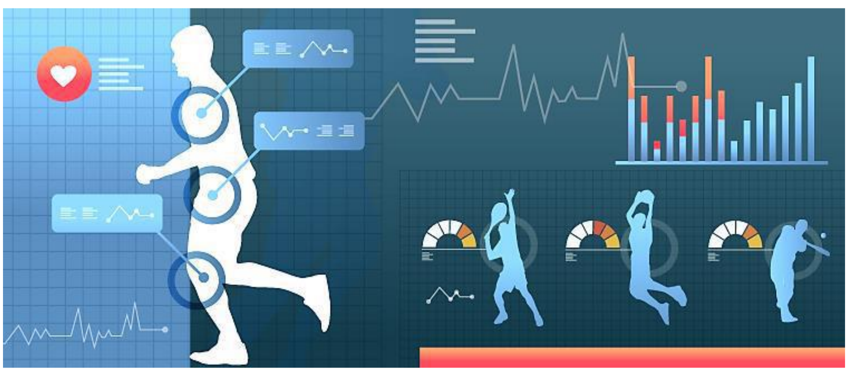
Brian Ostasiewski

Director of Research Informatics
Clinical and Translational Science Institute
Center for Artificial Intelligence
Wake Forest School of Medicine

Project 38 - Summer 2024

Professional North American Sport Data Scraping

Data scraping or web scraping is the process of obtaining free form data from the internet and customizing it to be usable for human consumption. Within the last decade, professional sport data has become ubiquitous through the internet, including injury and performance data. These data can be harnessed to better understand the implications of injury and performance, where data was once kept secret by each professional club or organization. This project involves learning and implementing data scraping methods, and basic epidemiological analyses.



The student intern will learn data scraping methods and basic epidemiological concepts and analysis

Jaime Lynn Speiser, PhD, MS

Assistant Professor, Biostatistics and Data Science
Department of Biostatistics and Data Science
Division of Public Health Sciences
Wake Forest University School of Medicine
Faculty Bio

Location:

Wake Forest University School of Medicine

Garrett Scott Bullock, PhD,DPT

Assistant Professor
Department of Orthopaedic Surgery
Wake Forest School of Medicine
Faculty Bio

Wake Forest University
School of Medicine

Project 39 - Summer 2024

Standardized, HArmonized REpository of longitudinal aging data (SHARE data)

Data sharing is an essential part of clinical and translational science research because it facilitates secondary data analysis and reproducibility of existing studies. However, there are barriers to data sharing, including challenges accessing data that are siloed on different websites and non-standard formatting across datasets. This necessitates tedious processing and results in wasted time that is often duplicated by multiple researchers using the same datasets. There are some data repositories containing datasets with standard formatting, but none have longitudinal data. We focus on longitudinal data with repeated measurements over time to address unanswered methodological and applied questions in studies of aging. The intern will work with one publicly available, longitudinal dataset in aging. The intern will process the data to harmonize key features, including demographics, physical function, comorbidities, cognitive function and lifestyle. A standard format will be used for the subject identifier variable and the longitudinal variable representing time of the repeated measurements.

The intern will code using R software and document data processing. The intern's work will integrate into an open source R package that will include code for processing and harmonizing datasets with repeated measures in studies of aging. The intern will learn about R coding, longitudinal data in studies of older adults, data processing and data harmonization.

Location:

Wake Forest University
School of Medicine

Jaime Lynn Speiser, PhD, MS

Assistant Professor, Biostatistics and Data Science
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Division of Public Health Sciences
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[Faculty Bio]

Byron Jaeger, PhD

Assistant Professor, Biostatistics and Data Science
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Project 40 - Summer 2024

Cross validation methods for prediction modeling of small and imbalanced data

The process of splitting data into training and validation sets for prediction model development is subject to variation, particularly in the **presence** of small and imbalanced data. Here, we define small data as having 100-500 observations. Imbalanced data occurs when the distribution of the outcome is not close to 50/50 for binary outcomes. Failure to appropriately account for this variability can decrease the validity and replicability of a prediction model, and lead to erroneous conclusions in a statistical comparison of competing prediction models' performance metrics.

