Raghunath Jaganathan Vennila

Curriculum Vitae

Cheenta Academy,
22, Lake Place,
Kalighat, Kolkata - 700029
(+91) 9566535400
raghunathjv1999@gmail.com

Objective

PhD applicant in Pure Mathematics seeking to conduct innovative research in Topology, Group Theory (Geometric, Combinatorial) and allied topics. I am also interested in computational aspects of mathematical research.

Education

2024 **GRE Subject Test**, *Mathematics*
- Percentile rank 95 (Score - 920)

2023 **Tata Institute of Fundamental Research Graduate School Exam**, *Entrance for PhD at TIFR*
- All India Rank 70

2017–2022 **B.Tech & M.Tech**, *Electrical Engineering*, *Indian Institute of Technology Madras, Chennai*
- Secured 81.2%

2017 **JEE Advanced**, *Entrance exam for IIT*
- All India Rank 2121

2017 **Higher Secondary (Std 12) Examination**, *Maharishi International Residential School, Kanchipuram*
- Secured 93.2%

2015 **Secondary (Std 10) Examination**, *Maharishi International Residential School, Kanchipuram*
- Secured 100%

Professional Experience

Math Olympiad Coach (2021-present) **Cheenta Academy for Olympiad and Research**, *Cheenta*, Kolkata

- This is one of the most exhilarating works that I'm doing for around 3.5 years (1.5 years of part-time faculty + 2 years of full-time faculty).
- I teach inquisitive students for Math Olympiad everyday evening with exciting **problems from Tournament of Towns, Russia; Old Balkan Olympiads; Iran Geometry Olympiad**, etc. These problems are really challenging and interesting and sometimes demand application of advanced math lemmas.
- We deviate multiple times from exam oriented approach to focus on embellishing math ideas and devising our own strategies. I feel elated to share that in 2024, we had 6 **students qualifying for IMOTC (International math Olympiad Training Camp)** out of which 5 are my students.
- I framed the entire class notes and homework for 48 weeks that we used to teach at Cheenta for Level-6 and Level-7. I also wrote some short notes on beautiful concepts of Math Olympiad in my leisure time (Symmedians, Division in polynomials, Ceva's and Menelaus theorem). I'm also creating **Youtube videos** sponsored by Cheenta academy based on interesting problems and concepts in Olympiad Math.

Program Creator (2023-present)

SuMON math program, *SuMON*, Kolkata

- I'm building SuMON math program, a subsidiary of Cheenta, which aims to provide students with hard copy of worksheets containing 8 problems that are non-routine which evoke the critical thinking in students. These questions are usually activity based problems like **paper folding, paper cutting, filling the squares, number of ways to colour**, etc that is tailored to intellectually engage students into it for a profound analysis. We provide one **fortnight** of duration (14 days) to allow students to meditate on the problems. These also come with two hints per problem and a solution manual at the end of every fortnight.
- This experience of building something gave me an idea on team management, emotional balance and the process by which ideas turn into reality. We are continuing great with about 10 active participants.

Contest Jury Member (2022-24)

Sharygin Geometry Olympiad Jury, *Cheenta*, Kolkata

- Sharygin Geometry Olympiad is conducted by multiple Russian committees which consists of intricate and non-routine euclidean geometry problems. It has two rounds: correspondance round (online) and final round (offline).
- I was one of the 4 judges of the final round, where students come and present their solution to us for evaluation. Cheenta hosted the final round in India for the years $2022, 2023, 2024$ towards the end of July and I was a Jury member in all these years. The paper consists of 4 problems to be solved in 4.5 hours.
- These students are exposed to advanced level of high school mathematics and are usually national math olympiad awardees. It enriched my ideas and approaches in olympiad geometry and exposed me to different perspectives of students.

Math content creator (2021-22)

Learn Basics, *Salem*, Tamilnadu

Learn Basics is aimed at consolidating the **fundamental understanding** of concepts for middle and high school students of NCERT. I created several math content videos based on their syllabus for about 1 year. It was my first experience on an online teaching platform, which honed my communication skills to a great extent.

Research Experience

M.Tech Project (2022)

Cardiovascular Aging, *IIT Madras*, Chennai

Supervisor: Dr. Jayaraj Joseph, Assistant Professor, Dept. of Electrical Engineering, IIT Madras

- As a part of my M.Tech research project, I got an opportunity to work on a parameter determining the vascular aging due to the diverse nature of research works in IIT Madras.
- I modelled 5 parameters to represent the **vasodilation system** (a pivotal indicator of vascular aging) and evaluated its repeatability over days and with in a day to conclude the best parameter. The foundation of these parameters is the **Flow-mediated dilation** (FMD).
- The full length project report can be found here and its associated presentation here.
- It gave me a rich experience of the advancing in medical instruments, making inferences based on the data and advantages in collaboration. We conducted multiple experiments over 2 months period for our analysis.

