Rachel Luo

PHD CANDIDATE IN ELECTRICAL ENGINEERING · MACHINE LEARNING, COMPUTER VISION, AND ROBOTICS

Stanford, California

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Education

Stanford University *Stanford, CA*

PHD IN ELECTRICAL ENGINEERING *2017 - Present*

- Advisors: Prof. Marco Pavone and Prof. Silvio Savarese
- Thesis: Sample-Efficient Uncertainty Calibration for Reliable Autonomous Systems

Stanford University *Stanford, CA*

M.S. IN ELECTRICAL ENGINEERING *2014 - 2017*

- Conducted research in machine learning and computer vision with Prof. Silvio Savarese
- Conducted research in device physics with Prof. Eric Pop

Massachusetts Institute of Technology *Cambridge, MA*

B.S. IN ELECTRICAL ENGINEERING AND COMPUTER SCIENCE, MINOR IN MATHEMATICS *2010 - 2014*

- Elected to Tau Beta Pi and Eta Kappa Nu honor societies (GPA: 4.9/5.0)
- Conducted research with Prof. Tomás Palacios on MoS_2 flash memory

Research Interests

Machine learning, computer vision, robotics, uncertainty quantification and calibration, distribution shift detection and mitigation, foundation models. I am particularly interested in developing autonomous systems that can reason about uncertainty in unstructured real-world environments, where the systems are complex and may be composed of classical algorithms, specialized learning-based components, and general-purpose foundation models.

Publications

PREPRINTS

Sample-Efficient Safety Assurances using Conformal Prediction *(extended version)*

RACHEL LUO, SHENGJIA ZHAO, JONATHAN KUCK, BORIS IVANOVIC, SILVIO SAVARESE, EDWARD SCHMERLING, MARCO PAVONE

Invited to a special issue of the International Journal of Robotics Research (IJRR) featuring the best papers of WAFR 2022

Online Distribution Shift Detection via Recency Prediction

RACHEL LUO, ROHAN SINHA, YIXIAO SUN, ALI HINDY, SHENGJIA ZHAO, SILVIO SAVARESE, EDWARD SCHMERLING, MARCO PAVONE

arXiv preprint: https://arxiv.org/abs/2211.09916

A System-Level View on Out-of-Distribution Data in Robotics

ROHAN SINHA, APOORVA SHARMA, SOMRITA BANERJEE, THOMAS LEW, RACHEL LUO, SPENCER RICHARDS, YIXIAO SUN, EDWARD SCHMERLING, MARCO PAVONE

arXiv preprint: https://arxiv.org/abs/2212.14020

Privacy Preserving Recalibration under Domain Shift

RACHEL LUO, SHENGJIA ZHAO, JIAMING SONG, JONATHAN KUCK, STEFANO ERMON, SILVIO SAVARESE

arXiv preprint: https://arxiv.org/abs/2008.09643

PUBLICATIONS

Local Calibration: Metrics and Recalibration

RACHEL LUO*, AADYOT BHATNAGAR*, YU BAI, SHENGJIA ZHAO, HUAN WANG, CAIMING XIONG, SILVIO SAVARESE, STEFANO ERMON, EDWARD SCHMERLING, MARCO PAVONE