The intern will compare existing methods of cross validation in the context of small and imbalanced datasets, including split sampling, repeated split sampling, k-fold cross validation and repeated k-fold cross validation. The intern will learn about methods for cross validation and use R software to conduct a simulation study based on five real datasets from the UCI Machine Learning Repository to compare performance metrics with the different cross validation methods.

Location:

Wake Forest University School of Medicine

Jaime Lynn Speiser, PhD, MS

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[Faculty Bio]

Nathaniel O'Connell

Assistant Professor, Biostatistics and Data Science
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[Faculty Bio]

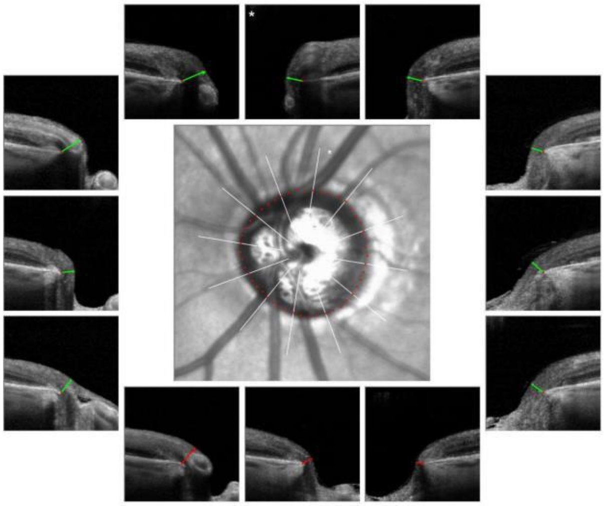
Wake Forest University
School of Medicine

Project 41 - Summer 2024

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.

Atalie Thompson, MD, MPH

Assistant Professor, Dep. of Surgical Ophthalmology
Assistant Professor, Div. of Gerontology and Geriatric Medicine
Wake Forest School of Medicine
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Wake Forest University School of Medicine

Project 42 - Summer 2024

Admixture Mapping of Genes Related to Tanning Response

Facultative pigmentation, the result of impermanent changes in skin color in response to ultraviolet radiation (UVR) from the sun, is an essential but poorly understood component skin color and susceptibility to skin cancer. This tanning response is the primary interface between the skin and the sun, but the majority of previous research has focused on basal melanin pigmentation levels measured on non-UVR exposed regions of the skin. Like increased basal melanin, the persistence of melanin in the skin following UVR exposure may mediate skin cancer risk.

We have quantitatively measured tanning response and persistence among 91 Mexican Americans living in South Texas. Participants received controlled UVR exposures on naïve skin to measure response and 7- to 30-day persistence following a single exposure at a UVA/UVB ratio equivalent to equatorial sunlight. Measures of melanin content at exposed hand and unexposed underarm were compared to assess the cumulative impact of daily exposure to UVR.

The student will: 1) Perform admixture mapping to identify genes associated with tanning response; and 2) Use bioinformatics techniques to identify melanogenic pathways interrupted by identified genes; and 3) Evaluate the relationship between tanning response and cancer genes. This data will inform our understanding of skin cancer risk across populations

Day 1: Participants receive 4 increasing exposures of UVA/UVB to mimic summer sun on unexposed skin on upper buttocks (Solar Simulator).

Day 2: Erythemal Response is measured via reflectance spectroscopy (DSM-II E value). Minimal erythemal dose and erythemal dose-response are calculated.

Day 7: Melanogenic Response is measured via DSM-II M value. Tanning intensities are determined from the slope of the of melanin production across the range of UV exposures.

Day 23: Melanogenic Response is measured via DSM-II M value. Tanning persistence is determined from the amount of melanin at day 28 / day 7 in adjusted for initial response.

