

Shivam Garg

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Current Position

July 2016 - **Microsoft Research India, Bengaluru.**
Present Research Fellow, Algorithms and Data Sciences Group
Mentors: Deeparnab Chakrabarty and Ravishankar Krishnaswamy

Education

2012-2016 **Indian Institute of Technology Bombay.**
B.Tech (Honours) in Computer Science and Engineering
CGPA: 9.35/10.0

Interests

Design and Analysis of Algorithms, Learning Theory, and Game Theory.

Publications and Patents

- 2016 Shivam Garg and Geevarghese Philip. "Raising The Bar For Vertex Cover: Fixed-parameter Tractability Above A Higher Guarantee.", **Symposium on Discrete Algorithms (SODA)** 2016.
- 2015 Meghanath Macha Yadagiri, Ritesh Noothigattu, Shivam Garg, Abhishek Kandoi, Atanu Sinha "A method to find the stages of a customer's buying cycle in e-commerce website.", US Patent 14/949,088, Filed on 23/11/2015.

Research Experience

May 2014 - **Parameterized Algorithms for Vertex Cover Problem** | Mentor: Prof. G. Philip.
June 2015 Max Planck Institute for Informatics, Germany

We came up with a branching based fixed parameter tractable (FPT) algorithm for the vertex cover problem. Our parameter is smaller than any other parameter for which FPT algorithms are known. We also showed novel applications of the Gallai-Edmonds decomposition (a classic graph theoretic tool) to obtain FPT algorithms. Our paper on this work got accepted at **Symposium on Discrete Algorithms (SODA)**, 2016.

July 2016 - **Non Uniform k-Median Problem** | Mentors: Dr. D. Chakrabarty & Dr. R. Krishnaswamy.
Present Microsoft Research India

We are working on a general version of the k -median problem, which involves placing k weighted facilities in a metric space so that the weighted sum of distances of points from their nearest facility is minimized. We have shown that there is no polynomial time uni-criteria approximation algorithm for this problem even if all the points lie on a line. We have also come up with a dynamic programming based exact algorithm when the points lie on a line.

July 2015 - **Inferring Coalition Structure from Payoffs** | Mentor: Prof. N. Hemachandra.
Present Indian Institute of Technology Bombay

Given the payoff of each player and the payoff allocation scheme in a cooperative game, we tried to ascertain the formation of grand coalition (all players in a single coalition). We came up with sufficient conditions for this. We also showed that this can be done for "most" (leaving a measure zero set) of the games, if nucleolus is used as the payoff allocation scheme. An invited talk on this work was given by Prof. Hemachandra at IIT Madras, as a part of the National Mathematics Initiative. We are planning to submit this work to The **Annals of Operations Research**.

Jan 2016 - **Competitive Exam Games** | Mentor: Prof. Milind Sohoni.

April 2016 Indian Institute of Technology Bombay

We modeled the contestants appearing in competitive exams for admission to institutions such as IITs, IIMs etc. It was done using all-pay auctions, where the contestants submit bids according to attributes such as “raw talent” and “preparation”, and those with high bids are admitted. The “raw talent” was assumed to be fixed and came from a probability distribution, while the level of preparation had to be strategized by the contestants. We studied the equilibrium strategies of the contestants. We also showed how incomplete information among the contestants about their “talent”, leads to inefficiencies in the system. We also ran experiments to study the equilibrium when multiple factors such as “raw talent”, the expected benefit from clearing the exam, and the level of preparation, were considered in a single model.

May 2015 - **Predicting Customer Behavior on E-Commerce Websites** | Mentor: M. Macha.

July 2015 Adobe Research, Bengaluru

We devised a framework to predict the number of page views and probability of conversion of customers in their next online session on an e-commerce website. The predictions were made using a non-homogeneous hidden markov model, where the latent states represented the stage of the customer in the conversion funnel. Our model gave better results as compared to multiple baseline models, and as a result, Adobe filed a patent for our work.

Jan 2016 - **Non-Stationary Correlated Multi-Armed Bandit Problem** | Mentor: Prof. N. Hemachandra.

Present Indian Institute of Technology Bombay

We studied an extension of the multi-armed bandit problem in which the arms are correlated and reward distributions can change over time. One of its applications is in dynamic pricing, where one needs to decide the price at each time point so as to maximize the revenue. Previous solutions to this problem used a sliding window based approach, where one only takes into account a fixed number of observations from the recent past to predict the best action. We came up with regret lower bounds for this approach. We also devised a new approach based on dynamic sliding window, and showed that it performed better than the previous approaches.

Scholastic Achievements and Awards

2014, 2016 Awarded **AP grade** for exceptional performance in *Foundations of Machine Learning* (**top scorer** out of 287 students) and *Abstractions and Paradigms in Programming* (top 3 out of 105 students)

2015, 2016 Secured **10.0/10.0 GPA** in the 7th and 8th semesters

2015 Awarded Microsoft India, IARCS and Xerox Research travel grant to attend SODA 2016

2012 Amongst the **top 300** (0.1%) to be selected for Indian National Chemistry Olympiad

2011 Among **top 1%** in National Standard Examination in Physics out of 43000 candidates

Academic Talks

Jan 2016 **Fixed-parameter Tractable Algorithms for Vertex Cover Problem** .

SODA 2016, Arlington, Virginia, USA.

Sep 2016 **Non-Uniform k-Median Problem** .

Microsoft Research India.

Professional Service

2016 **Reviewer** for the International Colloquium on Automata, Languages and Programming (ICALP)

2015 **Teaching Assistant** for a course on Linear Algebra, IIT Bombay

2015-2016 **Academic mentor** for 6 sophomores

Extra-Curriculars

- 2013 Successfully completed **26 days Basic Mountaineering Course** from Atal Bihari Vajpayee Institute of Mountaineering and Allied Sports (ABVIMAS), Manali
- 2013 **Swam continuously for 9 hours** covering **12.2 km** in Swimathon conducted by IITB Aquatics
- 2013 **Social Service:** Taught slum children in an initiative by Abhyasika, IIT Bombay

Referees

Geevarghese Philip

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Ravishankar Krishnaswamy

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