Shubham Goel

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IIT Bombay

Computer Science & Engineering
4th Year Undergraduate
GPA : 9.63/10.0

INTERESTS

Computer Vision, Artificial Intelligence, Logic for Computer Science

PUBLICATIONS

[1] **Pushing The Envelope for Boolean Function Synthesis**[+]
S. Akshay, Supratik Chakraborty, Shubham Goel, Sumith Kulal, Shetal Shah
CSE IITB Technical Report (TR-CSE-2017-87)

[2] **Computing Scores of Forwarding Schemes in Switched Networks with Probabilistic Faults**
Guy Avni, Shubham Goel, Thomas A. Henzinger, Guillermo Rodriguez-Navas
23rd International Conference on Tools & Algorithms for the Construction and Analysis of Systems (TACAS),2017

[+] Names of authors sorted alphabetically by last name. Abridged version, full preprint available on request.

SCHOLASTIC ACHIEVEMENTS

· Secured All India Rank **6** in JEE Advanced 2014 among 150 thousand candidates
· Secured All India Rank **50** in JEE Mains 2014 among over 1.3 million candidates
· Awarded the **AP Grade** for exceptional performance in courses Logic for CS, Digital Logic Design, Engineering Drawing and Biology
· Received the **Institute Academic Award**, IIT Bombay for exceptional academic performance in 2014-15

Olympiads & Scholarships

· **Silver** Medalist at the 46th International Chemistry Olympiad, Hanoi, Vietnam
· **Best Theorist and Experimentalist** at the Orientation cum Selection Camp for the 46th IChO
· Received the **Best Solution Award** at the National Selection Camp for the 54th IMO, Colombia
· Recipient of the **KVPY** (Kishore Vaigyanik Protsahan Yojna Fellowship) in 2013 by Govt. of India
· Awarded the **NTSE** (National Talent Search Examination) Scholarship in 2010 by N.C.E.R.T. New Delhi

RESEARCH EXPERIENCE

Estimating Dense Correspondences on Wide Baseline Images   *Ongoing since Autumn 2017*
Guide: Prof. Arjun Jain, IIT Bombay

· Using data driven approaches for finding dense correspondences between images with scale and viewpoint changes
· Have taken a 2-step hierarchical approach by first predicting a coarse match, and then a fine one
· Use robust descriptors and a correlation volume encoding descriptor similarity between points and coarse regions in the first and second image respectively
· Preliminary experiments gave promising results, beating state-of-the-art tools like DeepMatching by 10%
· Currently working on reducing memory intensiveness and improving network architecture to improve performance

BFSS: Boolean Functional Synthesis   *Ongoing since Spring 2017*
Guide: Prof. Supratik Chakraborty, IIT Bombay

· Working on a CEGAR+AIG based state-of-the-art tool (BFSS) for the Boolean Functional Synthesis problem
· Devised an algorithm reducing the total number of refinements required at the cost of a few extra SAT calls
· Built a synchronous system wherein the solver runs in the background and pipelines counterexamples to BFSS; Cut-shorts on waiting time and provides probabilistic guarantees on correctness of the Skolem Functions
· Worked on writing a full length research paper which will be under submission soon in CAV 2018
· Currently working on improving the algorithm even further by exploiting AIG structure

Restoration of Manifold-Valued Images
Summer 2017

Guide: Prof. Stefan Roth, TU Darmstadt

· Worked on restoration (denoising and inpainting) of images that take values in Riemannian manifolds
· Explored the use of higher order differences and arbitrary filters in modeling the loss objective.
· Came up with a family of frameworks for applying arbitrary zero-sum filters to manifold valued patches; Provided flexibility and generalized previously defined first and second order differences over manifolds
· Implemented this framework, reproduced previous work and built an image denoiser in MATLAB that works with multiple arbitrary filters

Forwarding Schemes in Switched Networks with Probabilistic Faults
Summer 2016

Guide: Dr. Thomas Henzinger, IST Austria

· Assigned scores to forwarding schemes indicative of their robustness towards link crashes and faults
· Designed and implemented a reduction of the scoring problem to SAT counting
· Implemented different iterative and statistical approaches for scoring propositional rule based forwarding schemes
· Proved #P-completeness of the scoring problem, started work on complexity of approximate scoring algorithms
· Gave a talk at IST Austria regarding the same