Research Group (2024)

Cheenta Academy for Olympiad and Research, *Cheenta*, Kolkata

- I'm leading a research group with 4 high school students who excelled in olympiad mathematics in India and we have studied the Hyperbolic Plane and Poincaré disk extensively. We used the "Low dimensional Geometry" book by Francis Bonahan for its reference. This work started in April 2024.
- We then progressed to understand its application by **Max Dehn** that solved the long stood "**word**" problem. It is regarded as the origin of Gromov's hyperbolic groups. It is based on conjunction of Geometry and Group Theory culminating to **Geometric Group theoretic** ideas. The main paper was written in German and we used its English translated version by John Stillwell which can be found here. John introduces the "word problem" and solution in a sequential order so that it is systematic.
- Models of hyperbolic geometry and Papers by Dehn - Group theory and surface topology are expository papers that I wrote based on our exposition. This work is still ongoing and I hope it will be a great value addition to the existing literature.
- I learned how to establish a connection between surface topology and abstract group theory and last but not least, I got a wonderful experience to cooperate with students and guide them through this research work. Here is youtube link to a live student presentation given by one of my students based on this work.
- I guided a student of Cheenta in an expository paper on the proof of the **Seven Circles Theorem** using **Poincaré model of hyperbolic space**. It elaborates a proof of Euclidean geometry result using hyperbolic geometry. Here is the expository paper written by the student.

Research scholar (2022-present)

Cheenta Academy for Olympiad and Research, *Cheenta*, Kolkata

Supervisor: Dr. Ashani Dasgupta, PhD from University of Wisconsin - Milwaukee

- I've been involved in research programs at Cheenta for 2.5 years. It is primarily focused on Gromov's Hyperbolic group, Relatively Hyperbolic groups.
- Along with a team of 3 enthusiastic scholars, we read an intense paper by Bowditch on "**Relatively Hyperbolic Groups**" thoroughly. It was an incisive and pithy written paper that took around 8 months to give a comprehensive read through it. This paper was one of his famous publication that can be found here. It provided me with intuitive sense of relatively hyperbolic group pair, fine graphs and that how ideas are developed in advanced mathematics.

Associated Activities

English Translation (2022-24)

Sur les Groupes Hyperboliques d'après Mikhael Gromov

- I worked with Cheenta research team on English translation of a celebrated book in the literature of Gromov's hyperbolic group in French named "**Hyperbolic Groups**" by **E.Ghys** and **P.de la Harpe**, both prominent mathematicians, helped make Gromov's abstract and somewhat dense ideas more understandable to a wider mathematical community.
- Our complete translated version of the book can be found here. It was a fruit of our several months of hard work.
- This book covers a total of 14 chapters including one for the Bibliography. W.E.Grosso did an incomplete translation of the book in English which goes until chapter 7 and there are no other English translations of this book presently available.

Math Game development (2024)

Criss-Cross Game, *SuMON math program (SuMON)*, Kolkata

- I developed a $2-$player math puzzle game which is now available online. It can be played here. It is deployed via browser using HTML+CSS+Javascript.
- The first one to form a rectangle using **cross marks** wins the game. I implemented a winning strategy with a computer mode of play.
- As a part of SuMON program, I would like to develop multiple other games involving math puzzles and also teach students to learn and develop their own games. I see a propitious outcome out of this work because I believe that Math can be taught to students as a fun activity, engaging even students who are not sound, to think critically.

Institute Project (2019-20)

Power train management, *NikOttO PVT. LTD.*, IIT Madras, Chennai
Supervisor: Dr. Jubin V Jose, PhD & Research scholar at IIT Madras

- NikOttO is private limited company which works to create sustainable and smarter mobility ecosystem.
- Here, I worked to develop a **BLDC motor driver** which acts as a controller that transmits electrical power from battery to the BLDC motor. I also worked on retrieving the kinetic energy of the car while braking using regenerative braking mechanism.
- Through this work, I learned about the functionality of hybrid system in cars and got deep insights about motor drivers. I had made a brief presentation on BLDC motors and battery health parameters during my tenure of work, 5 months, here.

