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PhD Candidate

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Summary

Experienced PhD candidate specializing in human movement science with a track record of over five years. My research leverages wearable sensors, optical motion capture, and machine learning to identify patient specific pain mechanisms runners and athletes. Eager to utilize my distinct skillset that merges human health, performance, and data science in research initiatives at industrial organizations.

Education

2020 – 2024	University of Massachusetts Amherst; Amherst, MA Doctor of Philosophy Biomechanics and Data Science GPA: 3.9/4.0
2020 – 2022	University of Massachusetts Amherst; Amherst, MA Computer Science and Statistics Departments Graduate Certificate in Statistical and Computational Data Science GPA: 3.8/4.0
2018 – 2019	University of Connecticut; Storrs, CT Master of Science Biomedical Engineering GPA: 3.9/4.0
2014 – 2018	University of Connecticut; Storrs, CT Bachelor of Science Biomedical Engineering GPA: 3.5/4.0

Research Experience

Musculoskeletal & Orthopedic Biomechanics Laboratory, University of Massachusetts Amherst – Amherst, MA
Research Assistant, August 2020 – Present

PI: Katherine Boyer, PhD

- Identify biomechanical movement adaptations by those with musculoskeletal injuries and in the aging population.
- Utilize data science approaches such as supervised learning and clustering to analyze and interpret large data sets.
- Automate time-taxing tasks by developing and implementing automated pipelines for data collection and processing.
- Create high quality, publication ready visualizations for translating findings to diverse audiences.
- Developing a wearable sensor-based system for detecting mechanisms of running injury with machine learning models.

Center for Health and Human Performance, University of Massachusetts Amherst – Amherst, MA
Data Science Intern, May 2023 – Present

PI: Michael Busa, PhD

- Develop gait event detection algorithms for a novel smart wearable insole that records signals from various sensors.
- Validate wearable sensors signals using ground truth pressure mapping systems using statistical modeling and testing.
- Create high quality visualizations and presentations to translate findings to key stakeholders such as startup founders.
- Leverage the results of analysis to inform future decisions around designing and testing new prototypes.

University of Massachusetts Men's Ice Hockey Team, University of Massachusetts Amherst – Amherst, MA
Sports Science Intern, May 2022 – December 2022

Supervisor: Brandon Wickett, MS

- Leverage Catapult's wearable technology to monitor player load and make informed decisions to reduce injury risk.
- Support development of interactive dashboards to help the sports performance team and coaches plan practices.
- Analyze and interpret large sets of longitudinal data for optimizing player work output, identifying asymmetries, and more.
- Simplify findings to interpretable formats for key stakeholders such as on ice, strength, and sports performance coaches.

Research Experience (*continued*)

Orthopedic Rehabilitation and Biomechanics Laboratory, University of Michigan - Ann Arbor, MI

Research Associate 1, May 2019 – August 2020

PI: Lindsey Lepley, PhD

- Examined biomechanical implications of ACL tears in animal models using deep learning-based motion tracking system.
- Wrote custom written scripts (Matlab) to automate data processing procedures such as ultrasound muscle fiber tracking.
- Developed data processing procedures for analyzing CT scans of animal model knee joints with knee osteoarthritis.
- Overhauled laboratory space including full synchronization of motion capture, force plate, and ultrasound systems.

Sports Optimization and Rehabilitation Laboratory, University of Connecticut - Storrs, CT

Graduate Researcher, December 2018 – May 2019

Co – PIs: Lindsey Lepley, PhD and Adam Lepley, PhD

- Investigated anatomical and pathological outcomes after traumatic joint injury, specifically ACL tears.
- Collected and analyzed biomechanical data including kinematics, kinetics, strength, muscle activation patterns, and more.
- Assisted other students with data processing procedures such as tracking of muscle fibers via ultrasound recording.

Entrepreneurial Pursuits

Gait Guard, Early stage/pre-revenue startup

Founder, January 2023 – Present

- Leading a pre-revenue startup focusing on revolutionizing running related injury detection and treatment with wearable tech.
- Conducting extensive customer discovery interviews to understand user pain points, needs, and technology gaps.
- Developing a prototype with inertial measurement units and deep learning models to identify abnormal movement patterns.
- Participating in Innovation Corps programs through MIT and UMass Amherst to identify and refine customer segments.
- Working with key collaborators and partners in the startup space and wearable industry to secure initial seed funding.

