

# CAILONG HUA

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A **Ph.D. candidate** with expertise in LLMs, Machine Learning, Signal Processing and Data Analysis, driven by a passion for pushing the boundaries of AI in the medical area.

## EDUCATION

- Ph.D. in Electrical Engineering with Computer Science Minor** 08/2019 - 12/2025 (*Expected*)  
University of Minnesota - Twin Cities | GPA: 3.95/4.0
- Master of Science in Control Systems** 09/2016 - 09/2017  
Imperial College London, London | GPA: 75.4/100 (Distinction)
- Bachelor of Science in Automation Engineering** 09/2015 - 07/2016  
Politecnico di Milano, Milano | GPA: 110/110
- Bachelor of Engineering in Electronic Information and Engineering** 09/2012 - 07/2016  
Tongji University, Shanghai | GPA: 89.52/100(4.45/5.0)

## RESEARCH EXPERIENCE

- Error Quantification for Non-Equilibrium Experiments with Limited Data** 06/2020 - *Present*  
*Ph.D. Thesis Project*
- Developed an algorithm for quantifying errors in non-equilibrium experiments
  - Released a Python-based toolbox for error quantification and validated on simulated spring-mass system
  - Validated the algorithm through Optical Tweezers experiments under high-noise conditions
- Single Molecule Modeling of Muscle Proteins** 06/2021 - *Present*  
*Ph.D. Thesis Project*
- Designed force spectroscopy experiments to characterize muscle proteins associated with muscular dystrophy
  - Automated analysis of experimental data with Matlab, reducing processing time from days to hours
  - Resolved electrostatic discharge issues in atomic force microscopy experiments through collaborative troubleshooting
  - Developed Monte Carlo simulation to replicate experimental processes
  - Conducted statistical analysis of experimental data to model muscle proteins
  - Reconstructed energy landscapes of proteins from noisy and uncertain data
  - Collaborated with biochemists to investigate the impact of different expression systems on protein behavior
- Identification of single molecule force spectroscopy data** 03/2023 - *Present*  
*Ph.D. Thesis Project*
- Compiled single-molecule force spectroscopy (SMFS) datasets from four biologically significant proteins
  - Developed a physics-based Monte Carlo engine to simulate force spectroscopy data
  - Designed a novel deep learning model incorporating the physics of protein unfolding to identify single-molecule data
  - Reduced the time required to extract meaningful statistics from days to under an hour using our model
- Coordinating Wind Turbines in a Wind Farm** 10/2016 - 09/2017  
*Master Thesis Project*
- Developed mechanical models for individual wind turbines
  - Created a wind farm model integrated with the electrical grid
  - Designed a control strategy to optimize power generation based on frequency variations

## PROFESSIONAL EXPERIENCE

- Data Scientist Intern** 05/2024 - 08/2024  
*University of Phoenix, Inc.*
- Fine-tuned large language models (LLMs) on task-specific data
  - Evaluated various parameter-efficient fine-tuning (PEFT) methods on different pre-trained LLMs
  - Developed a chatbot in Amazon Web Service (AWS) to interface with fine-tuned LLMs

## PROJECTS

- Determining Causality in Protein Unfolding Pathways** 09/2022 - 12/2022
- Uncovered causal relations from protein pulling data
  - Quantified the change of effects among protein properties
  - Investigated causality under the assumption of unobserved data
- Different Sampling Methods in Energy-Based Models (EBMs)** 09/2022 - 12/2022
- Explored Langevin-based sampling methods in a 2D localization problem
  - Applied sampling techniques to EBMs, reducing computational workload and improving performance on the MNIST dataset
- Deep Learning Based Pose-Guided Person Image Generation** 09/2021 - 12/2021

- Utilized Generative Adversarial Networks (GANs) to generate realistic images of individuals in target poses
- Enhanced person transfer performance using the HUMBI dataset

### Performance Discrepancy in Natural Language Processing (NLP)

09/2020 - 12/2020

- Explored the impact of fine-tuning layers and pooling strategies on BERT (a transformer based machine learning technique for NLP) performance
- Achieved improvements in accuracy and F1 score over the baseline method

### Advanced Control Techniques for Dynamic Systems

10/2016 - 05/2020

- Implemented PID control on both simulated and real-world unmanned aerial vehicles (UAVs).
- Applied PID and model predictive control (MPC) to stabilize an inverted pendulum system.
- Designed and implemented  $H_\infty$  control for the experimental aircraft.
- Modeled and developed linearized control strategies for autonomous grocery trolleys.
- Applied double PID, LQR,  $H_\infty$ , and  $\mu$ -synthesis control techniques for robust stabilization.