Ellen Quillen, PhD

Assistant Professor
Department of Internal Medicine-Molecular Medicine
Wake Forest School of Medicine
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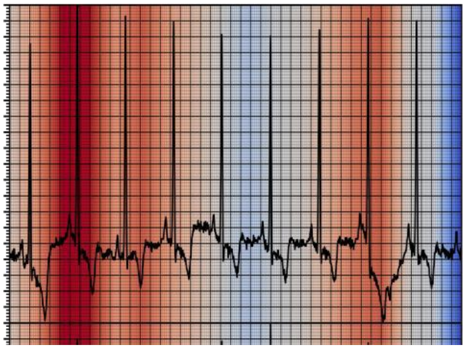
SCHOOL OF BIOMEDICAL ENGINEERING AND SCIENCES

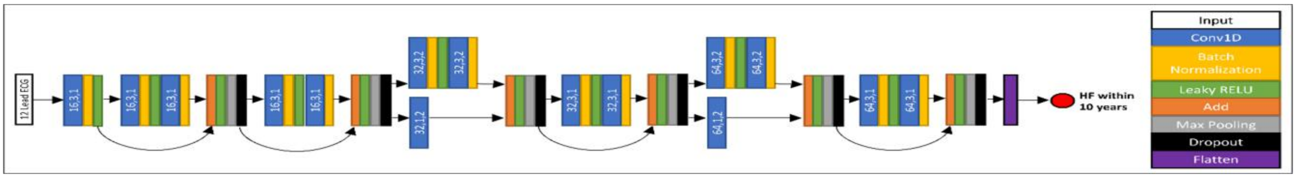
Project 43 - Summer 2024

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

Ibrahim Karabayir, PhD

Assistant Professor, Wake Forest University Health Sciences,
Wake Forest University School of Medicine,
Internal Medicine, Section on Cardiovascular Medicine

VIRGINIA TECH

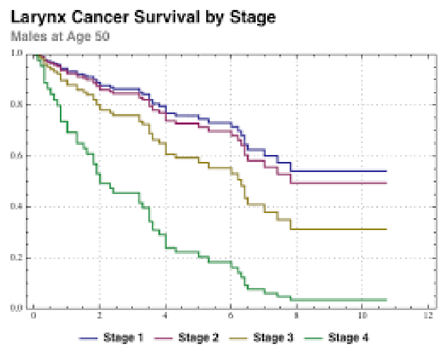
WAKE FOREST UNIVERSITY

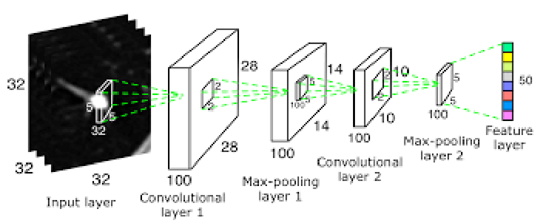
SCHOOL OF BIOMEDICAL ENGINEERING AND SCIENCES

Project 44 - Summer 2024

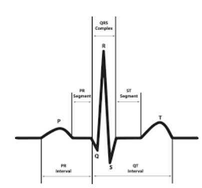
Deep Survival Learning for Signal Type Data

Background: Survival analysis, e.g. Cox Proportional Hazard's Regression is frequently used to model the relationship between a set of input (continuous, binary, or categorical) to a future event taking time-to-event information into account. However, there has been a lack in deep learning methodology to take time-to-event information into account. Despite there is a recent literature on integrating survival analysis with deep learning for image analysis, there a lack in literature to associate physiologic signals into future events.





Goal: The goal of this project is to create a new deep learning model that can process signal type of data to predict risk for a future event a desired time point.



Expectation: The student in this project will is expected to have Python programming skills and work on 1) building the deep survival model for signal type data 2) apply them to real world problems such as heart failure risk prediction.

