Aaryan Singh

Email: theaaryansingh@outlook.com
GitHub: https://github.com/theaaryansinghh
LinkedIn: https://linkedin.com/in/aaryan-singhh
Portfolio: http://theaaryansinghh.github.io/

Research Interests

Spectral analysis of complex networks, graph geometry, high-dimensional statistical modeling, and structured machine learning.

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 Structures and Algorithms, Design and Analysis of Algorithms, Discrete Mathematics (A+), Linear Algebra (A+), Probability and Statistics (A+), Numerical Analysis (A+), Artificial Intelligence and Machine Learning, DBMS, Data Analytics (R/Python), Object-Oriented Programming.

Projects

Neural Network for Graph Curvature Prediction
[GitHub]
- Implemented a fully connected neural network with manual forward pass, backpropagation, and gradient descent without high-level ML frameworks.
- Generated synthetic graph datasets using Erdős–Rényi, Barabási–Albert, and Watts–Strogatz models.
- Computed exact Gromov hyperbolicity for 40-node graphs using all-pairs shortest paths and quadruple distance evaluation.
- Engineered structural and spectral features and compared against a closed-form linear regression baseline.
- Achieved 0.79 test R^2 versus 0.45 baseline R^2, demonstrating nonlinear learnability of curvature-related structure.

Research Experience

Research Intern, Collective Dimensionality in Hyperbolic Network Models
Dec 2025 – Feb 2026
Collaboration with Dr. Arvind Iyer (University Health Network, Toronto, Canada)
- Designed a spectral framework to analyze collective structure in hyperbolic random graph ensembles.
- Constructed synthetic networks using a distance-based probabilistic model inspired by the Popularity–Similarity Optimization framework with explicit curvature, temperature, and scale control.
- Represented each network as a high-dimensional observable vector including degree statistics, clustering coefficients, motif counts, and distance-based descriptors.

- Performed eigenvalue analysis of observable correlation matrices to quantify effective dimensionality and spectral concentration.
- Demonstrated strong low-dimensional spectral concentration in synthetic hyperbolic ensembles via rapid eigenvalue decay of observable correlation matrices, while empirical networks showed weaker mode stability under identical analysis pipelines.

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.

Technical Skills

Mathematical and Statistical Foundations: Linear algebra (spectral methods, eigenvalue analysis), probability theory, statistical inference, covariance modeling, high-dimensional feature analysis, optimization fundamentals.

Graph and Network Analysis: Graph Laplacian construction, spectral clustering, eigenvalue analysis of graph observables, random graph generation (Erdős–Rényi, Barabási–Albert, Watts–Strogatz).

Machine Learning and Modeling: Neural networks from scratch, gradient-based optimization, regression modeling, model evaluation (R^2, cross-validation), feature engineering.

Programming:
Python (NumPy, SciPy, scikit-learn, PyTorch, NetworkX), C, C++, R, PostgreSQL, LaTeX.

Publications

Manuscript under preparation (preprint forthcoming): *Collective Dimensionality in Hyperbolic Network Models.*