Teaching and Mentorship Experience

Kinesiology Department, University of Massachusetts Amherst – Amherst, MA

Teaching Assistant, February 2023 – Present

Primary Lecturer: Sarah Roelker, PhD and Katherine Boyer, PhD

- Teaching assistant for an undergraduate kinesiology course titled *Kinesiology 430: Biomechanics*.
- Responsible for leading teaching lab sections, meeting with students, hosting office hours, and other teaching related tasks.
- The course is designed to help students develop an understanding of biomechanical concepts related to human movement.

Kinesiology Department, University of Massachusetts Amherst – Amherst, MA

Teaching Assistant, August 2022 – December 2022

Primary Lecturer: Gregory Grinnell, MS

- Teaching assistant for an undergraduate kinesiology course titled *Kinesiology 110: Human Performance and Nutrition*.
- Responsible for leading discussion activities, meeting with students, grading assignments, and other related items.
- This class gives students necessary skills to critically evaluate information and research related to human performance.

Kinesiology Department, University of Massachusetts Amherst – Amherst, MA

Teaching Assistant, August 2020 – May 2021

Primary Lecturer: Thomas G. St. Laurent, MS

- Teaching assistant for an undergraduate kinesiology course titled *Kinesiology 100: Introduction to Kinesiology*.
- Responsible for planning lessons, executing course material, and providing support for discussion section of the course.
- Topics included general kinesiology, health, nutrition, physical activity, biomechanics, and fitness testing.

Undergraduate Research Opportunity Program, University of Michigan - Ann Arbor, MI

Student Mentor, August 2019 – August 2020

Supervisor: Lindsey Lepley, PhD

- Recruit students in the Undergraduate Research Opportunities Program to participate in lab's research.
- Trained students on project specific protocols including collecting, compiling, and analyzing 3D CT scan image data.
- Simultaneously managed a total of 5 students by delegating tasks, responsibilities, and deadlines for projects.

MCB Department, University of Connecticut - Storrs, CT

Teaching Assistant, August 2018 – July 2019

- Lab teaching assistant for an undergraduate biology course titled *Biology 1107: Principles of Biology 1*.
- Responsible for teaching lab exercises, mentoring students, assisting students, grading, and hosting office hours.
- Learned and developed valuable skills such as lecturing, grading, and providing extra support for students.

Publications

1. **Brancati RJ**, Kent, JA, Boyer. Assessing Aging Related Declines in Postural Control by Quantifying Center of Pressure Movement during the Advanced Version of the Short Physical Performance Battery. *Drafted*
2. **Brancati RJ**, Hamill J, Boyer KA. A Data Mining Approach for Determining Gait Abnormalities in Runners with Patellofemoral Pain Syndrome. *J Sports Science*. 2024 Jan; doi: 10.1080/02640414.2024.2308419
3. White MS, **Brancati RJ**, Lepley LK. Relationship between altered knee kinematics and subchondral bone remodeling in a clinically translational model of ACL injury. *J Orthop Res*. 2022 Jan;40(1):74-86. doi: 10.1002/jor.24943. Epub 2020 Dec 23. PMID: 33295680; PMCID: PMC8187469.
4. Davi SM, **Brancati RJ**, DiStefano LJ, Lepley AS, Lepley LK. Suppressed quadriceps fascicle behavior is present in the surgical limbs of those with a history of ACL reconstruction. *J Biomech*. 2021 Dec 2;129:110808. doi: 10.1016/j.jbiomech.2021.110808. Epub 2021 Oct 11. PMID: 34666248.

