Ayush Agrawal

PhD Student, MILA - Quebec AI Institute and University of Montreal

ayushagrawal1801@gmail.com
ayush1801.github.io
github.com/ayush1801
linkedin.com/in/ayush-agrawal-7841b1178
@TheFavAyush
Google Scholar

Education

University of Montreal and MILA, Canada — *2024 - present*
PhD in Computer Science — GPA: 4.3/4.3
Advisors: Aaron Courville, Navin Goyal

Birla Institute of Technology and Science Pilani, India — *2017 - 2022*
B.E. Computer Science and M.Sc. Economics — GPA: 9.48/10 | distinction
Thesis: Formal theorem proving through AI lenses
Advisor: Navin Goyal, Microsoft Research

Research Experience

MILA - Quebec AI Institute — Montreal, Canada
Graduate Researcher — *2024 - present*
Topics: automated mathematical discovery (conjecturing, interestingness), LLM reasoning and post-training

Microsoft Research — Bangalore, India
Visiting Scholar (2024-present), Research Fellow (2022-2024), Research Intern (2021-2022) — *2021 - present*
Advisors: Navin Goyal, Adam Tauman Kalai, Lester Mackey, Siddhartha Gadgil
Topics: RLVR optimization, safety alignment, LLM hallucination, autoformalisation and proof search, interpretability

Artificial Intelligence Lab, Otto von Guericke University — Magdeburg, Germany (Remote)
Research Intern | Advisor: Sebastian Stober — *Summer 2021*
Topics: audio source separation, generative audio modelling

Data Science Lab, University of Twente — Enschede, Netherlands (Remote)
Research Intern | Advisor: Christin Seifert — *Summer 2020*
Topics: generative models for medical imaging, synthetic data augmentation

Publications

2026 **Automated Conjecturing: Generation, Selection, and Evaluation**
Ayush Agrawal, Vedant Shah, Navin Goyal, Ankit Anand, and Aaron Courville
Preprint, under review

2025 **Shape of Thought: When Distribution Matters More than Correctness in Reasoning Tasks**
Abhranil Chandra*, **Ayush Agrawal***, Arian Hosseini, Sebastian Fischmeister, Rishabh Agarwal, Navin Goyal, and Aaron Courville (*equal contribution)
Preprint, under review

2025 **Towards Demystifying the Optimization Landscape of RLVR Methods**
Samyak Jain, **Ayush Agrawal**, Navin Goyal
FoRLM Workshop, NeurIPS 2025

2025 **Language Models' Factuality Depends on the Language of Inquiry**
Tushar Aggarwal*, Kumar Tanmay*, **Ayush Agrawal***, Kumar Ayush, Hamid Palangi, Paul Pu Liang (*equal contribution)
Preprint

2025 **Learn Globally, Speak Locally: Bridging the Gaps in Multilingual Reasoning**
Jaedong Hwang, Kumar Tanmay, Seok-Jin Lee, **Ayush Agrawal**, Hamid Palangi, Kumar Ayush, Ila Fiete, Paul Pu Liang
Preprint

2024 **Do Language Models Know When They're Hallucinating References?**
Ayush Agrawal, Mirac Suzgun, Lester Mackey, and Adam Tauman Kalai
Findings of the Association for Computational Linguistics: EACL 2024; ICBINB Workshop, NeurIPS 2023
Covered in Nature News, Jan 2025: "AI hallucinations can't be stopped — but these techniques can limit their damage"

2023 **Aesop Gets the Fables: Towards a Hybrid Proof Search Using Ingredient Prediction by Language Models**
Siddhartha Gadgil, **Ayush Agrawal**, Anand Rao Tadipatri, and Navin Goyal
Preprint

2023 **Ambient Intelligence for Securing Intelligent Vehicular Networks: Edge-Enabled Intrusion and Anomaly Detection Strategies**
Tejasvi Alladi, **Ayush Agrawal**, Bhavya Gera, Vinay Chamola, Biplab Sikdar, and F. Richard Yu
IEEE Internet of Things Magazine

2022 **Towards Automating Formalisation of Theorem Statements using Large Language Models**
Siddhartha Gadgil, Anand Rao Tadipatri, **Ayush Agrawal**, Ashvni Narayanan, and Navin Goyal
MATH-AI Workshop, NeurIPS 2022

2022 **Towards a Mathematics Formalisation Assistant using Large Language Models**
Ayush Agrawal, Siddhartha Gadgil, Navin Goyal, Ashvni Narayanan, and Anand Tadipatri
Preprint

2022 **NovelADS: A Novel Anomaly Detection System for Intra-vehicular Networks**
Kushagra Agrawal, Tejasvi Alladi, **Ayush Agrawal**, Vinay Chamola, and Abderrahim Benslimane
IEEE Transactions on Intelligent Transportation Systems

2021 **Deep Neural Networks for Securing IoT Enabled Vehicular Ad-hoc Networks**
Tejasvi Alladi, **Ayush Agrawal**, Bhavya Gera, Vinay Chamola, Biplab Sikdar, and Mohsen Guizani
IEEE International Conference on Communications (ICC 2021)

2021 **DeepADV: A Deep Neural Network Framework for Anomaly Detection in VANETs**
Tejasvi Alladi, Bhavya Gera, **Ayush Agrawal**, Vinay Chamola, and F. Richard Yu
IEEE Transactions on Vehicular Technology

