AGAM GOYAL

https://agoyal0512.github.io   Madison, Wisconsin, USA   agamg2@illinois.edu
+1 (608) 867-9142

Education		
	University of Illinois at Urbana-Champaign, Champaign, IL	**May 2024 − Present**

Doctor of Philosophy (Ph.D.) in Computer Science

Areas of Focus: Machine Unlearning, Computational Modeling of Online Behavior

University of Wisconsin − Madison, Madison, WI   **Sep 2020 − May 2024**

Bachelor of Science with Comprehensive Honors

Majors: Computer Science (Honors), Mathematics, and Data Science
Minors: Economic Analytics
Honors Thesis: *Learning Latent Spatiotemporal Patterns to Predict Emergent Properties of Complex Dynamical Systems* advised by Dr. Hanbaek Lyu

Honors		

Trewartha Senior Honors Thesis Research Award − $1500   **2023**
  Grant awarded to ∼18 students for an honors thesis based on significance of research proposal.

Bromley Conference Travel Award − $500   **2023**
  Grant awarded to support international travel to conferences for oral presentation.

Hilldale Undergraduate Research Fellowship − $4000   **2023**
  Grant awarded to ∼100 undergraduates for soundness and significance of research proposal.

Summer Study Scholarship − $1000   **2021, 2022, 2023**
  Scholarship awarded for summer study based on academic excellence.

UW-Madison Team @ ProjectX, UofT AI   **2022**
  Led the UW-Madison team at UofT AI's international-level machine learning competition.

NSF Research Experience for Undergraduates (REU) Grant − $4000   **2022**
  Grant awarded for the NSF-funded REU program.

Welton Honors Summer Sophomore Research Apprenticeship Grant − $3000   **2022**
  Grant awarded to ∼25 undergraduates for soundness and significance of summer research.

IIT-JEE Advanced Qualified   **2020**
  Achieved top 1%-ile in entrance examination to IITs– top engineering institutes in India.

KVPY Fellowship Examination Round Qualified   **2019**
  Young Researcher Fellowship, IISc Bangalore, India.

NTSE Scholar   **2018**
  Awarded to ∼1000 grade 10 students by the Government of India for higher studies.

Publications	

∘ **For an updated list of publications and status, please see my Google Scholar profile.**
∘ **Equal contribution is denoted by** *

7. (Under Review) Goyal, Agam* and Hanbaek Lyu. "Learning low-rank mesoscale spatiotemporal patterns in complex dynamical systems." arXiv preprint (2024)

6. (Under Review) Yun-Shiuan Chuang, Zach Studdiford*, Krirk Nirunwiroj*, **Agam Goyal**, Sijia Yang, Dhavan Shah, Junjie Hu, and Timothy T Rogers. "Beyond Demographics: Human-aligned LLM Agent Construction through Belief Network." arXiv preprint arXiv:2406.17232 (2024)

5. (Under Review) Goyal, Agam*, Zhaoxing Wu*, Richard P. Yim, Binhao Chen, Zihong Xu, Hanbaek Lyu. "A latent linear model for nonlinear coupled oscillators on graphs." arXiv preprint arXiv:2311.14910 (2023)

4. Chuang, Yun-Shiuan, Nikunj Harlalka*, Siddharth Suresh*, **Agam Goyal**, Robert Hawkins, Sijia Yang, Dhavan Shah, Junjie Hu, and Timothy T. Rogers. "The Wisdom of Partisan Crowds: Comparing Collective Intelligence in Humans and LLM-based Agents." In Proceedings of the Annual Meeting of the Cognitive Science Society, vol. 46. 2024.

3. Yun-Shiuan Chuang, **Agam Goyal**, Nikunj Harlalka, Siddharth Suresh, Robert Hawkins, Sijia Yang, Dhavan Shah, Junjie Hu, and Timothy T Rogers. "Simulating Opinion Dynamics with Networks of LLM-based Agents". In Findings of the North American Chapter of the Association for Computational Linguistics (NAACL). 2024

2. Misra, Diganta*, Muawiz Chaudhary*, **Agam Goyal***, Bharat Runwal*, and Pin Yu Chen. "Uncovering the Hidden Cost of Model Compression." In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 1611-1621. 2024.

1. Goyal, Agam and Hanbaek Lyu. "Tensor Decomposition to Capture Spatiotemporal Patterns of Coupled Oscillator and Opinion Dynamics". In Proceedings of the 12th International Conference on Complex Networks and their Applications. 2023

Industry Experience	**Amazon (Amazon Web Services)** — May 2024 - Present

Amazon (Amazon Web Services)   May 2024 - Present
Software Developer Engineer Intern (Research)   Santa Clara, CA
- Working on semantic information extraction and similarity detection in binary files.