Conference Abstracts and Presentations

1. Boyer KA, Holmes SC, **Brancati RJ**, Bushe K, Kent JA, Ayers D. Knee Extensor Functional Demand Following Total Knee Arthroplasty. Orthopaedic Research Society. *Poster Presentation*. Long Beach, CA. February 4, 2024.
2. **Brancati RJ**, Kent JA, Hayes KL, Alvarado F, Boyer KA. Aging and Speed Adaptations in Functional Demand of the Knee Extensors During Walking. American Society of Biomechanics. *Poster Presentation*. Knoxville, TN. August 10, 2023.
3. **Brancati RJ**, Kent JA, Hayes KL, Alvarado F, Boyer KA. Assessment of Aging Related Changes in Postural Control Using Time to Contact. UMass Amherst IALS Core Facilities Showcase. *Poster Presentation*. Amherst, MA. November 29, 2022.
4. **Brancati RJ**. A Data Mining Approach for Determining Gait Abnormalities in Runners with Patellofemoral Pain Syndrome. UMass Amherst Kinesiology Graduate Seminar Series. *Oral Presentation*. Amherst, MA. November 28, 2022.
5. **Brancati RJ**, Boyer KA. Data Mining Approach for Determining Gait Abnormalities in Runners with Patellofemoral Pain Syndrome. North American Congress on Biomechanics. *Running Symposium Presentation*. Ottawa, Canada. August 21-25, 2022.
6. **Brancati RJ**, Kent JA, Hayes KL, Alvarado F, Boyer KA. Assessment of Aging Related Changes in Postural Control Using Time to Contact. North American Congress on Biomechanics. *Oral Presentation*. Ottawa, Canada. August 21-25, 2022.
7. **Brancati RJ**, Boyer KA. Biomechanical Characteristics of Runners Recently Recovered from Patellofemoral Pain Syndrome. 9th World Congress of Biomechanics. *Oral Presentation*. Taipei, Taiwan. July 10-14, 2022.
8. **Brancati RJ**, Boyer, KA. Determining gait abnormalities in runners with patellofemoral pain syndrome using a data mining approach. UMass Amherst School of Public Health & Health Sciences Research Day 2022. *Poster Presentation*. Amherst, Massachusetts. April 6, 2021.
9. **Brancati RJ**, Kent JA, Boyer KA. Time to Contact Captures Declines in Postural Control Following Fatiguing Activity. 43rd Annual Meeting of the American Society of Biomechanics. *Oral Presentation*. Virtual Meeting. August 11, 2021.
10. **Brancati RJ**, Boyer, KA. Time to Contact Captures Declines in Postural Control Following Fatiguing Activity. UMass Amherst School of Public Health & Health Sciences Research Day 2021. *Oral Presentation*. Virtual Meeting. April 16, 2021.
11. Davi SM, **Brancati RJ**, Lepley AS, DiStefano LJ, Lepley LK. Examining the Dynamic Complexity of the Quadriceps Following Anterior Cruciate Ligament Reconstruction. National Association of Athletic Trainers Convention. *Oral Presentation*. Orlando, Florida. June 29, 2021.
12. White MS, Davi SM, **Brancati RJ**, Lepley LK. Alterations in Gait and Knee Joint Alignment Substantiate New PTOA Rodent Model of ACL Injury. Orthopaedic Research Society Annual Meeting. *Oral Presentation*. Phoenix, Arizona. February 10, 2020.

Conference Abstracts and Presentations (*continued*)

13. Lepley LK, White MS, Davi SM, Lepley AS, **Brancati RJ**. Novel Pre-clinical Model of Post-traumatic Osteoarthritis Demonstrates Unicompartamental Declines in Trabecular Bone Volume. Orthopaedic Research Society Annual Meeting. *Poster Presentation*. Phoenix, Arizona. February 10, 2020.
14. Davi SM, **Brancati RJ**, Lepley LK. Characterizing Abnormalities in Dynamic Quadriceps' Function Following Anterior Cruciate Ligament Reconstruction. Orthopaedic Research Society Annual Meeting. *Poster Presentation*. Phoenix, Arizona. February 8, 2020.

Grants, Fellowships, Awards, and Honors

2023 – 2024	UMass Institute of Applied Life Sciences Graduate Student Translational Research Fellowship - \$35,000
2023	Sigma Xi Research Society Dissertation Grant – <i>Not Funded</i>
2022	DeLuca Foundation Training Initiative Grant – <i>Not Funded</i>
2022	National Biomechanics Day Loadsol Grant – <i>Not Funded</i>
2021	National Biomechanics Day Loadsol Grant – <i>Not Funded</i>
2021	UMass Amherst School of Public Health and Health Sciences Research Day Award Winner - \$1500
2020 – 2021	UMass Amherst Kinesiology Department Graduate Student Annual Travel Award - \$150
2018 – 2019	Outstanding Teaching Assistant Recognition – <i>MCB Department, University of Connecticut</i>
2017 – 2019	Academic All-American – <i>American Collegiate Hockey Association</i>
2017 – 2018	Dean's List – <i>University of Connecticut School of Engineering</i>