Conference on Uncertainty in Artifical Intelligence (UAI), 2022

Sample-Efficient Safety Assurances using Conformal Prediction

RACHEL LUO, SHENGJIA ZHAO, JONATHAN KUCK, BORIS IVANOVIC, SILVIO SAVARESE, EDWARD SCHMERLING, MARCO PAVONE

Workshop on the Algorithmic Foundations of Robotics (WAFR), 2022

Belief Propagation Neural Networks

JONATHAN KUCK, SHUVAM CHAKRABORTY, HAO TANG, RACHEL LUO, JIAMING SONG, ASHISH SABHARWAL, STEFANO ERMON

Conference on Neural Information Processing Systems (NeurIPS), 2020

Scene Semantic Reconstruction from Egocentric RGB-D-Thermal Videos

RACHEL LUO, OZAN SENER, SILVIO SAVARESE

International Conference on 3D Vision (3DV), 2017

Analytical Model of Graphene-Enabled Ultra-Low Power Phase Change Memory

AARON ALPERT*, RACHEL LUO*, MEDHI ASHEGHI, ERIC POP, KENNETH GOODSON

IEEE Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems (ITherm), 2016

Using Iterated Local Search for Solving the Flow-Shop Problem

ANGEL JUAN, HELENA LOURENCO, MANUEL MATEO, RACHEL LUO, QUIM CASTELLA

International Transactions in Operational Research, 2013

Experience

Stanford Autonomous Systems Lab
Stanford, CA

RESEARCH ASSISTANT, ADVISED BY PROF. MARCO PAVONE
2021 - Present

- Research focus: rigorously quantifying uncertainty to improve the safety and reliability of autonomous systems
- Applied uncertainty quantification techniques to better calibrate confidences for foundation models used in robotics applications
- Designed a novel algorithm for quickly detecting distribution shifts in online settings, with a guaranteed false positive rate
- Developed a general-purpose framework for providing safety assurances over the actions of an autonomous system using the statistical inference technique of conformal prediction

Stanford Vision Lab
Stanford, CA

RESEARCH ASSISTANT, ADVISED BY PROF. SILVIO SAVARESE
2016 - Present

- Designed a novel uncertainty calibration metric that interpolates between global and individual notions of uncertainty, and leverages rich learned feature representations; developed a corresponding algorithm that improves this metric
- Worked on predicting hand motion trajectories from high-dimensional video data of human hands performing everyday actions
- Developed 3D scene reconstruction and 3D semantic segmentation algorithms leveraging egocentric RGB, depth, and thermal video data

J.P. Morgan AI Research
New York, NY

RESEARCH INTERN, WITH NAFTALI COHEN
Summer 2020

- Improved uncertainty calibration for predicting buy/sell opportunities based on stock market data
- Learned a distribution over future stock market values based on historical data to facilitate improved decision-making for buy/sell actions

Stanford Nanoelectronics Lab
Stanford, CA

RESEARCH ASSISTANT, ADVISED BY PROF. ERIC POP
2014 - 2016

- Worked on thermoelectric energy harvesting using novel nanomaterials
- Created Matlab simulations to model the power and voltage outputs for thermoelectric generators of various materials

Maxim Integrated
San Jose, CA

POWER ELECTRONICS INTERN, WITH SEAN GOLD
Summer 2014

- Designed a programmable step-down power supply module optimized for size and ease of use; final module design was about 1.5% of the original size and required very few external components
- Automated frequency response testing for a power supply datasheet

MIT Microsystems Technology Lab
Cambridge, MA

UNDERGRADUATE RESEARCHER, ADVISED BY PROF. TOMAS PALACIOS
2012 - 2013

- Designed and fabricated a flash memory device on MoS_2
- Built functioning MoS_2 transistors and measured their I-V characteristics

Cisco Systems
San Jose, CA

POWER ELECTRONICS INTERN, WITH BOB BALLENGER
Summer 2013

- Performed PSpice simulations and power system testing in lab
- Used Allegro to perform CAD reviews on various circuit boards

Internet Interdisciplinary Institute
Barcelona, Spain

STUDENT RESEARCHER, ADVISED BY PROF. ANGEL A. JUAN
Summer 2012

- Implemented and tested an iterated local search algorithm to find its effectiveness in solving the Flow Shop Problem
- Conducted a literature review on the Green Vehicle Routing Problem

Talks

Incorporating Sample Efficient Monitoring into Learned Autonomy

Jan. 2023   Stanford Robotics Seminar

Nov. 2022   NASA University Leadership Initiative Seminar

Sample-Efficient Safety Assurances using Conformal Prediction

Jun. 2022   Workshop on the Algorithmic Foundations of Robotics

Awards

2015   **NSF Graduate Fellowship**, National Science Foundation (NSF)

2014   **Stanford Graduate Fellowship**, Stanford University

2012   **EECS-Intel Undergraduate Research and Innovation Scholar**, Massachusetts Institute of Technology

2012   **Tau Beta Pi**, Massachusetts Institute of Technology

2012   **Eta Kappa Nu**, Massachusetts Institute of Technology