Aaryan Singh

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Research Interests

Geometric algorithms in Euclidean and hyperbolic spaces, structural and spectral theory of graphs, discrete and computational geometry, complex analysis in network and geometric settings, probabilistic methods in graph models, theoretical analysis of network structure, algorithmic and complexity-oriented perspectives on geometric graph problems.

Education

Jaypee University of Information Technology, Solan Aug 2024 – Present
Bachelor of Technology in Mathematics and Computing
Current GPA: 8.77 / 10
Relevant coursework: Data Structure and Algorithms, Design and Analysis of Algorithms, Discrete Mathematics, Data analytics using R and Python, Artificial Intelligence and Machine Learning, Linear Algebra, Probability and Statistics, Numerical Analysis of Mathematical Computing, Object-Oriented Programming

The Shri Ram Universal School, Rohtak Mar 2019 – Mar 2023
High School Diploma

Research Experience

Research Intern, Collective Dimensionality in Hyperbolic Network Models
Dec 2025 – Feb 2026
Collaboration with Dr. Arvind Iyer (University Health Network, Toronto, Canada)

- Studying hyperbolic random graph models to evaluate whether their generative mechanisms reproduce higher-order structural organization observed in empirical networks, beyond matching local statistics.
- Constructing and analyzing synthetic network ensembles using a distance-based probabilistic model inspired by the Popularity–Similarity Optimization framework, with explicit control over curvature, temperature, and scale parameters.
- Representing each network as a high-dimensional observable vector including degree statistics, clustering measures, distance-based quantities, centrality proxies, and motif-level descriptors, and treating ensembles as point clouds in observable space.
- Performing spectral analysis on correlation matrices of graph observables to study collective structure, including eigenvalue concentration, stability of dominant eigenmodes under perturbations, and effective dimensionality via spectral decay.
- Demonstrating empirically that synthetic hyperbolic networks exhibit strong low-dimensional collective structure, while real-world networks often fail to show comparable spectral concentration or mode stability under the same analytical pipeline.
- Extending the theoretical problem by investigating how to construct synthetic hyperbolic models whose collective structure exhibits higher effective dimensionality, closer to real-world networks.

Academic and Outreach Experience

Math Circle Outreach Intern Jun 2025 – Jul 2025
International Centre for Theoretical Sciences (ICTS), Tata Institute of Fundamental Research, Bangalore

- Designed and facilitated mathematical sessions focused on problem solving, logical reasoning, and mathematical thinking.
- Collaborated with mathematicians and educators to simplify advanced concepts without compromising rigor.
- Assisted in organizing outreach activities promoting interest in mathematics.

Leadership and Service

President, Technoire Computing Club Jan 2026 – Present
Jaypee University of Information Technology

- Founded the club and defined its technical vision focused on computing, mathematics, and research-oriented learning.
- Organizing sessions on algorithms, theoretical topics, and technical skill development.

Volunteer Teacher, Koshish Club Aug 2024 – Present

- Teaching underprivileged students foundational mathematics and logical reasoning.
- Designing interactive lessons and adapting teaching approaches to different learning needs.

Honors and Achievements

- Developed "Swachh Rohtak", a civic waste-mapping web platform to help citizens and authorities identify and address garbage dump locations.
- Ramanujan Award in Mathematics, awarded twice during school for excellence in mathematics.
- First place in two mathematics competitions organized by the SIAM student chapter at JUIT.

Technical Skills

Mathematics and Theory: Discrete mathematics, graph theory, probability theory, spectral methods, geometry of networks, structural graph properties, theoretical modeling

Algorithms and Theory Focus: Algorithmic analysis, complexity-aware modeling, parameterized structures, generative models for graphs, structural characterization of networks

Programming and Tools (for research prototyping): Python, NetworkX, NumPy, pandas, scikit-learn, Jupyter, LaTeX

Research Practice: Mathematical writing, literature review, experimental design for theoretical questions, reproducible computational experiments

Publications

Manuscript in preparation: *Collective Dimensionality in Hyperbolic Network Models.*
Currently being refined toward preprint submission. A detailed draft is attached at the end of this document.