

Murtaza Rangwala

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RESEARCH PROFILE

My research investigates unified representations and high-throughput execution for single- and multi-agent reinforcement learning. I am the sole creator and principal architect of Coordination for Scale RL (casRL), an open-source research framework whose compiler and runtime convert typed algorithm and experiment compositions into validated, prebound execution plans. casRL unifies more than 100 algorithms and variants across online, offline, hybrid, single-agent, and multi-agent learning and sustains 2–4 million environment steps per second during end-to-end single-node training on one CPU and one GPU. I also develop learning and coordination methods for heterogeneous robotic systems.

EDUCATION

Virginia Tech

Ph.D. Candidate in Electrical Engineering

Dissertation: “Composable Systems for Unified Single- and Multi-Agent Reinforcement Learning.”

Advisor: R. K. Williams.

Blacksburg, VA

Expected Dec. 16, 2026

Virginia Tech

M.S. in Electrical Engineering

PES Institute of Technology (now PES University)

B.E. in Electrical and Electronics Engineering

Blacksburg, VA

Dec. 2020

Bengaluru, India

2008 – 2012

RESEARCH EXPERIENCE

Laboratory for Coordination at Scale, Virginia Tech

Ph.D. Researcher, 2020–Present; M.S. Researcher, 2017–2020

Blacksburg, VA

- **casRL — Sole Creator and Principal Architect, 2020–Present.** Designed and built an open-source research framework whose compiler and runtime convert typed RL and MARL experiment compositions into validated, prebound execution plans.
- Designed a composable experiment lifecycle in which users define the order, timing, repetition, and synchronization of rollout, inference, training, evaluation, teacher and target updates, and user-defined operations across synchronous and asynchronous multi-trainer schedules.
- Unified live environments, offline datasets, and hybrid sources through the same typed, device-resident dataflow, supporting heterogeneous combinations of environments, datasets, policies, replay, and training requests.
- Implemented more than **100 RL and MARL algorithms and variants** from reusable operators spanning on- and off-policy, online, offline, hybrid, supervised, imitation, teacher–student, model-based, safety-constrained, auxiliary, and federated learning.
- Represented safety, planning, world models, auxiliary learning, and coordination as independent experiment elements with separately composable policies, losses, optimizers, trainers, and synchronization schedules.
- Supported policy-internal coordination through message passing and attention together with policy-external k-NN, graph, and hypergraph construction over agent and environment structure.
- Sustained **2–4 million environment steps per second** during end-to-end training on a single node with one CPU and one GPU through compiled execution, device-resident processing, and zero-copy data movement where tensor aliasing is valid.
- **Prior work leading to casRL, 2018–2020.** Independently reimplemented MD–MADDPG from its published specification when no author code was available, reconstructing its learned shared-memory communication mechanism. I then created SARNet and its multiprocessing TensorFlow trainer; the observed data-movement and runtime limits motivated casRL’s device-resident, zero-copy PyTorch architecture. SARNet was published at NeurIPS 2020.
- Developed DeepPaSTL for long-horizon pasture prediction and co-developed a data-synthesis, prediction, and intermittent multi-robot deployment pipeline; published in *Agronomy* and IEEE T-ASE.
- Developed field-topology feedback using Morton Z-codes to coordinate heterogeneous swarms over spatially structured fields; ICRA 2027 manuscript in preparation.
- Serve as sole administrator for CASLab’s research and computing infrastructure, maintaining laboratory equipment and servers, repairing hardware, managing the laboratory website, and performing system upgrades and software installations.

ADDITIONAL RESEARCH PROJECTS

- Distributed Multi-Agent Asynchronous Advantage Actor–Critic (A3C)** 2018
- Implemented distributed multi-agent A3C for mixed cooperative–competitive environments using centralized critics and asynchronous actor execution.
- Autonomous Driving with Multi-Timescale Hierarchical Reinforcement Learning** 2018
- Investigated hierarchical multi-agent reinforcement learning for joint motion planning and trajectory control in autonomous-driving systems.
- CHIRP Laboratory Research** 2018
- Supported statistical analysis and parameter estimation for binary black-hole mergers observed by the Laser Interferometer Gravitational-Wave Observatory.
- Autonomous Drone** 2018
- Trained an autonomous flight policy from a large crash dataset using reinforcement learning, ROS, and TensorFlow.
- Power Electronics and Optimization** 2012
- Evaluated neural-network and particle-swarm methods for economic load dispatch and derived state-space averaged transfer functions for non-ideal DC–DC converters with parasitic components.

