Carl Louis Mueller

Roboticist, Software Engineer, Entrepreneur

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Research Foci

Robot Learning from Demonstration

Develop algorithms and systems that enable robotic systems to learn from human counterparts during collaborative tasks in order to create generalized plans for future autonomous behavior.

Constrained Robotic Learning Systems and Motion Planning

Use abstract constraints to enhance the learning capacity of robotics systems and provide guarantees of safe behavior by developing novel constrained motion planning algorithms that leverage robot Learning from Demonstration models.

Human-Robot Interfaces for Learning from Demonstration

Design and evaluate interfaces that best enable human operators to effectively and intuitively communicate important information about tasks demonstrated to a robotic learning system.

Education

University of Colorado Boulder — Boulder, CO
Ph.D. Candidate in Computer Science — 9/2017–1/2023 *Expected*

Dissertation: "Safer Collaborative Robots through Constrained Motion Planning and Learning from Demonstration"

Committee: Prof. Bradley Hayes (Advisor); Prof. Christoffer Heckman; Prof. Alessandro Roncone, Prof. Nisar Ahmed; Laura Hiatt, Ph.D.

University of Colorado Boulder — Boulder, CO
Master of Science in Computer Science — Awarded 8/2021

Santa Barbara City College — Santa Barbara, CA
Continuing education: engineering, mathematics, and computer science. — 9/2012–12/2015

University of California Santa Barbara — Santa Barbara, CA
B.S. in Biopsychology — 9/2007–4/2011

Experience

University of Colorado Boulder — Boulder, CO
Research Assistant — 1/2021–Current

Research assistant in the Collaborative Artificial Intelligence and Robotics (CAIRO) laboratory, funded under the ASIRT "Natural Language Constraint-based Learning from Demonstration" and the NSF NRI "Life-long Learning for Motion Planning in Human Populated Environments" grants.

University of Colorado Boulder — Boulder, CO
Teaching Assistant — 9/2019–1/2021

Teaching Assistant for CSCI3308 - Software Development Methods and Tools.

GetUsPPE — Boulder, CO
Engineer / Volunteer — 3/2020–9/2020

Helped start GetUsPPE.com, a national volunteer and donation organization dedicated to getting hospitals Personal Protective Equipment (PPE) during the COVID-19 pandemic.

Circadence Corporation — Boulder, CO
Research Engineer — 6/2019–11/2019

Contributed to the design and implementation of automated redteaming software for Department of Defense cybersecurity research efforts.

Lightning in a Bot, Inc Los Angeles, CA

Co-Founder / CTO 8/2015–9/2017

Co-founded a startup that developed chatbots to serve analytics reports for e-commerce companies.

Qualtek Molecular Laboratories Santa Barbara, CA

Research Scientist / Project Manager 4/2011–7/2014

Designed and tested clinical assays as companion diagnostics for oncology therapeutics.

Management Skills

Management Approach	Empowers team members by leveraging the skills and expertise of individuals and by delegating challenging tasks to the right person. Focuses team development efforts and direction at the highest value-added contributions needed by the company. Resolves conflict through honest communication, logical understanding of the problem, and an open mind.
Technical Management Skills	Extensive experience mapping out project feasibility against known constraints, choosing appropriate technology stacks, and directing development efforts. Excellent communicator evidenced through publications, grant proposals, and public speaking. Experienced with uncertainty/unstructured problem domains as a researcher and co-founder. Well-versed in Agile software development and best-practices.

Research Skills

Research Management	Organized, principled, and hypothesis-driven execution of projects. Value-added focus to ensure quality contributions.
Technical Writing	Strong technical writing skills evidenced through publications, workshops, fellowships, and grant proposals.
Public Speaking	Confident and experienced speaker in front of technical and layman audiences alike by adapting content legibility to the expertise of the audience.
Personal Skills	Punctual. Committed to seeing things through. A natural self-starter. Eager and quick to learn new topics, fields, and technologies.

Projects

Augmented Reality (AR) Interfaces for Learning from Demonstration (LfD) *CAIRO Lab*

Summary: Currently extending an AR interface to enable use of a data tong for motion capture-based teleoperation. Utilizes online pose optimization to generate feasible robot configurations for visualization in AR. The prior system allows users to interact with a Constrained LfD robot learning system by allowing users to edit constraints, update learned models, and visualize expected robot behavior.

Skills/Technologies: ROS, Motion Capture, Human-Trials Design, Pose Optimization, Unity/Hololens

Constrained Learning from Demonstration *CAIRO Lab*

Summary: Implemented CAIRO lab's entire Learning from Demonstration (LfD) stack utilizing the ROS ecosystem: from human demonstration capture, to robot learning, to skill execution. This stack supports the LfD algorithm Concept Constrained Learning from Demonstration. It also integrates user interfaces that allow behavioral constraint annotation on learned skills. The system's modularity supports a variety of experiment designs and robot platforms.

Skills/Technologies: ROS, Motion Capture, Human-Trials Design, Pose Optimization, Unity/Hololens, Variational Gaussian Mixture Models, Kernel Density Estimation

Constrained Motion Planning Software *CAIRO Lab*

Summary: Built a software/simulation stack in order to implement the novel algorithm called Intersection Point Dependence Relaxation that helps solve constrained multimodal/sequential manifold planning problems using constrained robot LfD models.