Amazon Inc.   May 2023 - September 2023
Software Developer Engineer Intern
- Developed a sample application in **React Native** using **TypeScript** that enables seamless end-to-end testing capabilities for **Alexa voice integration** for any application developer.
- Designed an **architecture** to incorporate Alexa voice navigation capabilities into the application, increasing the **velocity of internal quality assurance testing by 10-15%**.
- Worked in a cross-team operational manner to integrate the application into the **production pipeline** to achieve the goal of **reducing end-to-end testing effort** for multiple teams.

Institute of Clinical and Translational Research   October 2021 - May 2022
Data Analytics Intern
- Designed and developed a database framework using **Remote Procedure Calls (RPCs)** to reduce the server load and **improve hot-refresh capability** of the front-end database by **7%**.
- Maintained & improved database workflows for **large-scale clinical research records** ($\sim$1M rows) using **MySQL**, including reorganization of data in column-format for faster processing.
- Worked with **APIs** to manage over 100,000 system calls to manage the **stress-testing of accessing the contents** of these databases.

CamfyVision Innovations Pvt Ltd   May 2021 - August 2021
Computer Vision Research Intern
- Re-implemented the baseline **Violence Detection and Image Colorization algorithms** in **PyTorch** based on the latest research-based methods to achieve a **3-4% accuracy gain**.
- Modified existing CNN architectures and used **image processing** to **enhance blurred images** by scratch from first-principle computer vision techniques.
- Carried out an **extensive literature review** and surveys on existing state-of-the-art convolutional neural network and **vision transformer architectures**.

Invited Talks

"Supervised Nonnegative CP Decomposition of Tensors with Provable Convergence Guarantees"
- **(Upcoming) Oral Presentation. Undergraduate Symposium (Apr 2024)**

"Reprogramming under constraints: Revisiting efficient and reliable transferability of lottery tickets"
- **Extended Talk. Google Brain Sparsity Reading Group (Oct 2023)** [<u>Slides</u>]
- **Lightning Talk. ML Collective Open Research Jam (Oct 2023)** [<u>Slides</u>]

"LLM Group Dynamics: A New Approach to Social Simulations"
- **Lightning Talk. 2023 Wisconsin Institute for Discovery Symposium (Nov 2023)**[<u>Slides</u>]

Presentations and Posters

Latent Linear Model for Nonlinear Dynamics Data [Poster Presentation].
5th annual Research Bazaar, UW–Madison's Data Science Hub, 2024

Nonnegative Tensor Decomposition to Capture Spatiotemporal Patterns of Complex Dynamics on Underlying Networks [Oral Presentation].
International Conference on Complex Networks and their Applications, 2023 (CNA '23) [**Slides**]

How Do They Synchronize? Interpretable Feature Learning For Coupled Oscillators [Poster Presentation].
Madison Experimental Mathematics (MXM) Labs Open House, 2022. [**Poster**]

Research Experience	**Generalized Supervised CP Tensor Decomposition** PI: Dr. Hanbaek Lyu

- Contributed to the project ideation by extending my prior work from a **matrix factorization-based framework** to a **tensor decomposition-based framework** for interpretable feature extraction and prediction of emergent properties of complex systems on underlying networks.
- **Leading the project** individually to (1) harness the potential of **nonnegative CP decomposition** to extract interpretable features from **coupled oscillator and opinion dynamics**, and (2) developing a **supervised tensor decomposition method** and **analyzing** its convergence.

The first part of the project led to an **extended abstract at CNA'23** titled **"Tensor Decomposition to Capture Spatiotemporal Patterns of Coupled Oscillator and Opinion Dynamics"** and the supervised tensor decomposition is the topic of my **Senior Honors Thesis**.

Latent Linear Dynamics Model for Nonlinear Dynamics   PI: Dr. Hanbaek Lyu

- Developed a framework for predicting the **synchronization of coupled oscillators** on underlying graphs, by linearizing the highly nonlinear dynamics in the latent space, which **matches the performance of black-box methods** while also **extracting interpretable features**.
- Worked as the **first author** and led all code implementation along with contributing to the **experimental design** and paper writing. Analyzed the existing knowledge gap through a **thorough literature review** and the lack of emphasis on interpretability.

Led to the paper titled **"A latent linear model for nonlinear coupled oscillators on graphs"** currently under submission at the **Proceedings of the National Academy of Sciences (PNAS)**.

LLM Agents for Social Simulations   PI: Dr. Junjie Hu and Dr. Timothy T. Rogers

- Developed an **LLM generative agent framework** to utilize these agents as proxies for studying humans in a group dynamics setting. Focused on both **Opinion Dynamics** and **Wisdom of Partisan Crowd** to elucidate challenges to simulate group dynamics with LLMs.
- Worked as the **second and third author** on opinion dynamics and wisdom of partisan crowd respectively, contributing to experiment and **interaction-interface design**, paper writing, and leading all code implementation, as well as interpretation and analysis of results.