Nodal Domains of Eigenfunctions of Quantum Billiards
Summer 2015

Guide: Dr Sudhir Jain, BARC

· Made analytical attempts for solving the Helmholtz equation for the 60°-120°rhombus
· Numerically solved for eigenfunctions of the 60°-120°rhombus using the Method of Fundamental Solutions (MFS)
· Developed a modification to the Hoshen-Kopelman Algorithm for counting nodal domains

ACADEMIC PROJECTS

Real-Time Tracking of Non-Rigid Objects — *Computer Vision*

· Implemented the mean shift algorithm for tracking non-rigid objects in a video sequence
· Extended the algorithm to handle huge scale changes
· Implementation was robust to blur, deformation and partial occlusions

Vector-Valued Image Regularization with PDEs — *Fundamentals of Digital Image Processing*

· Built an image regularization tool using techniques based on solutions to Oriented Laplacian PDEs
· Used a generic anisotropic diffusion equation which provides a simple interpretation of the regularization process in terms of local filtering with spatially adaptive Gaussian kernels
· Applied the solution for colour image smoothing, colour image inpainting, and flow visualization

tusSAT: A FPGA based SAT solver — *Digital Logic Design*

· Designed a VHDL package for representation of atomic variables, clauses and expressions
· Implemented a modification of the DPLL algorithm alongside heuristics for variables selection
· Testing suite built from DIMACS Implementation Challenge: Satisfiability
· Featured among other SAT Solvers on satlive.org

Movie Recommendation Engine — *Foundations of Machine Learning*

· Developed a movie recommendation engine in Python using popular collaborative filtering techniques
· Primarily based on the research done on Single Value Decomposition method during the Netflix Prize competition
· Implemented and tested other machine learning techniques like Baseline predictor and k-Nearest Neighbor Model

TECHNICAL SKILLS

Programming Languages	Fluent in C++, Lua, Python; Familiar with Java, VHDL
Libraries	Torch, NumPy, TensorFlow, Scikit-Learn
Software Skills	git, MATLAB, GNU Octave, AutoCAD, LaTeX, CMake
Web Development	HTML, CSS, JavaScript, PHP, Laravel (PHP), Django, MySQL, PostgreSQL

POSITIONS OF RESPONSIBILITY

Teaching Assistant, IIT Bombay
· MA 105 : Advanced Calculus under Prof. I.K.Rana   *Autumn '15*
· CS 226 : Digital Logic Design under Prof. Supratik Chakraborty (Awarded **TA of the Month**)   *Spring '17*

Mentor, Institute Student Mentorship Programme   *2017 - Ongoing*
· Responsible for guiding 12 freshman, focussing on academics and holistic development
· Providing counsel and helping them adjust to campus life

Mentor, Department Academic Mentorship Programme   *2017 - Ongoing*
· Mentor to 6 students for their academic and general concerns, and helping them cope with the curriculum
· Mentor to additional 2 students in academic rehabilitation program (ARP), and helping them get back on track

Academic Resource Person, 46th IPhO, Mumbai   *2015*
· Responsible for grading the theory papers of participants from 87 Countries
· Responsible for moderation of marks with Leaders from participating countries

Web Convener, Student Technical Activity Body, IIT Bombay   *2015-16*
· Developed portals for documentation and registration of participants of STAB events
· Responsible for maintaining the STAB website, modifying content and improving functionality

EXTRACURRICULARS

· Ranked **14th** in ACM ICPC Chennai Onsite contest and **20th** in the Online Regionals in 2016
· **Winner** in Microsoft's code.fun.do Finalist Forum from amongst 53 teams across 15 colleges
· Qualified for the onsite finals of Microsoft's Build The Shield, a network security competition
· Won **Bronze** medal in Table Tennis General Championship, IIT Bombay in 2015
· Secured 4th position in an autonomous line-following bot making competition organized by Electronics Club, IITB
· Successfully completed a 1 year of social service under the **National Service Scheme** IIT Bombay
· Attended the **Vijyoshi National Science Camp** in 2013 organized by Indian Institute of Science, Bangalore
· Represented District Hisar at the **State Level Championship** in Inline Roller Skating in 2007,2008