Shubham Goel

Curriculum Vitae

145, Hostel 3, IIT Bombay
Powai, Mumbai - 400076
India
✉ *shubham.g@cse.iitb.ac.in*
shubham-goel.github.io

Education

2014-present **B.Tech (Honors) in Computer Science and Engineering** ,
Indian Institute of Technology, Bombay,
CGPA: 9.75/10 *after 4 semesters*.

2014 **Higher Secondary Examination**, *SGGS Collegiate Public School*, Chandigarh,
96.8%.

Internships and Key Projects

Summer 2016 - present **Forwarding Schemes in Networks with Probabilistic Faults**.
Guided by: *Prof. Thomas Henzinger, IST Austria*
Submitted to TACAS 2017

Time-triggered switched networks are a deterministic communication infrastructure used by real-time distributed embedded systems. Due to the criticality of the applications running over them, developers need to ensure that end-to-end communication is dependable and predictable. Traditional approaches assume static networks that are not flexible to changes caused by reconfigurations or, more importantly, faults, which are dealt with in the application using redundancy, and which has limitations. We adopt the concept of handling faults in the switches from non-real-time networks. Maintaining the required predictability is challenging, and it is the focus of this work. We study a class of forwarding schemes that can handle various types of failures. We consider probabilistic failures. For a given network with a forwarding scheme and a constant ℓ, we compute the *score* of the scheme, namely the probability (induced by faults) that at least ℓ messages arrive on time. We reduce the scoring problem to a reachability problem on a Markov chain with a "product-like" structure. Its special structure allows us to reason about it symbolically, and reduce the scoring problem to #SAT. Our solution is generic and can be adapted to different networks and other contexts. Also, we show the computational complexity of the scoring problem is #P-complete, and we study methods to estimate the score. We evaluate the effectiveness of our techniques with an implementation.

Spring 2016 **tusSAT: A FPGA based SAT solver**, [report], [repository].
Guided by: *Prof. Supratik Chakraborty, IIT Bombay*

We designed and implemented a FPGA based SAT solver which takes in a CNF formula and returns a satsifying model, if any. We designed an underlying VHDL package for the dense representation of atomic variables, clauses and boolean expressions and implemented an iterative version of the DPLL algorithm for SAT solving that ensures completeness. Optimizations such as variable selection heuristics that help in choosing the decision variable were also implemented. Alongside, we implemented a package for testbench generation.
The testing suite included The DIMACS Implementation Challenge: Satisfiability.
Features among other SAT solvers in http://satlive.org/.

Summer 2015 **Nodal Domains of Eigenfunctions of Quantum Billiards**.
Guided by: *Dr. Sudhir Jain, BARC Mumbai*

Analytic ground state solutions to the Helmholtz Equation are not known even for some simple billiards like the 120-60 rhombus. Numerical solutions however, can be computed using methods like Method of Fundamental Solutions (MFS) and the Finite Element Method (FEM). We made some analytical attempts for finding the ground state eigenfunction for the 120-60 rhombus and implemented a MFS algorithm for computing eigenfunctions numerically for integrable nonseparable billiards, for deriving emperical results on the number of nodal domains. We also developed a modification to the popular Hoshen-Kopelman Algorithm for counting nodal domains, reducing the complexity by a constant factor.

Honours and Awards

Academic

- Currently **ranked 5**th out of 96 students in the Department of Computer Science and Engineering, IIT Bombay after 4 semesters *2016*
- Secured **All India Rank 6** in JEE Advanced and All India Rank 50 in JEE Mains, taken by over 1.5 million students *2014*
- Awarded Institute Academic Prize (top 3 out of 880) for exceptional performance across all departments during the freshman year, by IIT Bombay *2014-15*
- Awarded AP grade for performing in the top 1% of the class in Biology, Logic for CS, Digital Logic Design and Engg. Drawing at IIT Bombay *2014-16*

Olympiads

- Represented India and won the **Silver Medal** at the 46^{th} International Chemistry Olympiad (IChO), Hanoi, Vietnam *2014*
- Awarded as the **Best Theorist and Experimentalist** at the OCSC (Orientation cum Selection Camp) for the Indian team to the 46^{th} IChO *2014*
- Received the **Best Solution Award** at the OCSC for the Indian team to the $\mathbf{54^{th}}$ International Mathematics Olympiad, Colombia *2013*
- Cleared the Indian National Astronomy Olympiad, was amongst the 39 students eligible for attending the National camp for selction of the Indian team to the 19^{th} International Astronomy Olympiad *2014*

Scholarships and Others

- Awarded the **KVPY** (Kishore Vaigyanik Protsahan Yojna) Fellowship by the Department of Science and Technology, Govt. of India *2013*
- Cleared the **NTSE** (National Talent Search Examination) and was awarded a scholarship by N.C.E.R.T. New Delhi) *2010*
- Shortlisted for the Aditya Birla Scholarships Programme *2014-15*

Other Projects

Autumn 2016 **ReaR: Rent a Ride**, *a vehicle rental service*.

Guided by: *Prof. S. Sudarshan, IIT Bombay*

We built an android app that allowed users to browse, rent and lend rides to/from a particular company. Built as a service provided by the company, the app used the Google Maps API to show locations of nearby ride stands for renting and unrenting rides. Additionally, users could lend (loan) their ride to the company for renting by other users and see their ride rental history. We also built the backend server using temporal PostgreSQL databases with Java Servlets, which used cookies to maintain sessions. The android app, which uses persistent cookies and a file cache for loading images from the web, fetched all data from this server. The android application was accompanied with an Admin Portal built using Java Server Pages for handling different user requests.

