

Statement of Purpose

Shagun Rawat

As I reflect back, I realize how intellectual curiosity led me from understanding mathematical concepts to working on solutions for engineering problems. High school made me realize the beauty of mathematics, but I learnt its power through the rigorous theoretical and applicative study while pursuing my Bachelors' degree in Mathematics and Computing at the Indian Institute of Technology (IIT) Guwahati. I enjoy the diligence and perseverance demanded by a scientific study and the prospect of working on new ideas is exhilarating. I am interested in getting associated with academia in the future and thus to build a solid background, I wish to pursue ICME's M.S. program in Computational and Mathematical Engineering at Stanford University.

Math is ubiquitous in a student's life, but I believe that true inspiration comes from exploration. The prestigious KVPY scholarship, a research scholarship provided to high school students in India, not only provided me with an opportunity to interact with Nobel laureates and top academicians from across the world, but also with the motivation to work relentlessly on intriguing questions. The training for various Olympiads like the Indian National Mathematics Olympiad sparked my curiosity, as seeing entire theories built up seemingly from scratch instilled an appreciation for the inherent artsy nature of math. As I entered a new academic setup at IIT Guwahati, robotics instantaneously caught my interest since it provided me a hands-on set of lessons that reinforced STEM concepts in an engaging and concrete manner. Seeing the robots perform tasks based on the underlying algorithms made me realize that mathematical ideas can have practical implications.

During the summer break of my sophomore year, I interned at the Technology Office of Wipro Infotech, a leading Indian multinational in the field of software development. I worked on modeling a prototype of an autonomous patrolling robot, inspired by Stanley, the autonomous car developed by a group led by Sebastian Thrun at Stanford. I implemented an algorithm, for the robot motion planning problem by using Kalman filtering on the sensor data for obstacle avoidance and simultaneous localization of the robot, and adaptive mapping of the actual space into a 2 dimensional map for path planning. The fruitful deployment of the robot gave me a chance to understand how modeling influences the accuracy of systems when put to application. The project was mainly responsible for inculcating in me the virtues of team work as it was a large scale project involving many interdependent subsystems. It also encouraged generation of new ideas, creating and sticking to deadlines and errors and improvisation – all essential to research.

I continue to work on the robot motion planning problem but from an algorithmic point of view on graphs, for my final year Bachelor's thesis. Given a setup with multiple robots and several movable obstacles, I am currently exploring algorithms for deciding reachability and minimum distance paths, which has practical importance as being able to model train-rail networks and priority scheduling in buffers in a network. The area is extremely challenging as there is no significant work in the field of multiple robot motion planning on graphs in the past. The limited literature available makes it difficult to test the proposed algorithm due to lack of benchmark models. However, I believe that these challenges make you mature as a budding researcher, who should be ready to face the rigors of graduate school.

I got a chance to delve into mathematical research under the guidance of Prof. G. K. Srinivasan at IIT Bombay for a project under the National Program on Differential Equations - Theory, Computation and Applications. While studying the problem of modeling interacting populations, I came across an interesting problem in Mathematical biology, about the dynamics of infectious diseases. I prepared an analytical study of the theoretical and computational aspects of finding the rate of epidemic spread and the final population count of an area affected by an epidemic. Since then, I have explored other problems like the Colony collapse disorder and its effects on the colony dynamics of honey bee populations and generation of fractals in nature. In addition to the research experience, the project provided me with an opportunity to interact with top researchers

and graduate students at IIT Bombay. Discussions with fellow students about their work and graduate student life helped me strengthen my conviction that graduate school is definitely where I want to be after graduation.

With a motivation to explore interesting computer science problems and having developed interest in the field of networks through a course in junior year, I did my junior year summer research internship at Victoria University of Wellington in New Zealand under the supervision of Senior IEEE Member, Prof. Winston Seah and Prof. Ramesh Rayudu. At the Wireless Sensor Lab, I worked on the implementation of IPv6 protocol in wireless sensor networks and connected several physically separated networks through internet. Since these networks in the 'Internet of Things' have severe power restrictions and high loss rate, I implemented an algorithm for improved route selection with higher received signal strength, rather than the minimum number of hops, by providing a skewed view of the topology to network, while keeping all the underlying protocols intact. The extensive literature survey during my internship exposed me to immense possibilities of improving reliability and performance in networks and thus I continue to collaborate with the research work going on at the Network Engineering Research Group. I am currently working on improving event reliability in a WSN by finding the location of an event using multilateration technique on the data sent by the nodes and the possible coverage holes in the network by using Voronoi diagram. Through projects, I have not only gained academic knowledge but the project reports and presentations have ameliorated my communication skills and taught me perseverance and consistency required for research.

My coursework over the last four years has been a unique blend of mathematics - pure and applied - as well as computer science. I have come across many interdisciplinary subjects of interest and deciding a field for higher studies in such a setup was a tough and enriching challenge. Throughout my undergraduate studies, I have always been open to new and diverse areas and have worked on interesting projects in statistics and data analysis, computational finance, scientific computing and algorithm design. Due to a strong background and breadth of knowledge in Computer Science, Mathematics, Finance and Engineering, through my coursework and projects, I envision combining the best of these worlds; to understand engineering problems and work for optimal solutions from a mathematical and computational point of view.

Consistent with my past education and research experiences, I am keen to pursue higher studies in the field of Mathematical modeling and its applications in diverse fields like Robotics and Data analysis. My decision to apply for graduate studies to ICME has been influenced by both the intensity and diversity of research carried out at Stanford, by eminent researchers like *Prof. Ashish Goel*, *Prof. Peter Glynn*, *Prof. Ramesh Johari* and *Prof. Marco Pavone*. The course curriculum offered at ICME is synchronous with my interests and thus the graduate program would help me develop the technical skill set required for future research.

During the course of my undergraduate studies I have been through a variety of humbling experiences that have molded my academic life and the way I perceive education. I consider them as challenges, those that have eventually provided me a greater appreciation for my accomplishments. I sincerely believe that I am ready to accept the challenges associated with graduate studies as I am wholly motivated to learn from every experience linked with both the Stanford campus and its people. At this juncture in my life, I wish to step against all odds and work on the edge of human understanding to see what lies beyond. I want a chance to work on new problems; to make mistakes; to be involved in erudite discussions; to work tirelessly and relentlessly in the search of answers; to be overjoyed by exciting theories; to be able to take a stand against STEM gender gap; to motivate others; to make a difference; to learn in the process and to always be inspired by mathematics.

I bring to Stanford, my energy and enthusiasm for strengthening the community along with pursuing excellence in academics and research. Thank you for considering my application.

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