

# Dario Fumarola

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## RESEARCH INTERESTS

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Agentic LLM systems; multi-agent interaction and emergent behavior; reinforcement learning for long-horizon decision-making; influence and coordination dynamics in networked environments; robust evaluation under distribution shift; scalable simulation testbeds and efficient inference.

## EDUCATION

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### Washington and Lee University

Bachelor's Degree in Computer Science and Mathematics

Lexington, VA

Aug 2019 – May 2023

- **Honors:** Davis United World College Scholar
- **Relevant coursework:** Deep Learning, Real Analysis, Differential Geometry, Probability, Social Networks.

## PROFESSIONAL EXPERIENCE

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### Solutions Developer, Prototyping Team

New York, NY

Amazon Web Services (AWS)

Jun 2023 – Present

- Lead 10+ customer-facing rapid prototyping engagements as the technical owner, coordinating developer teams and senior stakeholders to turn ideas into concrete AI solutions influencing \$100M+ in annual recurring revenue.
- Design and implement end-to-end prototypes using LLMs, tool-using agents, and RL-based perception/control pipelines for robotics, industrial automation, and knowledge workflows.
- Engineered high-throughput training pipelines on multi-GPU clusters, identifying and resolving I/O bottlenecks and data-loading latency to ensure full saturation of compute resources during distributed runs.
- Build real-time and near-real-time decision pipelines that route streaming sensor and event data into ML policies and control logic, meeting strict millisecond-scale latency and safety constraints.
- Define success metrics and automated evaluation harnesses, and distill prototypes into reference architectures and infrastructure-as-code that customer teams can extend toward production.

## PRESENTATIONS & PAPERS

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**Fumarola, D.**, Tan Ruan, J. *Knobs of the Mind: Dopamine, Serotonin, and a Maze-Running Rover*. International Conference on Machine Learning (**ICML Expo**), 2025.

**Fumarola, D.**, et al. *Who Needs Attention Anyway? Elastic State Models for Real-Time Streaming Tasks*. Neural Information Processing Systems (**NeurIPS Expo**), 2025.

**Fumarola, D.**, Gaikwad, A. *Broadcast-Gain: A 2-Byte, Stop-Gradient Control Plane to Trim Long-Tail Latency*. New York Reinforcement Learning Workshop (**NY-RL**), 2025.

**Fumarola, D.**, et al. *Sandbox Societies: Phase Transitions in Cooperation and Deception Among Networked LLM Agents*. Manuscript in preparation for Special Interest Group on Discourse and Dialogue (**SIGDIAL**), 2026.

## PATENTS

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**Fumarola, D.**, Ferhatosmanoglu, H., Wagner, T., Warfield, A. *Selective Vector Replication for Nearest Neighbor Search*. P89832-US01, 2025 — Filed.

## RESEARCH EXPERIENCE

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### Machine Learning Researcher

New York, NY

Amazon Science

Dec 2023 – Present

- Part of research rotation collaborating with Amazon Scholars to investigate billion-scale similarity search for the Amazon S3 Vectors service, analyzing HNSW neighborhood structure and developing replication strategies.
- Design and study neuromodulated reinforcement learning and attention mechanisms for agent control tasks, from grid mazes and procedurally generated environments to quadruped robots and protein folding scenarios.
- Lead large-scale experiments and contribute analysis and writing across these projects, resulting in reports, conference presentations, and IP on distributed vector search and adaptive compute for real-time decision-making.

### Undergraduate Researcher, Mathematics

Lexington, VA

Washington and Lee University

Jan 2022 – May 2023

- Studied numerical methods for nonlinear ordinary differential equations with emphasis on stability, stiffness, and eigenvalue-based analysis.
- Implemented MATLAB experiments to compare time-stepping schemes and to visualize phase portraits and stability regions for representative dynamical systems.
- Produced clear write-ups and reproducible scripts enabling other students and faculty to replicate experiments and reuse visualizations in advanced coursework.

## TEACHING & MENTORING

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### Course Assistant, MATH 332: Ordinary Differential Equations

Lexington, VA

Washington and Lee University

Fall 2021

- Authored comprehensive  $\text{\LaTeX}$ -based solution guides and review materials covering existence and uniqueness, boundary value problems, and numerical integration schemes.
- Held weekly office hours and exam review sessions to help students build intuition for nonlinear dynamics, phase portraits, and stability concepts.
- Supported MATLAB-based modeling assignments, guiding 30+ students in implementing numerical solvers and interpreting simulation results.

## CERTIFICATIONS & MEMBERSHIPS

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**Certifications:** AWS Cloud Practitioner; AWS Solutions Architect; AWS Machine Learning – Specialty.

**Memberships & Activities:** IEEE; ACM; AAI; oSTEM; W&L Williams Investment Society (Tech Group).

## SELECTED PROJECTS

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### Neuromodulated RL for Maze Navigation & Quadruped Robots

2025

Implemented an actor-critic policy with three neuromodulatory “mood knobs” and showed that a single frozen network can be retuned across grid mazes and on a Jetson-Nano quadruped robot without retraining.

### Elastic State Models for Streaming Control

2025

Built an elastic compute layer on top of a streaming state-space model that activates extra latent-space correction steps only near fragile states, demonstrated on a grid-maze agent and a protein loop “repair” control task.

### Broadcast-Gain Overlay for Cooperative MARL

2025

Developed a 2-byte, stop-gradient broadcast overlay for PPO+GAE agents in congested junction grids with packet drop, engineering the simulator, overlay logic, and evaluation to trim long-tail latency.

### Cloud-Native Distributed Vector Search on S3

2024

Designed and implemented a hierarchically partitioned, cloud-native vector search prototype on Amazon S3 using distributed indexing and benchmarking against disk-based baselines.