Rishav Aryan

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Summary

Research Engineer with expertise in implementing machine learning algorithms, reinforcement learning loops (PPO, GRPO) and self-adaptive frameworks for optimized performance. Skilled in designing and scaling distributed GPU infrastructure and robust evaluation pipelines to support large-scale experiments. Experienced in adversarial robustness studies and post-training alignment of multimodal models.

Independent Research Projects

Enough Thinking - Efficient Reasoning via RL-Driven Self-Adaptation | Link

- Frontier reasoning models (e.g., DeepSeek-R1) exhibit "rumination," consuming excessive tokens on simple logic and increasing inference costs.
- A base **0.5B LLM achieved a GSM8K accuracy of 0.20** and required 218 tokens per query without Induction of Explicit Verification.
- Engineered a proof-of-concept system to incentivize token efficiency and permanent weight-internalization of reasoning patterns using limited compute (Google Colab).
- Implemented **Group Relative Policy Optimization (GRPO)** from scratch to induce emergent reflection; designed a **SEAL-inspired self-edit loop** utilizing **LoRA and ReSTEM** RL to "cache" logic into parameters.
- Improved accuracy to **0.30 (+50%) while reducing token overhead by 48% (218 → 112 tokens); deployed via Model Context Protocol (MCP)** for deterministic tool-use via API.

Search-Embedding-Lab | Training Transformer Embeddings for Semantic Search | Link

- Dense retrieval quality is often limited by weak hard-negative discrimination and opaque pretrained embeddings, making it difficult to reason about failure modes in search systems.
- Implemented a **transformer encoder from scratch in PyTorch** and trained a **dual-encoder dense retriever** using **in-batch InfoNCE contrastive learning**.
- Designed **asymmetric query/document encoders** (light query, deeper document) to better match query entropy and document complexity while preserving fast inference.
- Introduced **BM25-based hard-negative mining** and built a full **FAISS-backed evaluation pipeline** reporting **Recall at K, MRR, and nDCG**.
- Achieved **Recall = 0.84 on BEIR (SciFact)**, demonstrating competitive retrieval performance with a from-scratch architecture.

Experience

George Mason University | *Research Assistant --- Machine Learning & Reinforcement Learning*　　　Jul 2025 - Present

- Financial time-series data is highly non-stationary; standard RL policies often collapse or "overfit" during sudden market regime shifts.
- Static PPO-based allocation models failed to maintain alpha when market volatility spiked. Baseline performance was limited to a Sharpe ratio of ~0.85 – 0.95 and a Sortino ratio of ~1.10, with an alpha near +0.05 that vanished during regime changes.
- Engineered a regime-aware RL system capable of autonomously distinguishing between market states and deployed as a scalable distributed system to ensure steerable and stable policy learning.
- Developed latent state representations using VAE + GMM and implemented hierarchical PPO-based policies with realistic risk constraints, leveraging probability and statistics to optimize performance.
- Achieved a consistent Sharpe ratio of 1.23 and positive alpha of +0.23, satisfying the engineering rigor required for regulated foundation models for deployment in products.

Wall Street Quants | *Quantitative Research Intern*　　　Jul 2024 - Oct 2024

- Cryptocurrency markets exhibit extreme non-stationarity and "regime blindness," where standard momentum models frequently collapse or suffer from excessive drawdown during sudden market reversals.
- Baseline trading models were achieving 18% annualized returns but lacked the volatility filters and calibration necessary to survive high-variance periods across the top-10 crypto assets.
- Engineered and calibrated a suite of adaptive momentum and reversal strategies designed to balance high-yield returns with rigorous, real-time risk management.
- Developed and backtested strategies using Python and software engineering best practices, implementing RSI and moving average calibrations across thousands of simulated scenarios to identify the most stable parameters.
- Developed and backtested algorithmic trading strategies, applying statistics and calculus to boost annualized returns from 18% to 25% (+38% improvement) and improve the Sharpe ratio by 15%.

Foxmula | *Machine Learning Intern*　　　May 2022 - Jul 2022

- HR analytics at scale often lack predictive depth, leading to reactive decision-making and significant "human-in-the-loop" latency when identifying employee dissatisfaction or promotion eligibility.
- The department relied on manual data triage, costing 10+ hours weekly in analysis and failing to provide a structured pipeline for proactive strategic initiatives.
- Developed and deployed an automated, end-to-end ML pipeline to identify key drivers of dissatisfaction and accurately predict promotion pipelines with high interpretability.
- Implemented ensemble models (XGBoost, Stacking) and engineered specialized tenure and skill-gap features; automated the entire deployment via AWS and TensorFlow.
- Achieved 90% precision (+15% improvement in accuracy) and saved 10+ hours weekly, transforming a manual bottleneck into an automated, data-driven system.

Publications

- First Author, ACL 2026 Submission. Learning to Act Anywhere: Experience-Based Similarity for Universal Interface Agents.. *training-free cross-platform UI agents using FAISS-based Elastic Visual Memory, achieving ~40% higher task success under interface perturbations with 83 ms per-step latency.*
- Co-Author, NLDB 2025. Multimodal Event Detection: Current Approaches and Defining the New Playground through LLMs and VLMs.. *systematic evaluation of multimodal ED identifying failure modes of generative LLM/VLM approaches and conditions where supervised fusion models outperform.*

Technologies

- **Programming Languages:** Python, SQL, Rust (Familar)
- **ML & Frontier Reasoning:** Transformers, Preference Optimization (RLHF/RLAIF), Reinforcement Learning, LoRA, Natural Language Processing, GMMs, VAEs
- **Agentic & Multimodal Systems:** Vision-Language Models (VLM), Retrieval-Augmented Generation (RAG), Model Context Protocol (MCP)
- **Infrastructure & Scale:** vLLM, PyTorch, FAISS, FastAPI, Docker, AWS (Lambda, EC2, S3), Distributed Systems, TensorFlow
- **Research Practice:** Problem Framing, End-to-End ML Pipelines, Ablation Studies, Robustness Evaluation
- **Core Competencies:** Software Engineering, Linear Algebra, Calculus, Probability, Statistics

Education

George Mason University | *Masters, Data Analytics and Engineering*　　　Aug 2023 - May 2025

Vellore Institute of Technology (India) | *Bachelors, Electronics and Communication Engineering*　　　Jun 2019 - Jul 2023