Spring 2016 **Movie Recommendation Engine**.

Guided by: *Prof. Ganesh Ramakrishnan, IIT Bombay*

We developed a movie recommendation engine in Python using popular collaborative filtering techniques, motivated by the research previously done on the Singular Value Decomposition method during the Netflix Prize competition. We also implemented and tested other techniques like the k-Nearest Neighbors for comparison, observing that matrix factorization methods worked better.

Autumn 2015 **Django Webapp: Branch Allocation**.

Guided by: *Prof. Sharat Chandran, IIT Bombay*

We built a webapp for conducting branch allocation, where students are allotted branches based on their preferences, CGPA and branch strength constraints. We reduced branch allocation to a variation of the stable matching problem and solved it using a modification of the Gale Shapley algorithm following specifications mentioned in the IIT Bombay rulebook.

Summer 2015 **Sustenance**, *an environmental life game*, [repository].
Winner, *Microsoft's code.fun.do Finalists Forum*
Targeting young users, we developed an environment based strategy game that showcases the natural inter-dependence of different species and the abiotic environment by simulating an ecosystem using a food web. We also modelled and implemented the trophic dynamics of this system and introduced players to concepts of extinction, epidemics and genetic strains as the game progressed. Developed in C# and XAML, this Windows 8.1 Universal App led us to win Microsoft's code.fun.do Finalists Forum, where 53 teams from 15 colleges across India participated.

Autumn 2016 **Vector-Valued Image Regularization with PDEs**.
Guided by: *Prof. Ajit Rajwade and Prof. Suyash Awate, IIT Bombay*
Built an image regularization and in-painting tool in Matlab by implementing Oriented Laplacian PDE based techniques mentioned in this paper which take inspiration from the heat equation.

Autumn 2014 **Digital Image Processor**, [repository].
Guided by: *Prof. Deepak B. Phatak and Prof. Supratik Chakraborty, IIT Bombay*
We built a bitmap image processor in C++ during the freshman year by understanding and implementing popular image processing algorithms like Adaptive Histogram Equalization, Sobel Edge Detection, Dither, Halftoning etc. without using any image processing libraries.

Spring 2016 **Distributed Hash Breaker**, [repository].
Guided by: *Prof. Kameshwari Chebrolu, IIT Bombay*
We implemented a client-server distributed application using socket and threading libraries in C++ that dynamically handles entry and exit of multiple clients and workers. It uses brute force to crack passwords.

Autumn 2016 **Bash-Like shell for File Transfer**.
Guided by: *Prof. Mythili Vutukuru, IIT Bombay*
We built a multi-threaded client with a basic bash-like shell and a multi-process server for file transfer in C++. The client-side shell is capable of handling standard Linux commands in addition to a few custom commands. We also supported features like pipes, IO redirection and signal handling.

Spring 2016 **Simulating Physical Layer**, [report].
Guided by: *Prof. Kameshwari Chebrolu, IIT Bombay*
We replicated the low level reliable data transfer of the physical layer in the TCP/IP stack by demonstrating bit manipulation and clock syncronization between communicating Arduino devices.

Technical Skills

Programming **C++**, **Python**, Bash, Java, VHDL
Software Git, MATLAB, GNU Octave, AutoCAD, Mathematica, LaTeX, CMake
Web HTML, CSS, JavaScript, PHP, Laravel (PHP), Django, MySQL, PostgreSQL

Mentorship and Teaching

2016-2017 **Department Academic Volunteer**.
Data Structures and Algorithms, IIT Bombay
- Volunteered under the Department Academic Volunteer Programme to hold sessions for a batch of 20 sophomores to help with the Data Structures and Algorithms course, IIT
- Involved in creation of problem sets, and discussion and their discussion on a weekly basis

2015-2016 **Teaching Assistant**.
Calculus, IIT Bombay
- Appointed as Teaching Assistant for the freshman course in Calculus, IIT Bombay.
- Held weekly sessions for a batch of 45; involved in exam correction for the course

2015-2016 **Academic Resource Person**.
46^{th} *International Physics Olympiad, Mumbai*
- Responsible for Grading the theory papers of participants from 87 Countries
- Responsible for moderation of marks with Leaders from participating countries

Extracurricular Activities

Technical

- Secured All India Rank 20 in the ACM ICPC Online round, qualified for the Chennai and Amritapuri Regional onsite contests *2016*
- Secured 4^{th} position in a one week autonomous line-following bot making competition organised by the Electronics Club, IIT Bombay *2014*
- Amongst the top 5 teams from IIT Bombay to qualify for and participate in Microsoft's Build the Shield, a network security based competition *2014*
- As the Web Convener for the Students Technical Activity Body (STAB), IIT Bombay, I was responsible for maintaining the STAB website, improving it's functionality and increasing Tech enthusiasm through seminars and talks. *2014*

Others

- Bronze medal in the Table Tennis General Championship, IIT Bombay *2015*
- Successfully completed a 1 year course under the National Service Scheme (NSS) IIT Bombay, ideating and implementing solutions to Social Problems *2014-15*
- Represented District Hisar at various State Level Inline Roller Skating Championships for 2 consecutive years *2007,2008*
- Represented my batch in the CSE Department Council and in Intra Department events during the freshman year *2014-15*

References

- Thomas Henzinger
  President
  IST Austria
  tah@ist.ac.at
- Supratik Chakraborty
  Professor
  IIT Bombay
  supratik@cse.iitb.ac.in