

Rahul Makhijani
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Senior Operations Research Scientist, Instacart

Education

PhD in Operations Research (Sep' 14 - June 19)
MS&E, Stanford University
Guide: Itai Ashlagi
Thesis Topic: Matching in Online Market Platforms
PhD Minor in Computer Science.

Masters in Statistics (Jan' 17 - Jan' 18)
Stanford University

Bachelor of Technology (Honors) in Electrical Engineering (July' 09 – Aug' 13)
IIT - Bombay, Mumbai, India
Guide: Vivek Vorkar

Professional Experience

Instacart (July' 21 - Present)
Senior Operations Research Scientist, Logistics Team
Worked on matching optimization - matching deliveries to shoppers.
Helped the company save 30 MM\$ due to my algorithmic improvements.

Facebook (July' 19 - July' 21)
Research Scientist, Core Data Science

1. Developed a Discrete Time Event Simulator to perform Human Reviewer Capacity analysis for Content Moderation.
2. Worked on implementing Thompson Sampling (TS) Algorithm for routing SMS messages and saved 7.5 MM\$

Barclays Capital (July' 13 - Aug' 14)
Quantitative Analyst, Foreign Exchange (FX)

1. Statistical Analysis of Volatility Surfaces.
2. Exercise Probability of path dependent products such as TARN options. Calculated exercise probabilities using PDE methods by running finite difference solvers in parallel.

Awards, Distinctions and Fellowships

1. Awarded the Randy and Chris Battat Fellowship during the course of the PhD.
2. Awarded the Dantzig Lieberman Operations Research fellowship during the course of the PhD.
3. Awarded the **Narotam Sekhsaria Certificate of Merit** and a cash prize of Rs. 50,000 for excellence in academic and extracurricular activities.
4. **K.C. Mukherjee award** for the Best Undergraduate Thesis in the Electrical Engineering Department.

5. Only undergraduate selected for an oral talk at Electronic Materials Conference (E.M.C. 2011) at University of California, Santa Barbara (UCSB).
6. All India Rank **49** in IIT JEE 2009 (out of more than 5,75,000 students).
7. Honorable mention at Asian Physics Olympiad (**APhO**).
8. **Gold** Medalist at Indian National Physics, Chemistry and Maths Olympiads (among top **30** in India).

Patents

1. Dale Struble, **Rahul Makhijani**, Yi Liu, Shreya Chakrabarti, "METHOD, SYSTEM, AND MANUFACTURE FOR MIN-COST FLOW ITEM RECOMMENDATIONS", Patent 11.367, 118 B1

Teaching Experience

1. MS&E 211 Introduction to Optimization (Undergraduate level course at Stanford)
2. MS&E 238 Recent Trends in Information Technology (Graduate level course at Stanford)
3. MS&E 260 Introduction to Operations Management (Graduate level course at Stanford)
4. MS&E 235 Analytics in Action (Graduate level course at Stanford)
5. MS&E 348 Optimization of Uncertainty and Applications in Finance (PhD level course)
6. Complex Analysis (undergraduate level course at IIT Bombay)
7. Introduction to Partial Differential Equations (undergraduate level course at IIT Bombay)

Research Interests: Matching, Market Design, Algorithms, Optimization

Graduate Research

My thesis focused on an in-depth study of problems that are motivated from challenges faced by online platforms. The first part looks at sequential matching problems in a decentralized marketplace and the second part looks at bipartite online matching in a centralized environment.

The first part of the thesis is concerned with the problem of assortment planning in such two-sided platforms, where on each side of the platform there are self-interested agents. While assortment planning has been studied extensively in the revenue management literature, it is concerned with the problem of assigning menus of goods to agents. We consider the problem of assortment optimization where people are present on both sides (one can be rejected by agents on the other end.) To describe the tradeoff that then arises, let us refer to the two sides of the market as customers and suppliers, respectively, where we assume that customers are presented with recommended assortments of potential suppliers to choose from. Naturally, increasing the number and mix of potential suppliers that a customer sees increases the chances that she finds an acceptable one to contact, instead of choosing not to pursue a match through the platform at all. However, if as a result the same supplier is shown to many customers, this would increase the chances that a supplier is contacted by many customers with conflicting requests at the same time, resulting in collisions when only one such request can be accepted. These collisions are bad for the platform as the number of transactions could have been increased by redirecting some of these customers to other suppliers. However, in a two-sided market, having a supplier receiving many requests might indeed increase the number of matches as this may increase the chances she finds a customer she prefers other outside options. Motivated by the above discussion, we study how to optimize over the assortments of recommended potential partners that are