Oguz Akbilgic, PhD

Associate Professor, Cardiovascular Medicine | Biomedical Informatics
Associate Director, Epidemiological Cardiology Research Center
Wake Forest School of Medicine
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SCHOOL OF BIOMEDICAL ENGINEERING AND SCIENCES

Project 45 - Summer 2024

AI-Assisted Pre-screening for Fragile X Syndrome

Fragile X syndrome (FXS) is the most prevalent inherited cause of intellectual disability and autism. It is associated with a wide range of symptoms and co-occurring medical conditions, with significant burden on patients and their families. Diagnosing FXS is challenging and current approaches in identifying individuals with FXS are not efficient. Therefore, there is an unmet need to develop advanced diagnostic approaches to improve current clinical practice and accelerate FXS diagnosis in the general population. Using the medical history of 3.8 million patients, we created an artificial intelligence (AI) assisted pre-screening model that can identify potential cases with FXS. In this project, we will evaluate the generalizability of our approach across different health care systems and in a diverse patient population.

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

Location: Wake Forest University School of Medicine

Arezoo Movaghar, PhD

Assistant Professor, Department of Pediatrics
Center for Artificial Intelligence
Wake Forest University School of Medicine

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

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SCHOOL OF BIOMEDICAL ENGINEERING AND SCIENCES

Project 46 - Summer 2024

Health Characteristics of Patients with Profound Autism

Autism affects more than 78 million individuals worldwide. Due to the heterogeneity of the condition, there is a critical need for personalized and patient-centered intervention and services. Individuals with profound autism require high levels of care and support, have difficulty advocating for themselves, and often have been excluded from research. Understanding their clinical needs is a public health priority and is essential for proper and timely treatment and intervention. In this project, we will utilize electronic health records to identify all co-occurring medical conditions that differentiate those with profound autism from those who have autism without any level of intellectual disability. In addition, we will explore differences between those with profound autism and individuals with single-gene neurodevelopmental disorders. This study will offer new information about medical needs and health care utilization of patients with profound autism.

The student will: 1) review literature on profound autism, 2) characterize health care utilization of profoundly autistic patients, 3) compare patterns of health care utilization in cases versus autistic patients without intellectual disability, and those with single-gene neurodevelopmental disorders. The data will offer new insight into co-occurring conditions associated with profound autism and will provide important information for patients, families, researchers, and clinicians.

Location: Wake Forest University School of Medicine

Arezoo Movaghar, PhD

Assistant Professor, Department of Pediatrics
Center for Artificial Intelligence
Wake Forest University School of Medicine

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Winston-Salem, NC 27103

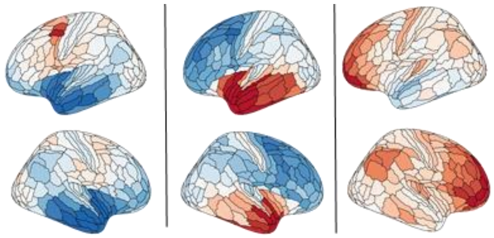
SCHOOL OF BIOMEDICAL ENGINEERING AND SCIENCES

Project 47 - Summer 2024

Identify neuroimaging-based Alzheimer's subtypes using machine-learning-based data-driven approaches

Background: Alzheimer's disease (AD) is a neurodegenerative disease with heterogeneous brain neurodegeneration pathology patterns that leads to the diverse cognitive function decline of the brain, eventually leading to dementia, which poses challenges in developing effective diagnosis and treatment. Therefore, clustering neuroimaging of AD patients into distinctive disease subtypes would significantly improve the precision diagnosis, finally facilitation the development of effective personalized intervention.

Goal: The goal of this project is to develop novel machine learning / deep learning approaches that can identify neuroimaging-based brain patterns (i.e. MRI-based atrophy patterns and PET-based neuropathological patterns through novel data-driven self-supervised clustering approach.



Expectation: The student in this project will be expected to have Python programming skills and work on 1) neuroimaging-based feature extraction; 2) self-supervised data-driven clustering; 3) distinctive disease-subtype neurodegeneration pattern visualization. Prior experience in Matlab is also beneficial.

Da Ma, PhD

Associate Professor, Gerontology and Geriatric Medicine
Center for Biomedical Informatics
Alzheimer's Disease Research Center
Wake Forest School of Medicine
https://profiles.wakehealth.edu/display/Person/dma