INDUSTRY & STARTUP EXPERIENCE

- Co-Founder** Jan. 2016 – Apr. 2017
LightSpeed Mobility Ahmedabad, India
- Defined product strategy and led engineering for two electric two-wheelers; launched one at a lower price than comparable products in India.
 - Raised more than \$200K through private investment and crowdfunding.
- EE System Leader** Dec. 2013 – Sep. 2015
Volvo Trucks Bengaluru, India
- Led a cross-functional pre-study involving more than 40 people on Ethernet-based ECU software delivery and directed technical execution of a large-scale cost-optimization program.
 - Led engineering, product planning, and purchasing for a new suspension-control product.
- EE System Design Engineer** Jul. 2012 – Dec. 2013
Volvo Trucks Bengaluru, India
- Architected electrical and ECU systems for medium-duty trucks in Southeast Asia and redesigned the electrical system to reduce cost by 2%.
 - Pioneered a physical-layer vehicle-network simulation as an advanced-engineering project, replacing hardware prototypes for existing-product verification.
 - Served as the primary technical owner for body-builder applications.

PUBLICATIONS

- J. Liu, **M. Rangwala**, K. S. Ahluwalia, S. Ghajar, H. S. Dhami, P. Tokekar, B. F. Tracy, and R. K. Williams. “Intermittent Deployment for Large-Scale Multi-Robot Forage Perception: Data Synthesis, Prediction, and Planning.” *IEEE Transactions on Automation Science and Engineering*, 21(1):27–47, 2024.
- **M. Rangwala**, J. Liu, K. S. Ahluwalia, S. Ghajar, H. S. Dhami, B. F. Tracy, P. Tokekar, and R. K. Williams. “DeepPaSTL: Spatio-Temporal Deep Learning Methods for Predicting Long-Term Pasture Terrains Using Synthetic Datasets.” *Agronomy*, 11(11):2245, 2021.
- **M. Rangwala** and R. K. Williams. “Learning Multi-Agent Communication through Structured Attentive Reasoning.” *Advances in Neural Information Processing Systems (NeurIPS)*, 33:10088–10098, 2020.

PATENT

- **M. Rangwala**. “Method and System for Driver Assistance for a Vehicle.” U.S. Patent 9,889,847, granted Feb. 13, 2018; corresponding filings in Europe, India, Japan, and China.

MANUSCRIPTS IN PREPARATION

- **M. Rangwala** and R. K. Williams. “casRL: A Compiler and Runtime for Composable Reinforcement Learning Systems.” Manuscript in preparation; targeting MLSys 2027.
- **M. Rangwala** and R. K. Williams. “casRL: Composable Systems for Unified Single- and Multi-Agent Reinforcement Learning.” Manuscript in preparation; targeting JMLR.
- **M. Rangwala** and R. K. Williams. “Field-Topology Feedback via Morton Z-Codes for Heterogeneous Swarm Coordination.” Manuscript in preparation; targeting ICRA 2027.

ENGINEERING LEADERSHIP

Team Haya | Formula SAE Suspension and Brakes

Team Lead, PESIT

- Led a three-person suspension and brakes team through subsystem design, vehicle integration, and skidpad validation.
- Won the Skid Pad event at SUPRA SAE India 2011 against 44 teams, demonstrating the vehicle's handling and suspension performance.

PISat | 5.25 kg Remote-Sensing Nanosatellite

Team Captain and Electrical Power Systems Lead, PESIT

- Captained the PISat student satellite program and led electrical power-system design with former ISRO scientists; the satellite launched aboard PSLV-C35.
- Designed radiation-aware power reliability and fault tolerance that supported one year of successful on-orbit operation.

TEACHING EXPERIENCE

Graduate Teaching Assistant | Virginia Tech

Mar. 2018 – Present

- Led undergraduate power-engineering laboratories, including instruction and demonstrations.
- Assessed assignments and examinations in introductory circuit analysis, including grading for a 113-student course.

Guest Lecturer | PESIT

Aug. 2013 – Dec. 2013

- Designed and delivered research-informed course material to more than 50 undergraduate students.

Private Mathematics and Physics Tutor

Apr. 2016 – May 2017

- Delivered 15 hours of individualized instruction per week to a twelfth-grade student, using Socratic questioning to develop analytical reasoning.

REVIEWING

- **Reviewer:** NeurIPS, ICLR, ICML, and IEEE Robotics and Automation Letters (RA-L).

TECHNICAL SKILLS & INTERESTS

Programming: Python, C, C++, MATLAB

ML Systems: PyTorch, torch.compile, CUDA, TensorFlow, NumPy, PufferLib

Learning & Robotics: RL, MARL, offline RL, imitation learning, GNNs, MPNNs, attention, world models, planning, ROS, Gazebo

Systems & Engineering: Linux, Docker, Git, SolidWorks, CATIA, CANoe, Simulink

Interests: Self-hosted infrastructure and network administration; local LLM deployment and inference; workstation assembly; automotive diagnostics and repair; e-commerce price monitoring and discount research