Shehzad Hathi

PhD researcher in mathematics at UNSW Canberra

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Biography

In the past decade, I have studied and done mathematics in diverse settings around the world. I started off in electrical engineering but then switched to mathematics and computer science during my undergraduate studies in India. My master's degree took me to Padova, Italy and Bordeaux, France. I also briefly worked as a data scientist in India, developing components for a next-gen search engine specific to the financial domain. Currently, I am in Canberra, Australia, on track for submitting my doctoral thesis in early 2023.

I have a track record of exceptional academic achievement despite having limited resources growing up. I would not have been able to study at the top-ranked institutions or universities I did without holding scholarships all the way through since (and including) high school.

My keen interest in working on the bleeding edge is evidenced by the fact that I have worked for multiple startups operating in varied sectors like additive manufacturing or blockchain. Currently, I am working part-time at a Canberra-based software engineering company that specialises in big data and analytics. I have explained my mathematics research and subsequent career expectations in this LinkedIn article: What do number theorists do and want in life?

Education

Bachelor of Science in Mathematics and Scientific Computing
(Minor in English Literature)   2012-16
Indian Institute of Technology (IIT) Kanpur

ALGANT Master Program   2016-18
Università degli Studi di Padova
Université de Bordeaux

PhD in Mathematics   2019-
The University of New South Wales (UNSW) Canberra
Thesis Title: Some explicit results in number theory

Research

My primary area of research is number theory. Please see my homepage for detailed info. From a computational perspective, these are the highlights of my work:
- Employed the **high performance computing cluster** at NCI, GADI, for verification of a squarefree approximation to the Goldbach conjecture. This verification was **several orders of magnitude more elaborate than the previous best**.
- Devised **highly efficient number theoretic algorithms** using sparse matrices to find the **best approximation in the world to date** in a class of Linnik–Goldbach problems.

Publications/ Preprints

- Wolstenholme and Vandiver primes (with M. Mossinghoff and T. Trudgian): *The Ramanujan Journal 58, 913941 (2022).* Journal version.
- Representation of even integers as a sum of squares of primes and powers of two: *Accepted for publication (Acta Arithmetica)* Preprint on arXiv.

- On the sum of a prime and a square-free number with divisibility conditions (with D. R. Johnston): Preprint on arXiv.
- Mertens' third theorem for number fields: A new proof, Cramér's inequality, oscillations, and bias (with E. S. Lee): Preprint on arXiv.

Scholastic Achievements

- Received the **Tuition Fee Scholarship plus a Faculty Research Stipend (TFS)** at **UNSW Canberra** as a doctoral candidate.
- Selected for the **ALGANT Master Program 2016-18** with **full tuition scholarship and additional scholarship covering living expenses**. The ALGANT Consortium consists of ten reputed universities in France, Italy, Netherlands, Germany, India, South Africa, and Canada.
- Selected for the **UTokyo-IIT Graduate Students Scholarship Program 2016** for a master's degree in mathematics at the **University of Tokyo**. The scholarship covers living expenses as well as tuition. I chose to attend the ALGANT Master Program instead.
- Awarded the **INSPIRE Scholarship** by the Department of Science and Technology, Government of India from 2012-2016. It comes with a generous scholarship amount and is awarded to the **Top 1% successful students in the class XII exam** (last year of high school before university) in India.
- Secured **All India Rank 406** (among **450,000 applicants**) in the Indian Institute of Technology - Joint Entrance Examination (**IIT-JEE**) 2012.
- Secured **All India Rank 424** (among **1,000,000 applicants**) in the All India Engineering Entrance Examination (**AIEEE**) 2012.
- Awarded the **Kishore Vaigyanik Protsahan Yojana (KVPY) Fellowship** by the Department of Science and Technology, Government of India in 2011 with an **All India Rank 23**. It is the **most prestigious scientific award at high school level in India** that comes with a generous scholarship amount and enables direct entry into one of India's best research institutions – Indian Institute of Science (IISc) Bangalore. I chose to attend IIT Kanpur over IISc Bangalore.
- Awarded the **National Talent Search Examination (NTSE) Scholarship** by the National Council of Educational Research and Training (NCERT) in 2008. NCERT is an autonomous organisation of the Government of India and the NTS Scholarship was started in 1963. It is considered the **most prestigious pan-India award at high school level** for all students.
- Selected for the **Indian National Mathematical Olympiad** (**INMO**) **thrice** from 2008-10 based on performance in the Regional Mathematical Olympiad. INMO is the precursor to the **International Mathematical Olympiad** and only around **500 students in India were selected** to take INMO at the time.

Work Experience

Senior Analyst at Fidelity Investments 2019
- Worked as a **data scientist** in the Business Analytics and Research Division of Fidelity Investments in Bengaluru. I created **customised natural language processing (NLP) tools** such as part-of-speech (POS) tagger, named entity recognition (NER) tagger for the **financial domain**. This was a part of the **next generation search engine** for the company website.
- The POS tagger and the NER tagger that I created were remarkably successful at parsing search queries and potentially providing **direct answers to queries**, a capability that was missing before this.