### Automating Game Playing Using Deep Reinforcement Learning

09/2019 - 12/2019

- Designed an unsupervised agent to autonomously play the Flappy Bird game
- Applied Reinforcement Learning techniques to AI agent to learn the optimal policy and survive indefinitely

## PUBLICATIONS

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### Journal Publications

- **Hua, C.**, Rajaganapathy, S., Slick, R.A., Vavra, J., Muretta, J.M., Ervasti, J.M., and Salapaka, M.V., "A physics-augmented deep learning framework for classifying single molecule force spectroscopy data." *Proceedings of the 2025 International Conference on Machine Learning (ICML)*. Accepted.
- Ramirez, M.P., Rajaganapathy, S., Hagerty, A.R., **Hua, C.**, Baxter, G.C., Vavra, J., Gordon, W.R., Muretta, J.M., Salapaka, M.V., and Ervasti, J.M., "Phosphorylation alters the mechanical stiffness of a model utrophin fragment." *Journal of Biological Chemistry*, 299(2), 2023.
- Rajaganapathy, S.\*, **Hua, C.\*** and Salapaka, M.V., "Quantifying errors in the Jarzynski estimator." Under review, *Physical Review E*. (\*Co-first authors\*).
- **Hua, C.**, Vavra, J., Powers, J., Muretta, J.M., Ervasti, J.M., and Salapaka, M.V., "Multiple modes of atomic force microscopy reveal distinct mechanical properties for dystrophin and utrophin not manifest by small fragments." In preparation.
- **Hua, C.**, Slick, R.A., Vavra, J., Muretta, J.M., Ervasti, J.M., and Salapaka, M.V., "Two operational modes of atomic force microscopy reveal similar mechanical properties for homologous regions of dystrophin and utrophin." *bioRxiv*, 2024:2024-05. In preparation.

### Talks, Presentations, and Posters

- **Hua, C.** and Salapaka, M.V., "Assessing mechanical properties of a utrophin fragment with two operational modes." *Bulletin of the American Physical Society*, 2024.
- **Hua, C.**, Rajaganapathy, S., and Salapaka, M.V., "Quantifying errors in the Jarzynski estimator." *9th Midwest Workshop on Control and Game Theory*, Poster, 2023.
- Rajaganapathy, S., **Hua, C.**, and Salapaka, M.V., "Confidence bounds for the Jarzynski estimator." *APS March Meeting Abstracts*, Vol. 2022, pp. S09-007, 2022.

### Reviewed for contributed articles in

- International Conference on Learning Representations (ICLR)
- American Control Conference (ACC)

## SKILLS

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**Technical:** Python, AWS, Matlab, Simulink, Latex, C, C++, R

**Machine Learning Tools:** Tensorflow, Pytorch, Scikit-Learn, Seaborn, Pandas, etc.

**Communication:** English; Chinese; Italian

## TEACHING EXPERIENCE

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### Teaching Assistant

09/2020 - Present

*University of Minnesota, Twin Cities*

- Assisted in multiple labs: Linear Control Systems Lab, State Space Control Systems Lab, Electric Drives Lab, Digital System Design Lab and Microcontrollers Lab
- Transitioned the entire laboratory to an online format during the COVID time
- Modernized aging experiments using hardware-in-the-loop (HIL) control and developed new instructional manuals
- Mentored new teaching assistant

## HONORS & AWARDS

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Electrical & Computer Engineering Department Fellowship, University of Minnesota

2019

Outstanding Graduate, Tongji University

2016