Affiliations, Leadership, and Service

2021 – present	National Biomechanics Day – Lead Organizer
2020 – present	American Society of Biomechanics UMass Amherst Student Chapter – Vice President
2020 – present	American Society of Biomechanics Member
2020 – present	National Center for Neuromodulation for Rehabilitation Member
2019 – 2020	University of Michigan Undergraduate Student Research Program Mentor

Industry Experience

Karl Storz Endovision., Charlton, MA

Continuous Improvement Intern, May 2018 - August 2018

- Implemented lean manufacturing techniques such as Kanban and Six Sigma to improve device production.
- Improved machine shop product flow by creating an efficient work environment and improving work culture.

Medtronic, North Branford, CT

Research and Design Intern, May 2017 - August 2017

- Performed feasibility and reliability testing on prototypes utilizing high tech machinery to optimize design.
- Analyzed data using Minitab to formulate statistical analysis of data sets and decide on design factors.

Academic Projects

Leveraging Wearable Technology for Identifying Mechanisms of Running Related Injuries

Dissertation Project – Musculoskeletal & Orthopedic Biomechanics Lab, September 2021 – Present

- Running is one of the most accessible and popular forms of exercise, but almost half of all runners are injured each year. Patellofemoral pain accounts for a large proportion of those injuries and is known to cause alterations to neuromuscular control and biomechanics. Typically, biomechanical adaptations are measured in a lab environment, but clinicians do not have access to labs. Thus, the goal of this project is to develop a clinically translatable system that can measure adaptations displayed by individuals with patellofemoral pain using inertial measurement units and machine learning models.

A Data Mining Approach for Determining Gait Abnormalities in Runners with Patellofemoral Pain Syndrome

Research Project – Musculoskeletal & Orthopedic Biomechanics Lab, May 2021 – Present

- Biomechanics studies yield massive datasets that measure angles and loadings on joints along with muscle activation patterns. Typically, researchers extract single variables and test for statistical differences between groups. In this approach, I sought to use data science techniques such as principal component analysis and machine learning to understand which features of running gait are different between runners with and without patellofemoral joint pain.

Analysis of Aging Related Changes in Postural Control Using Time to Contact

Research Project – Musculoskeletal & Orthopedic Biomechanics Lab, October 2020 – Present

- Force plates utilize force transducers to generate forces in three dimensions, which can then be transformed to calculate metrics of the center of pressure (COP) such as its position, velocity, and acceleration. Time to contact, a metric derived from these features of the COP, is related to the perceived time to make postural corrections to prevent falls. In this project, I investigate how time to contact differs between younger and older adults to assess postural control.

Academic Projects (continued)

An Exploration of Inertial Measurement Data in NCAA Division 1 Ice Hockey Players

Regression Analysis Class Project, September 2022 – Present

- Inertial data collected from microelectromechanical inertial measurement units provide data for coaches and sports performance teams to improve athlete performance. In this project, we explored a large data set derived from Catapult Sports units and used regression analyses techniques to help the UMass Amherst Ice Hockey sports performance team assess player load, determine athletes at high risk of injury, and ultimately optimize player performance.

A Data Visualization of Ski Resorts and Statistics Across the United States

Data Visualization Class Project, January 2022 – May 2022

- The United States hosts many ski resorts with varying levels of terrain, skiable acreage, and difficulty. Many skiers and snowboarders plan trips to various mountains throughout the US, so we sought to develop an interactive map with all the ski resorts (and their statistics) across the country that helps people plan ski-related trips. This data visualization dashboard was a map developed using HTML, the D3 JavaScript library, and GitHub for collaboration purposes.

Movie Recommendation Engine with a Simulated Feedback Analysis

Statistical Computing Class Project, August 2021 – December 2021

- A project inspired by the famous Netflix Prize competition, we sought to understand the self-modifying effects of recommendation algorithms which effectively create their own data to use in subsequent predictions and effect those predictions in unknown ways. We employed several machine learning algorithms for the recommendation engine, then ran a user-rating simulation to understand how the user's movie selections deviated from the original recommendations.

