Maria Cardei

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Research Interests

My research interests lie at the intersection of machine learning, biomedical engineering, and healthcare. With expertise in both biomedical engineering and computer science, I bring a highly interdisciplinary approach to developing multi-modal, data-driven solutions for high-dimensional data in precision health. I thrive in collaborative, interdisciplinary teams and am eager to apply my experience to new challenges, continually seeking to learn and explore innovative approaches.

Education

- **Ph.D. in Computer Science —** Expected 2028
  M.C.S in Computer Science — Expected 2025
  University of Virginia, Charlottesville, VA, USA (Advisor: Professor Afsaneh Doryab)
  - GPA: 4.0

- **B.S. in Biomedical Engineering, minor in Computer Science** — May 2023
  University of Florida, Gainesville, FL, USA
  - GPA: 3.94

Publications

- **M.Cardei**, S. Ahmed, G. Chapman, A. Doryab, “Pairwise Spatiotemporal Partial Trajectory Matching for Co-Movement Analysis”, Preprint available at arXiv:2412.02879 [cs.CV]. Paper in submission.

- A. Balch, **M. Cardei**, A. Doryab, “Exploring Smartphone-based Spectrophotometry for Nutrient Identification and Quantification”, Preprint available at arXiv:2410.11027 [physics.med-ph]. Paper in submission.

- A. Balch, **M. Cardei**, S. Kranz, A. Doryab, "Towards an Accessible, Noninvasive Micronutrient Status Assessment Method: A Comprehensive Review of Existing Techniques", Preprint available at arXiv:2408.11877 [q-bio.QM]. Paper in submission.

- **M. Cardei**, A. Doryab, "Practical Heuristics for Victim Tagging During a Mass Casualty Incident Emergency Medical Response", paper in *2024 IEEE 20th International Conference on Automation Science and Engineering (CASE)*, Bari, Italy 2024.

- **M. Cardei**, A. Doryab, “Multi-Agent System for Optimizing Victim Tagging in Human/Autonomous Responder Team”, abstract in *2024 15th ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS)*, Hong Kong, China 2024.

- S. Davidashvilly, **M. Cardei**, M. Hssayeni, C. Chi, B. Ghoraani, “Deep neural networks for wearable sensor-based activity recognition in Parkinson's disease: investigating generalizability and model complexity”, paper in *Biomedical Engineering Online.* 2024.

Research & Project Experience

- Graduate Research Assistant — August 2023-present
  University of Virginia, Charlottesville, VA, USA (Advisor: Professor Afsaneh Doryab)
  - Designing an accessible device to non-invasively assess internal biological processes
  - Developed an image analysis-based framework for detecting movement patterns using partial trajectory matching, incorporating object detection and Siamese Neural Networks
  - Analyzed human behavioral rhythms through advanced machine learning techniques
  - Formulated a multi-agent problem and designed distributed heuristics for scalable simulation, employing agent-based modeling for generalizable solutions
  - Contributed to the development and application of a novel image representation approach to enhance human activity recognition and identify behavioral variations within and across individuals

- Machine Learning for Image Analysis Course Project – Fall 2024
  University of Virginia, Charlottesville, VA, USA
  - Implemented supervised contrastive learning for the classification of medical brain scan images, enhancing model performance for accurate diagnostics

- Natural Language Processing Course Project – Fall 2024
  University of Virginia, Charlottesville, VA, USA
  - Curated and pre-processed data for a Retrieval-Augmented Generation (RAG) model to support a science tutoring system for 5th grade students
  - Contributed to the overall LLM architecture and front-end/back-end integration
  - Utilized Python, GPT, Django, React, HTML, CSS, and GitHub for development
  - Evaluated output quality based on reading ease and grade level using Flesch-Kincaid Grade and Flesch Reading Ease scales

- Human-Robot Interaction Course Project —Spring 2024
  University of Virginia, Charlottesville, VA, USA
  - Designed and performed controlled user study with NAO robot to test robot persuasiveness in a customer service setting
  - Programmed NAO robot to recognize speech and have an interaction with participants
  - Use statistical analyses to determine robot persuasiveness

- Signal Processing, Machine Learning, and Control Course Project — Fall 2023
  University of Virginia, Charlottesville, VA, USA
  - Used a smartwatch (ASUS Zenwatch 2) for human activity recognition
  - Collected and pre-processed data, and implemented more than 10 machine learning models and feature selection for human activity recognition

- NSF REU Research Intern — May 2022-January 2023
  Florida Atlantic University Institute for Sensing and Embedded Network Systems Engineering (I-SENSE), Boca Raton, FL, USA (Mentor: Professor Behnaz Ghoraani)
    - Applied domain adaptation techniques with Python to generalize human activity recognition models to the Parkinson's population
    - Evaluated deep learning model complexity and data augmentation strategies

- Senior Design Project in Collaboration with HangTech LLC — August 2021-May 2022
  University of Florida, Gainesville, FL, USA
    - Designed a device and system that detects and classifies tremors for Parkinson's and Essential Tremor patients
    - Collected accelerometer data with Arduino
    - Utilized MATLAB and Python to develop a machine learning classification model

- REU Research Intern — May-August 2021
  Wake Forest Center for AI Research, Winston Salem, NC, USA (Mentor: Professor Metin Gurcan)
    - Detected cell nuclei in medical pathology images using deep learning and image processing techniques
    - Implemented Faster R-CNN models and pre-processed medical imaging datasets with MATLAB and Python
    - Researched and presented advanced object detection algorithms