Tutor and lab supervisor at UNSW Canberra at ADFA 2020-
- Tutor and lab supervisor for courses like Computational Problem Solving, Mathematical Modelling, Engineering Mathematics, and Discrete Mathematics.

Relevant Internships	*Australian Postgraduate Research Intern* at *12thLevel*	2022-

- Working on a **training schedule optimisation process for the Australian Defence Force (ADF)**. It is a combination of the assignment/allocation and the scheduling problem in the field of **Operations Research** (OR).
- The solution is novel and involves recasting the problem as a **set-union knapsack problem** and using **integer linear programming** (ILP). We are currently writing a paper based on this.

Industry Mentoring Network in STEM Mentee   2021-22

- Selected among a cohort of STEM PhD students at universities all over Australia. My mentor was Zoe Piper, a Canberra-based entrepreneur.
- Learnt networking and other soft skills from Zoe over a period of one year, in addition to understanding how technical and research skills acquired over the course of the PhD can be applied in an industrial setting.

Research Intern at Dunya Labs   Summer 2018

- This was a **blockchain startup** where I worked full-time for a couple of months. I worked on **secure multiparty computation and its applications**, mainly focusing on privacy-preserving genetic testing which resulted in a survey paper.
- I also worked on **analysis of a public blockchain**, especially for **address-linking**. At the end of the internship, I was offered a long-term position but I chose to work for Fidelity Investments instead.

Data Science Intern at Fidelity Investments   Summer 2016

- My project involved **text mining** using natural language processing (NLP) and other statistical methods. I modified algorithms from available computer science literature to achieve **extraction of key parameters and their values from a slide deck**. I also created a **web app** for this purpose. Two years later, after finishing my master's degree, I was hired as a Senior Analyst at Fidelity based on my performance during the internship.

Boeing sponsored Abhyast Phase V Externship   Summer 2014

- Worked in a **team of 11 students for one year** to design and implement an **aerial surveillance system** with terrain mapping. I was selected based on my proposal for developing an algorithm for such a system. We built a **quadcopter** using ardupilot as flight controller with capacity for **obstacle avoidance, video live streaming and two dimensional terrain mapping**. The project was sponsored by Boeing.

Executive at Objectify Technologies, SIIC, IIT Kanpur   2013-15

- Worked part-time at this **additive manufacturing/3D printing startup** (founded in 2013) during my undergrad. I was responsible (in a team of 5) for the **creation of a business plan** after conducting a market survey and evaluating strategies used by market-leading companies like Shapeways.
- I was also responsible (in a team of 4) for **developing the first version of their e-platform**, right from the SRS (Software Requirements Specification) stage to actual web development, alpha testing and content writing.
- The startup has since expanded to five cities in India and is a leader in the field of additive manufacturing. Its customers include multinational conglomerates like Honeywell.

Relevant Projects	*Open-Source Combinatorics Library in Haskell*	2015

- Created the first library of its kind in Haskell implementing functions related to integer partitions.

Relevant Coursework	*Mathematics*

Relevant Coursework

Mathematics
- Complex analysis, harmonic analysis (singular integral kernels and operator theory), and other graduate level analysis courses
- Linear algebra, commutative algebra, representation theory, and other graduate level algebra courses
- Ordinary differential equations, partial differential equations
- Probability, statistics, stochastic processes

Computer Science
- Machine learning in financial mathematics (AMSI summer course)
- MITx Statistics and Data Science MicroMasters (in progress, almost completed)
- Quantum computing
- Data structures and algorithms, graph theory, functional programming
- Theory of computation, numerical computation
- Cryptography, elliptic curve cryptography, algorithmic number theory

Technical Skills

Programming Languages: Python, Haskell, C
Web Development: Flask
Tools: Git, Pari/GP, Sage, NLTK, Stanford CoreNLP, SciPy, Gadi (HPC cluster)

Soft Skills

Positions of responsibility:
- HDR (Higher Degree Research) Student Representative for the School of Science, UNSW Canberra (2021-)
  A particular success during my tenure was instituting an election system to choose subsequent student representatives. I also organised talks by industry professionals for HDR students. A major theme of these talks was transitioning from academia to industry.
- Coordinator of the English Literary Society (ELS), IIT Kanpur (2014-15)
  Managed a team of 20+ people to organise literary events on campus often involving several hundred participants. Introduced events like poetry slam for the first time on campus that have become a staple over the years.
- Sports (volleyball) coordinator of Arc Canberra at UNSW Canberra (2022-)

Writing: I write and perform poetry. Some of my work can be found on my blog.
A recently commissioned piece can be found here.
Outreach: I have been invited to a few popular math/science programs as a panellist.
For more info, please see my homepage.
Languages: English, Hindi, Gujarati