Skills/Technologies: ROS, Constrained Motion Planning (Toploogy Theory, Jacobian Projection), PyBullet Simulation, Non-linear Multiobjective Optimization (OpEn in Rust, GEKKO in Python)

Automated Pen Testing Software *Circadence Corporation*

Summary: Contracted to implement an automated penetration testing suite for defense clients. Designed the system to utilize a microservices design to support a modular OS-agnostic system and to utilize Google Protocol Buffers as the message carrier in order to integrate with established company software.

Skills/Technologies: Google Protocol Buffers, Microservice Architecture, Kali Linux, Pen-tests for multiple OS

Back-end Asynchronous Chatbot Support *Lightning in a Bot, Inc*

Summary: Developed a PostgresSQL database system (over 1 million entries across hundreds of clients) and back-end Node.js server to handle thousands of websocket integrated chat queries per second, with analytics and report generation built on top of AWS Lambda for massively parallel load distribution. Implemented the entire NLP / information extraction pipeline to support parameter extraction from these queries.

Skills/Technologies: Query Classification, Intent-Slot Paradigm, Information Extraction, Node.js, Websockets, Heroku, Redis, MongoDB, PostgreSQL, AWS Lambda, EC2, S2, Elastic Beanstalk

Technical Skills/Expertise

Autonomous Systems	ROS, Constrained Motion Planning, Sampling-based Motion Planning, Learning from Demonstration, Trajectory Optimization, Human Trials Design, MoveIt, PyBullet, RVIZ
Machine Learning & AI	Bayesian Learning (VGMM), Optimization Theory, Classification, Clustering, Ensembles, Dimensionality Reduction, State Estimation, (PO)MDPs, NLP, *Familiar with*: Neural Networks / Deep Learning, Reinforcement Learning, Computer Vision (SLAM)
Software Engineering	VCS(git), OOP Design, Concurrency, Pub/Sub Architecture, Microservices, Containerization, Bash Scripting, Testing Design/QA, Documentation
Frameworks & Cloud	Django, Node.js, MongoDB, PostgreSQL, Redis, Heroku, AWS EC2, S3, RDS, EB, Lambda
Programming Languages	Python, Javascript, *Familiar with*: C++, Rust

Talks

2021 WARP-WOF Workshop RSS

2021 Talking Robotics Seminar Series

2020 Robotics Summer Series Seminar at CU Boulder

2020 Twenty-Fifth AAAI/SIGAI Doctoral Consortium New York City

2019 CU Boulder Aerospace Ventures Research Blitz Speaker

2018 TedX Mile High Adventure Interactive Presentation

Academic Service, Membership, and Outreach

Teaching	CU Boulder's CSCI3308 - Software Development Methods and Tools; 3 Semesters
Conference and Journal Review	*THRI*: ACM Transactions on Human-Robot Interaction *HRI*: ACM/IEEE International Conference on Human-Robot Interaction *ICRA* IEEE International Conference on Robotics and Automation *IROS*: IEEE/RSJ International Conference on Intelligent Robots and Systems
Professional Membership	ACM, IEEE
Outreach	2018 TEDxMileHigh Adventure

Awards

2020 HRI Pioneer

2019 AAAI Doctoral Consortium

2018/2019 Outstanding PhD Researcher Department Award

Mentorship

Graduate	**Ashwin Sankaralingam, M.S** 8/2018–12/2018	*CU Boulder*
Undergraduate	**Micah Zhang, B.S.** 2/2019–12/2019	*CU Boulder*

Publications

Conferences

In Submission: Mueller, C., & Hayes, B. (2023). Intersection Point Dependence Relaxation for Sequential Manifold Planning using Learning from Demonstration. *The 22nd International Conference on Autonomous Agents and Multiagent Systems*

Luebbers, M. B., Brooks, C., Mueller, C. L., Szafir, D., & Hayes, B. (2021). ARC-LfD: Using Augmented Reality for Interactive Long-term Robot Skill Maintenance via Constrained Learning from Demonstration. *2021 IEEE International Conference on Robotics and Automation (ICRA)*, 3794–3800

Mueller, C., Venicx, J., & Hayes, B. (2018). Robust Robot Learning from Demonstration and Skill Repair using Conceptual Constraints. *2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 6029–6036

Workshops

Mueller, C., Tabrez, A., & Hayes, B. (2021). Interactive Constrained Learning from Demonstration Using Visual Robot Behavior Counterfactuals. *Proceedings of the Accessibility of Robot Programming and Work of the Future Workshop at RSS.*

Mueller, C. L. (2020). Abstract Constraints for Safe and Robust Robot Learning from Demonstration. *Proceedings of the AAAI Conference on Artificial Intelligence*, *34*(10), 13728–13729

Mueller, C. L., & Hayes, B. (2020). Safe and Robust Robot Learning from Demonstration through Conceptual Constraints. *Companion of the 2020 ACM/IEEE International Conference on Human-Robot Interaction*, 588–590. https://doi.org/10.1145/3371382.3377428

Extracurricular Activities

Deming Center Venture Fund - Portfolio Manager

For three semesters I served as the portfolio manager for the Deming Center Venture Fund, an accredited venture capital firm run by graduate students within the CU Boulder business school.

Racer X Cycling / Colorado Bike Law Team Member

As a member for two years, I raced amateur mountain bike and cyclocross events and volunteered at local events/races in the greater Denver area.