- Computer Applications for Biomedical Engineering Course Project — Fall 2020
  University of Florida, Gainesville, FL, USA
    - Detected Diabetic Retinopathy (DR) in fundus images using image processing techniques
    - Developed a MATLAB model to import dataset, preprocess images, eliminate vessels, subtract optic disks, segment exudates, and classify DR severities

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Technical Skills & Tools

Programming Languages: Python, MATLAB, C++, Java
Machine Learning & Data Science Frameworks: TensorFlow, PyTorch, Scikit-learn, OpenCV
Data Analysis: Pandas, NumPy, SciPy
High-Dimensional Data Analysis Techniques: Multi-modal data integration, feature extraction, biomarker data analysis, model training and evaluation
Deep Learning & Specialized Techniques: Image analysis, CNNs, Siamese Neural Networks, medical image analysis, object detection, image preprocessing
Software & Development Tools: Google Colab, Jupyter Notebooks, Git for version control
Data Visualization: Matplotlib, Seaborn

Teaching Experience

- Graduate Teaching Assistant for Computational Behavior Modeling (CS6501) — Fall 2024
  University of Virginia, Charlottesville, VA, USA
    - Manage assignments, host office hours, and aid discussion for 17 graduate students

- Teaching Assistant — June-August 2023
  Girls Who Code Summer Immersion Program, Virtual
  - Delivered an engaging game design curriculum to high school girls (JavaScript,p5.js)
  - Collaborated with the teaching team to foster an inclusive environment for students to explore the STEM field
  - Debugged and checked over student projects during office hours, personalized assistance

- Teaching Assistant for Elements of Electrical Engineering (EEL3003) — Fall 2020
  University of Florida, Gainesville, FL, USA
  - Taught students course material at weekly office hours
  - Responsible for grading assignments and Arduino Build Reports

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Course Experience

Graduate:
Machine Learning for Image Analysis; Natural Language Processing; Machine Learning; Human-Robot Interaction; Cyber-Physical Systems: Formal Methods, Safety and Security; Cyber-Physical Systems: Technology and Ethics; Computational Behavior Modeling; Signal Processing, Machine Learning, and Control

Undergraduate:
Introduction to Data Science, Introduction to Multimodal ML in Python, Operating Systems, Introduction to Computer Organization, Data Structures/Algorithms, Programming Fundamentals 1 & 2, Applied Discrete Structures, Clinical Engineering Design, Quantitative Physiology, Computer Applications for Biomedical Engineering, Biosignals & Systems, Biomedical Instrumentation

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Volunteering

- Charlottesville High School Mentorship Program Mentor— August 2024-present
  University of Virginia, Charlottesville, VA, USA
  - Co-mentor senior high school student in his engineering capstone project
  - Weekly check-ins with student to assist with technical questions and time management

- Fluvanna SPCA Website Designer and Developer – May 2024-present
  Fluvanna County Society for the Prevention of Cruelty to Animals, VA, USA
  - Collaborate in bi-weekly meetings to align on design goals and strategies
  - Develop and optimize the website to effectively showcase the organization and support animal adoptions

- Paper Reviewer — March 2024-present
  University of Virginia, Charlottesville, VA, USA
  - Provided reviews of 3 potential publications for *ACM Health* and *IMWUT*

- Computer Science Graduate Student Group Social Chair — January 2024-present
  University of Virginia, Charlottesville, VA, USA

- Coordinate, plan, and run 2-3 social events every month for CS graduate students
- Elected by computer science graduate students for a one-year term

- Outreach Event Volunteer — January 2024-present
  University of Virginia, Charlottesville, VA, USA
  - Represented the UVA CS graduate program at 3 graduate and faculty recruitment events
  - Panelist at new graduate student orientation discussion "What to Expect at UVA CS"

- Wake Forest Biomedical Informatics Internship Alumni Panelist — June 2023
  Wake Forest University, Winston Salem, NC, USA
  - Invited to speak at "How to Find the Right Career Path" discussion panel for current undergraduate student interns
  - Sparked insightful discussion about career paths and inspired students to consider graduate school

- Content Co-developer and Co-teacher — June 2022
  Florida Atlantic University I-DeepLearn Summer Outreach Program, Boca Raton, FL, USA
  - Co-developed and delivered curriculum for I-DeepLearn summer outreach program
  - Introduced high school girls to deep learning through hands-on projects

Accomplishments, Awards, and Honors

- President's Provost Fellowship — August 2023-August 2028
  University of Virginia, Charlottesville, VA, USA

- National Science Foundation National Research Traineeship (NRT) (Cyber-Physical Systems) — August 2023-August 2024
  University of Virginia, Charlottesville, VA, USA

- Computer Science Scholar — August 2023- May 2024
  University of Virginia, Charlottesville, VA, USA

- Poster Presentation: **M. Cardei**, H. Binol, M. Gurcan, L. Cooper, D. Jaye, Nuclei Detection in Immunohistochemical Images of Diffuse Large B-Cell Lymphoma using Deep Learning,
  Biomedical Engineering Society (BMES) Conference, October 2021.
  Orlando, Florida, USA

- President's Honor Roll — May 2020
  University of Florida, Gainesville, FL, USA

- Florida Bright Futures Scholarship – July 2018-May 2023
  University of Florida, Gainesville, FL, USA