Pawpularity Contest – Generating a Cuteness Score of Adoptable Pets using Machine Learning Approaches

Machine Learning Class Project, August 2021 – December 2021

- A picture is worth a thousand words, but a picture can also save many lives. Animals up for adoption in Malaysia are often posted to a website with a photograph of the animal. Data has shown that animals with more appealing photos are more likely to be adopted. In this project, I built a convolutional neural network using TensorFlow to predict how appealing a pet photograph is, which achieved a good learning rate and a low root mean square error.

Data Science Projects

NASDAQ Stock History Analysis and Prediction

Data Science Portfolio Project – January 2024

- As most people could guess, the stock market is unstable and often unpredictable. For a long time, financial researchers have investigated if time-series data can predict future market trends. As expected, this is very challenging given fluctuations in the market. However, data science approaches such as exploratory data analysis, variance analysis, and machine learning models can provide valuable information for analyzing stock market trends. Through this project, I explored NASDAQ data, analyzed variability with PCA, and built several machine learning models to predict future stock price.

Heart Disease Prediction with UCI Dataset

Data Science Portfolio Project – December 2023

- The estimated prevalence of heart disease in the United States is about 7% as of 2023, costing the country north of \$200 billion annually. Using the UCI dataset, which consists of features related to age, sex, chest pain, blood pressure, cholesterol level, and more, I developed several supervised classification models to predict if a person would experience heart disease, resulting in an accuracy of 85%. This model could be useful for early detection and prevention of heart disease, ultimately increasing quality of life and expectancy.

Gait Speed Classification with Wearable Sensors and Deep Learning

Data Science Portfolio Project – January 2023

- Gait speed (i.e., the time it takes to ambulate over a certain distance) is an important predictor of aging, pathology, or injury. As people age or suffer from a musculoskeletal disorder, they tend to walk slower. Typically, gait speed is collected in a laboratory environment, however wearable sensors allow for longitudinal monitoring of movement outside of a lab environment. In this project, I used an open-source dataset of signals from inertial measurement units to classify gait speed of 22 participants with deep learning and a leave one subject out cross validation approach.

Abnormal Heartbeat Detection using Deep Learning

Data Science Portfolio Project – December 2022

- Digital health sensing technologies are gaining popularity for a variety of applications, such as for identifying problematic heartbeats that could require further clinical evaluation. In this project, I used a dataset with healthy and abnormal audio recorded heart beats. Signals were digitized to numerical format and these data were used to train a deep learning model for classifying if a heartbeat was normal or not. This model performed well, classifying abnormal heartbeats with high accuracy.

Skills

Programming Languages:

- Python (advanced – 4+ years)
- Matlab (advanced – 6+ years)
- R (advanced – 4+ years)
- Labview (beginner – 2 years)
- SQL (Intermediate – 2 years)

Data Science:

- Data cleaning and preprocessing
- Data analysis (Pandas, NumPy)
- Signal processing
- Feature extraction and engineering
- Dimensionality reduction (PCA)
- Hypothesis testing
- Regression modeling
- Data visualization (ggplot2, matplotlib, seaborn)
- Supervised machine learning (scikit-learn)
- Unsupervised machine learning (clustering)
- Deep learning (pytorch, tensorflow)
- ML operations (Weights and Biases, MLflow)
- Version control (Git)
- Microsoft excel

Entrepreneurial:

- Customer discovery
- Business model canvas development
- Lean startup methodology
- Pitch deck creation and presentation
- Market and cost analyses
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Movement Science Research:

- Wearable Technology (IMUs, EMG, HR)
- Human Subjects Research
- Medical imaging (MRI, CT, Ultrasound)
- Image processing (Dragonfly ORS, 3d Slicer)
- Motion Capture (Qualysis, Vicon, Visual 3D)
- Electromyography (Delsys, BioPac, Neuraxon)
- Force Plates (AMTI, Bertec)
- Instrumented treadmills
- Institutional Review Board (IRB)

Engineering Software:

- SolidWorks CAD
- Ansys FEA

Commercial Project Management:

- Agile
- Kanban
- Six Sigma

Soft Skills:

- Communication
- Problem solving
- Teamwork
- Adaptability
- Leadership
- Time management
- Interpersonal
- Attention to detail

References

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