Selected Awards and Honors

- **Bourse J.A. DeSève Award** (2026): Awarded through the Bourses d'excellence competition of Études supérieures et postdoctorales (ESP), UdeM. (*8K CAD*)
- **FRQNT Scholar** (2026): Awarded at the provincial level for the proposed AI4Math research program. (*100K CAD*)
- **AI for Math Fund Winner** (2025): One of the 29 winners worldwide for the proposed AI for Math Fund by **Renaissance Philanthropy**. (*242K USD*)
- **Bourse d'exemption UdeM** (2024): Awarded to carry out PhD at UdeM. (*44K CAD*)
- **DAAD WISE Scholar** (2021): Awarded to 100 students across India for engaging in research in German universities. (*3.5K CAD*)
- **MITACS GRI Scholar** (2021): Awarded to 2000 students worldwide for engaging in research in Canadian universities. (*4K CAD*)
- **Reserve Bank of India Scholar** (2021): Awarded to 120 students across India to carry out projects under RBI. (*4K CAD*)
- **IASc SRFP Fellow** (2020): Awarded to 300 students across India to carry out projects in Indian public Institutions. (*2K CAD*)
- **BITS Merit Scholarship** (2017-2022): Awarded to top 1% students in the institute. (*13K CAD*)

Selected Research Projects

Automated Conjecturing: Generation, Selection, and Evaluation *2026*
Role: *Project Lead* | Advisors: Ankit Anand, *Google DeepMind (GDM)*, Navin Goyal, *Microsoft Research (MSR)*, Aaron Courville, *MILA*

- Designed a controlled framework in the Peano formal environment that evaluates conjectures by how much training on their proofs improves a fixed prover on held-out theorems, across three mathematical domains.
- Showed that structurally perturbing known statements beats Minimo's learned self-play conjecturer by 6–13 percentage points at an equal training budget.
- Proposed *Hard Neighbours*, a selection score favouring conjectures whose proof difficulty grows disproportionately to their structural distance from easier statements.

Shape of Thought: When Distribution Matters More than Correctness in Reasoning Tasks *2025*
Role: *Project Lead* | Advisors: Rishabh Agarwal, *GDM*, Navin Goyal, *MSR*, Aaron Courville, *MILA*

- Challenged the "correctness-is-key" paradigm in data curation by showing that model-generated CoTs with incorrect final answers can be a superior training signal to human-verified data.
- Designed a novel experimental framework to disentangle data correctness from distributional alignment, using paraphrasing and controlled error injection to test the core hypotheses.

Towards Demystifying the Optimization Landscape of RLVR Methods *2025*
Role: *Collaborator* | Advisor: Navin Goyal, *MSR*

- Showed that GRPO's objective decomposes into likelihood maximization on correct rollouts and minimization on incorrect ones, and that each term's global minima are degenerate (entropy and length collapse, or entropy and length explosion).
- Identified the advantage-design choices that steer GRPO toward good minima despite these bad optima, and showed that clipping stabilizes training even when learning only from incorrect rollouts.

Concept Generalisation and Safety Failures *2024*
Role: *Project Lead* | Advisor: Navin Goyal, *MSR*

- Observed cross-concept generalisation alongside prompt-template overfitting when training data was biased towards a particular template.
- Found preliminary evidence of hierarchical concept learning when training concepts with opposing behaviours.

Hallucination Detection in LLMs *2023*
Role: *Project Lead* | Advisors: Adam Tauman Kalai, *OpenAI*, Lester Mackey, *MSR*

- Introduced references generation as a benchmark for hallucination study for LLMs.
- Discovered that combination of direct and indirect question strategies helps in detecting hallucinations with AUC of 0.93.

Formal theorem proving using Hybrid Proof Search *2023*
Role: *Project Lead* | Advisors: Siddhartha Gadgil, *IISc Bangalore*, Navin Goyal, *MSR*

- Proposed a neurosymbolic approach for leveraging proof ingredients and powerful tactics, such as Aesop, in proof search.
- Finetuned LMs to output these proof ingredients with $\sim 60\%$ accuracy.

LLMs as Mathematics Autoformalisation assistants *2022*
Role: *Project Lead* | Advisors: Navin Goyal, *MSR*, Siddhartha Gadgil, *IISc Bangalore*

- Developed various prompting strategies for autoformalisation of proofs and theorem statements.
- Conducted a comprehensive study to analyse emergent capabilities & limitations of LLMs in mathematics formalisation.

Research Software

Open-Source Tool, HilbertProverX (2026): Reproduction of the Hilbert recursive theorem prover in Lean 4, reaching 74.5% on MiniF2F-test, with an analysis of its failure modes. Code

Services, Teaching and Leadership Roles

Convening Talk, AI for Math Fund, Renaissance Philanthropy (2026): Gave a talk on "Automated Conjecturing: Generation, Selection, Evaluation".

Invited Speaker, Microsoft Research Montreal (2025): Gave a talk on "Shape of Thought" work.

Invited Speaker, TIFR Centre for Applicable Mathematics (TIFR-CAM), Bangalore (2023): Gave a talk on: "Large Language Models: Better Reasoners or Storehouses of Knowledge?"

Reviewer: ICLR 2027, EMNLP 2025, MATH-AI Workshop @ NeurIPS 2023.

Teaching Assistant, BITS Pilani (2020-2021): Led tutorial sessions and graded assignments for *Microprocessors & Interfacing* (CS) and *Fundamentals of Financial Accounting* (Economics).

Academic Mentor, Student Academic Cell, BITS Pilani (2018-2019): Taught supplementary lectures in *General Biology* for first-year students.

Member, Student Faculty Council, BITS Pilani (2019): Advised the faculty on new course offerings and curriculum changes.

Volunteer, Akshaya Patra Foundation (2018): Analysed sourcing data to reduce raw-material costs for the Mid-Day Meal programme; volunteered as a teacher.

Technical Skills

PyTorch, Hugging Face Transformers, vLLM, verl, DeepSpeed, Lean 4