Statement of Purpose

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The ubiquity of mathematics in both academia and industry is evident. Conducting research in applied mathematics is thus essential for inception of new ideas with varied scientific applications. The desire to explore exciting avenues in the field of computational mathematics, spurred by *my vision to develop rock solid understanding* of advanced mathematical tools, brings my application for graduate admission to the ICME Department, Stanford University.

My curiosity to learn mathematics naturally intensified manifold after attending rigorous national mathematics olympiad (INMO) training camps followed by my undergraduate training in Mathematics & Computing at Indian Institute of Technology (IIT) Guwahati. As a result, I have developed a strong theoretical and practical background in pure & applied mathematics. A careful introspection of my skills and research aspirations along with my closely guarded *vision to carry-out and promote cutting-edge mathematical research* has helped me develop a firm resolve to pursue a PhD at ICME, Stanford.

I got my first chance to delve into research during my sophomore year at CSIR-CMMACS, a leading national mathematical modeling & simulation lab in India. The project focused on *studying vibrational & buckling properties of multiwalled carbon nanotubes with pseudospectral methods*. Along with Dr. V Senthilkumar, my mentor, I solved[1][2] the coupled PDEs of Timoschenko beam model using Chebyshev pseudospectral methods using very few grid points and quick convergence. Our work[3] was selected for oral presentation at CMCGS 2013, Singapore.

This experience was *immensely encouraging* for me as I *learnt the fruitful technique* of mathematical modeling and realized the rich potential in modern spectral methods. I also learnt that the essence of research lies in persistently developing a concrete understanding of essential ideas and using them innovatively to discover new useful ideas. Working in close collaboration with a progressive researcher bolstered my research foundation and motivated me to pursue further coursework and research in the area.

The highlight of the above summer experience was my yearning to explore more in the areas of computational mathematics. This desire kicked off with my curriculum courses in the following semester where I studied a course on scientific computing and learnt modern numerical techniques including successive over relaxation & conjugate gradient method. Finally my search culminated at the end of my junior year, when *I was the only undergraduate student selected* for a research position at Digiplante, Paris, an INRIA-CNRS lab that creates and simulates mathematical models for plant growth. I worked with Professor Paul-Henry Cournede, a very dynamic, enthusiastic and a perfectionist researcher; an inspiration indeed.

At INRIA, my goal was to create a *generic Ensemble Kalman Filter(EnKF)* for all plant models, and further use it for parametric estimation. The filter uses bayesian statistics to estimate the plant yield on a discrete timeline using very few experimental data and estimate plant model parameters with high precision. The purpose was achieved with an *insignificant sample size, thus considerably reducing the computational costs*. While independently working on the filter, my efforts to apply the filtering concepts to the plant models taught me how to make better decisions and *broadened my perspective* of thought. The before time completion of the work allowed me to work on other variations of EnKF including the Dual EnKF and Iterative EnKF versions, allowing me to learn more about the filters. *The works received appreciation from Professor Paul-Henry and from Dr. Geir Evensen, the creator of EnKF, himself.* Furthermore, a comparative analysis of EnKF with other filtering techniques was presented at ASMDA 2013[4], Spain.

While working at Digiplante, I learnt a *sophisticated and systematic approach* towards problem solving in applied mathematics. Moreover, my efforts to absorb Professor Paul-Henry's perfectionist qualities have made me more meticulous. It has also helped me develop a *serious attitude towards scientific research*, a lesson that I will always cautiously practice in my research endeavors. Also, working in a team of like-minded researchers taught me the *importance of teamwork* and how it creates an intellectually productive work environment.

Motivated with my project outcomes, I decided to conduct my undergraduate thesis on the open problem of *ef-*

ficient decomposition of higher-order tensors with engineering applications under Professor Rafikul Alam. Currently, there is no generic way to efficiently decompose higher-order tensors into simpler ones. *Our research aims to investigate such efficient decompositions and generalize tensor counterparts for various matrix concepts*. I am highly inspired by the recent works of Tamara Kolda[1] and Tom Schlutz[2] in this area. Theoretical analysis of tensors is an intriguing area of research that I have never before ventured into and with time I have grown really passionate about this *open problem*. Many insights and breakthroughs in multidimensional data analysis, data mining and many other areas await us given we find such an efficient decomposition.

My interest in *linear and multilinear algebra* magnified when I read the beautiful text "Linear Algebra Done Right" by Sheldon Axler. Since then, I have only grown skillful and passionate about the topic. Furthermore, I envision my research experience in higher-order tensors, bayesian statistics and scientific computing converging towards carrying research in tensor decomposition, multidimensional data analysis, numerical linear algebra and related fields. My prior experience in these fields bolstered by my strong fundamentals in linear algebra, scientific computing and numerical simulation has engendered in me a confidence to pursue research in this area. Also, *my habit of persistently following what interests me the most, amidst all difficulties, always guides me to efficiently channelize my energies* to any initiatives that I undertake.

My parents motivate me to become a person of moral values and be sensitive to society's needs. After freshman year, I volunteered to work for Child Rights and You(CRY), a rights-based NGO in India. My statistical works on right to education act and malnutrition are still being used by the NGO to fight law cases in Delhi. The experience taught me how mathematics touches all our lives alike. Also, the very satisfaction of gifting back something useful to the society has always motivated me to aim high in life.

Vision. My research activity until now is a mere drop in the ocean. There is a lot more to be done, a lot more to contribute. I am confident that this focus and keen desire to learn advanced mathematics makes me an ideal candidate for the PhD program at ICME. This program, adhering to its reputation, will provide me a *healthy environment for dedicated research*. The ongoing research at Stanford, particularly in numerical linear algebra and high-dimensional statistics is influencing. The course curriculum caters to my curiosity and interests as well. I am highly motivated to work with eminent researchers viz. *Emmanuel Candes, Wing Wong and Lexing Ying*. Their work in the field of high dimensional statistics & numerical algorithms is challenging and interesting. After the PhD, I aspire to become a savant in my field and promote fruitful research in applied mathematics. In the end, I would like to thank the advisory committee for patiently reviewing my graduate application.

References

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[3] **A.Gupta** and V.Senthilkumar, "Nanoscale effect on vibration of Carbon Nanotube with elastic medium using Pseudospectral Method", in *The 2nd Annual International Conference on Computational Mathematics, Computational Geometry & Statistics, Singapore (CMCGS 2013)(Accepted; Not presented)*

[4] Yuting Chen, Samis Trevezas, **Aman Gupta** and Paul-Henry Cournede, "Some Sequential Monte Carlo Techniques for Data Assimilation", in *The 15^{th} Applied Stochastic Models and Data Analysis, International Conference, Spain (ASMDA 2013)*

[1] Distinguished Member, Sandia National Laboratory

[2] Junior Professor at University of Bonn, Germany