shown to each user to maximize the number of matches. The contribution is twofold: we propose a novel stylized model that captures the aforementioned tradeoffs, and we construct a simple algorithm that achieves a constant-factor approximation to the optimal number of matches.

The second part is concerned with a centralized marketplace, where agents (drivers and passengers) arrive in an online manner and are matched after a possible delay. A natural trade-off that arises is the following: matching agents faster reduces waiting costs but waiting for more agents to arrive allows to create better matches. Agents arrive on n points which form a metric (distance between points satisfying the triangle inequality) and the platform needs to minimize the sum of distance and waiting costs. A randomized and a deterministic algorithm are proposed on the tree metric (that has been embedded from the original metric); both of which achieve a constant competitive ratio on the tree metric leading to a logarithmic competitive ratio on the general metric.

Publications, Presentations and Abstracts

1. Itai Ashlagi, Anilesh K. Krishnaswamy, **Rahul Makhijani**, Daniela Saban, Kirankumar Shiragur "Assortment Planning for Two-Sided Sequential Matching Markets" *JOURNAL OF OPERATIONS RESEARCH* 2021
2. **Rahul Makhijani**, Parikshit Shah, Vashist Avadhanula, Caner Gocmen, Nicolás E. Stier-Moses, Julián Mestre "QUEST: Queue Simulation for Content Moderation at Scale"
3. Itai Ashlagi, Anilesh K. Krishnaswamy, **Rahul Makhijani**, Daniela Saban, and Kirankumar Shiragur "Assortment Planning for Two-sided Sequential Matching Markets" *Web and Internet Economics (WINE)* 2020.
4. **Rahul Makhijani**, Johan Ugander, "Parametric Models for Intransitivity in Pairwise Rankings", *World Wide Web Conference (WWW)*, 2019.
5. **R Makhijani**, S Chakrabarti, D Struble, Y Liu, "LORE: a large-scale offer recommendation engine with eligibility and capacity constraints" 13th ACM Conference on Recommender Systems, 160-168
6. Itai Ashlagi, Yossi Azar, Moses Charikar, Ashish Chiplunkar, Ofir Geri, Haim Kaplan, **Rahul Makhijani**, Yuyi Wang, and Roger Wattenhofer, "Min-cost Bipartite Matching with Delays" *APPROX* - 2017.
7. Borkar, Vivek S., **Makhijani, Rahul M.**, "Who is the fairest of them all?" (Allerton), 2012, 50th Annual Allerton Conference on Communication, Control, and Computing, pp.460 - 465, Oct. 2012.
8. Vivek S. Borkar, **Rahul Makhijani**, Rajesh Sundaresan, "How to gossip if you must", *IEEE Journal of Selected Topics in Signal Processing*.
9. Borkar, Vivek S., Makhijani, Rahul M., Sundaresan Rajesh, "Gossip with transmission constraints", *Information Theory and Applications Workshop 2013*, UCSD.
10. **Rahul M. Makhijani**, S. Chakrabarti, Vijay A. Singh "Photoluminescence spectra of InAs quantum dots embedded in GaAs heterostructure", *Journal of Luminescence*, Volume 136, 2013, Pages 401-406, ISSN 0022-2313,
11. **Rahul M. Makhijani**, N. Halder, S. Sengupta, S. Chakrabarti, "Temperature dependent photoluminescence investigation of the effect of growth pause induced ripening in InAs/GaAs quantum dot heterostructures", *Materials Research Bulletin*, Volume 47, Issue 3, 2012, Pages 820-825

References

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