Internship (2019 – 20)

Healthcare Technology Innovation Center (HTIC), *IIT Madras Research Park*, IIT Madras, Chennai

- During my 3^{rd} year, I worked as an intern in the health care start up HTIC where I tested a medical equipment iQuant, a portable rapid blood test kit for diagnosing Dengue, Malaria, etc.
- I worked on charging characteristics of the iQuant system, maximum power and current consumed by iQuant. I gained a lot of practical knowledge on the **buck and boost converter circuits** and their response to battery.
- I also developed a keen interest and knowledge on medical instruments and their entire process of design to manufacturing and to testing. The report and measurements of the experiments performed for this work is available here.

Club Project (2018-19)

Light cycling in ICU, *Center for Innovation*, IIT Madras, Chennai

- This was my first and unforgettable hands-on technical experience.
- As a team, we worked on a club proposed project at Center for Innovation (CFI), IIT Madras which is based on **quick recovery of ICU patients by replicating the 24 hours real world light cycle in ICU ambience**. This artificial lighting makes the patient feel comfortable by giving a sense of natural daily routine instead of felling hospitalised.
- I did the plotting of intensity of RGB colours at various hours of a day and implemented it using appropriate function in ARDUINO IDE software onto RGB LED's with the help of ARDUINO UNO board. We as a team, created a fully functional prototype model for this proposal.

Industry visit (2018)

Salem Steel Plant, *SAIL*, Salem, Tamilnadu

- I was visiting the Salem Steel Plant for one month to learn about large electric machines and motors. Primarily, Hot Rolling Mills and Cold Rolling Mills constitute the entire industry.
- Over here, I was able to relate the ideas of electric machines that I studied in my coursework into reality fostering pragmatic thinking towards subject. It gave me a rich experience of the type of machines, routine of workers there and the type of jobs they were assigned.

Position of Responsibilities

Shaastra Leadership role (2019)

ELECKART, *Shaastra Events*, IIT Madras, Chennai

- Shaastra is the annual technical festival conducted at IIT Madras. As a part of Shaastra 2019, a team of 4 members including me conducted the event named **ELECKART** under elecfest, a vertical in Shaastra, which unleashes the electronics enthusiast inside the participant.
- It is an open for all students and it consists of three rounds: Online Techgig Hackathon contest, Buzzer round based on basic Electronics questions, Circuit building competition (Based on controlling Traffic Lights). I created most of the questions for Hackathon contest and devised an intriguing question for the final round, Circuit building competition. I also invigilated the buzzer round.
- This experience is unique for me because it was my first leadership experience and I had to figure out a way to do multiple things by myself which was never taught (or) known to me earlier. It greatly enhanced my comprehension of the relation between planning and implementing.

Shaastra Live Webinar (2019)

Data structures and algorithm, Basic python, *Shaastra Workshop*, IIT Madras, Chennai

- As a part of Shaastra 2019, I hosted two live webinars, one on Data structures and Algorithms and other on Basic Python programming.
- This webinar was targeted on budding enthusiasts on these topics. This webinar helped me to enhance my communication skills and I was able to consolidate my basic ideas on these topics.

Relevant Coursework

Mathematics — Group Theory, Topology, Real Analysis, Linear Algebra, Probability and Statistics, Functions of several variable, Series and Matrices, Combinatorics, Mathematical Finance, Convex Optimization (My youtube videos on problem solving with "Topology by J.R.Munkres")

Electrical Engineering — Analog systems, Analog Circuits, Control Engineering, Device Modelling, Power electronics, Applied programming in Python

Economics — Principles of Economics, Production Economics

Computer Science — Data Structures and Algorithms, Numerical Methods

Other Scholastic Achievements

2024 **GRE General test** - Secured $316/340 : Verbal - 148,\ Quantitative - 168,\ Analytical - 3.5$

2024 **TOEFL** - Secured $103/120 - 26(reading) + 26(listening) + 26(speaking) + 25(writing)$, an English proficiency test

2021 **NMTC** Aryabhatta contest - Ranked 2^{nd}, held in April 2021, conducted by AMTI

2017 **UCEED Exam** - Secured an All India Rank of 707, the entrance for Arts in IITs

2016 **NSEA** - Among the top 250 students in India who qualified in the National Standard Examination for Astronomy, conducted by IAPT and was eligible for next stage INAO

2015 **NTSE** - Qualified in NTSE - stage 1 exam, conducted by NCERT

Other Information

Technical Expertise — Python, C, C++, HTML, Javascript, LaTeX, Geogebra, Matlab, LTspice, wxMaxima

Sport (2018) — Represented my hostel, Alakananda, for **Volleyball Schroeter** Match 2018-2019 at IIT Madras and won **Bronze** Medal. I cherish morning jog and gym sessions

Languages — Tamil, English