Led to two papers titled **"Simulating Opinion Dynamics with Networks of LLM-based Agents"** and **"Evaluating LLM Agent Group Dynamics against Human Group Dynamics: A Case Study on Wisdom of Partisan Crowds"**, both currently under review.

Reprogramming Under Data and Model Sparsity Constraints   PI: Dr. Pin-Yu Chen

- Developed an extensive study on benchmarking **visual prompting methods** on downstream transfer classification tasks under the **constraints of low data and model sparsity**, with a focus on both the **accuracy and reliability** of transfer along with a reason for the hidden cost.
- Worked as the joint **first author** in collaboration with researchers at **MIT-IBM Watson AI Lab** and **Mila** to identify knowledge gaps in prior literature and co-lead all experiment design, code implementation, paper writing, and analysis and visualization of results.

Led to a paper titled **"Uncovering the Hidden Cost of Model Compression"**, under review.

Teaching Experience	**COMP SCI 320: Data Science Programming - II** **Spring 2023**
	Undergraduate Teaching Assistant, UW-Madison Instructor: Dr. Meena Syamkumar

Responsibilities: Conducted 10 hours of **office hours** weekly and led the lab component. Developed **quiz, assignment, and exam** questions. Conducted **review sessions** for students prior to exams.

LIS 461: Data Ethics and Policy   **Spring 2022**
Course Grader, UW-Madison   Instructor: Dr. B. Ian Hutchins

Responsibilities: Course grader for over 400 students. Developed **exam and grading schemes**.

COMP SCI/ECE/ME 539: Artificial Neural Networks   **Fall 2021, Spring 2022**
Undergraduate Teaching Assistant, UW-Madison   Instructor: Dr. Yu-Hen Hu

Responsibilities: Conducted 5 hours per week of **office hours** and in class assignments. Received a mention for the **best undergraduate TA**.

Center for Academic Excellence (CAE)   **Fall 2021**
Academic Tutor: Calculus and Microeconomics, UW-Madison

Selected, Relevant Coursework

COMPUTER SCIENCE:
Signal Processing and Deep Learning: Signal Processing (ECE 252), Artificial Neural Networks (COMPSCI 539), Computer Vision (COMPSCI 639)
Theoretical Machine Learning: Linear Optimization (COMPSCI 524), Nonlinear Optimization (COMPSCI 726), Computational Learning Theory (COMPSCI 639)
Systems: Big Data Systems and Databases (COMPSCI 544), Operating Systems (COMPSCI 537)

MATHEMATICS AND STATISTICS:
Analysis (MATH 521), Abstract Algebra (MATH 541), Probability Theory (MATH 531), Stochastic Processes (MATH 632), Networks in Data Science (MATH 444), Data Modeling (STAT 240, 340)

Selected Course Projects

COMP SCI 639: Computer Vision with Dr. Mohit Gupta   Fall 2022
GitHub Link: https://github.com/AGoyal0512/VR-Toolkit

- Developed a Virtual Reality Toolkit (VR-Toolkit) software stack that would help people with low vision to identify objects, see images and read better by providing them the ability to enhance their overall viewing experience.
- The users can do this by changing the size of text by magnification, contrasting colors in images, and by generating captions for these images. Further, in order to mitigate dealing with issues related to reading these captions, we also implement a text-to-speech framework.
- **Tools:** Image Processing, Optical Character Recognition, `OpenCV`, `tesseract`

COMP SCI 524: Optimization with Dr. Line Roald   Spring 2022
GitHub Link: https://github.com/AGoyal0512/Madison-Metro-Optimization

- Used the Minimum-Cost network flow problem and linear optimization to model Madison Metro bus transit services and optimize it to reduce travel times and improve flow for passengers, while also reducing costs for the authorities.
- Our results indicate that not every existing route is the optimal one based on the current passenger trends and distances between stops. Rather, there exists a subset of these that would be a better option for Madison Metro to consider including in their new bus transit plan.
- **Tools:** Linear Programming, Network Flow, Julia `Clp` Optimizer

Community Involvement

Cohere for AI   August 2022-Present
ML Collective   Jan 2022-Present

Extra Curricular

Google Developer Student Club, UW-Madison
Vice President   June 2021 - May 2023
AI Club, UW-Madison
Reading Group Lead and Organizer   January 2021 - May 2021
TechKriti Open School Championship, IIT-Kanpur, India
Winner   December 2020
Technothlon International School Championship, IIT-Guwahati, India
Event Winner   October 2020