ROHITH DWARAKANATH VALLAM

CONTACT ADDRESS

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EDUCATION

Ph.D. [Aug 2009 - July 2015 (PhD. Thesis Defended)]
Dissertation Title: : Game-theoretic Analysis of Strategic Behaviour in Networks, Crowds, and Classrooms.
Thesis Supervisor: Prof. Y. Narahari.
Department of Computer Science and Automation (CSA),
Indian Institute of Science, Bangalore (IISc), Bengaluru, India.

M.S.(by Research), [Aug 2005 - Apr 2009]
Thesis Title: Optimization Models and Algorithms: Application to Security and Channel Assignment Problems in Ad Hoc Wireless Networks.
Thesis Supervisor: Prof. C. Siva Ram Murthy.
Department of Computer Science and Engineering (CSE),
Indian Institute of Technology, Madras (IITM), Chennai, India.

B.E., [1998 - 2002]
Department of Computer Science and Engineering,
R.V. College of Engineering, Bengaluru, India.
Visveswaraiah Technological University (VTU), Karnataka.
Percentage: 85.7% *(in Top 16 (State-wide) in B.E.(2002) Examination)*

Intermediate (10+2 Standard), [1996-1998]
M.E.S. College, Malleswaram, Bengaluru.
Department of Pre-University(P.U) Education, Karnataka.
Percentage: 93.83%
(in Top 11 in State in P.U Board Examination, Karnataka)
(60th Rank in Engineering stream in Karnataka Common Entrance Test (KCET), 1998)
(120th Rank in Medical stream in Karnataka Common Entrance Test (KCET), 1998)

10th Standard, [1995-1996]
V.V.S. Sardar Patel High School, Rajajinagar, Bengaluru.
Board of Secondary Education, Karnataka.
Percentage: 91.68%

RECENT AWARDS AND RECOGNITIONS

- Nominated for the "Best Thesis Award (2015)" from the Department of Computer Science and Automation (CSA), Indian Institute of Science, Bengaluru.
- Won Second Runner-up (all-India), Best Doctoral Dissertation Award, at the Xerox Research Center India (XRCI) Open 2015.
- Selected for receiving IBM PhD Fellowship for the year 2012-2014.

RESEARCH INTERESTS

My current interests include investigating the role of game theory, mechanism design, and machine learning in web-based applications like online education, crowdsourcing, social networks and prediction markets.

JOURNAL PUBLICATIONS

• A Markov chain based Stackelberg game for improving instructor-student interactions in online education forums.
Rohith Dwarakanath Vallam, Priyanka Bhatt, Debmalya Mandal, and Y. Narahari.
To be submitted.

• Strategic Network Formation with Localized Payoffs
Rohith Dwarakanath Vallam, C. A. Subramanian, Ramasuri Narayanam, Y. Narahari, and Srinath Narasimha.
Studies in Microeconomics, 2(1):63–119, 2014.

• A Non-Cooperative Game-theoretic Approach to Channel Assignment in Multi-Radio Wireless Networks.
Rohith Dwarakanath Vallam, Arun A. Kanagasabapathy, and C. Siva Ram Murthy.
Wireless Networks, Volume 17, Number 2, Pages 411-435, February 2011.

CONFERENCE PUBLICATIONS

• A Stackelberg game approach for incentivizing participation in online educational forums with heterogeneous student population.
Rohith Dwarakanath Vallam, Priyanka Bhatt, Debmalya Mandal, and Y. Narahari.
Proceedings of *29th AAAI Conference on Artificial Intelligence, AAAI '15, Austin, Texas,* USA, pp. 1043-1049, Jan 2015.

• Topologies of stable strategic networks with localized payoffs
Rohith Dwarakanath Vallam, C. A. Subramanian, Y. Narahari,
Ramasuri Narayanam, Srinath Narasimha. Proceedings of 9th IEEE International Conference on Automation Science and Engineering (CASE'13), Wisconsin, USA, pp 844-849, Aug 2013.

• Eliciting High Quality Feedback from Crowdsourced Tree Networks using Continuous Scoring Rules.
Ratul Ray, **Rohith Dwarakanath Vallam**, and Y. Narahari.
Proceedings of 12th International Conference on Autonomous Agents and Multiagent Systems (AAMAS '13), Saint Paul, Minnesota, USA, Pages 279-286, May 2013.

• Modelling Co-operative MAC Layer Misbehaviour in IEEE 802.11 Ad Hoc Networks with Heterogeneous Loads.
Rohith Dwarakanath Vallam, A. Antony Franklin, and C. Siva Ram Murthy.
In Proceedings of 6th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt'08), Berlin, Germany, Pages 197-206, April 2008.

INDUSTRY EXPERIENCE

- Worked 3 years (Aug 2002-July 2005) at Huawei Technologies India Private Ltd. (HTIPL), Bangalore.
  Domain: Intelligent Networks (specifically development of Voice over IP web services)

MENTORSHIP OF PROJECTS

- Worked on "Scalable Preference Aggregation on Social Networks" project at Game theory. Lab, IISc (Nov 2014-April 2015).
  Details: Preference aggregation refers to computing an aggregate preference over a set of alternatives given individual preferences of all the agents. In real-world scenarios, it may not be feasible to gather preferences from all the agents. Moreover, determining the aggregate preference is computationally intensive. It has been shown in the past that the aggregate preference of the agents in a social network can be computed efficiently with sufficient accuracy using preferences elicited from a small subset of critical nodes in the network using the homophily concept.For identifying these critical nodes and to develop a feasible model, we have to collect the preferences and interconnections from a large population. For collecting these preferences we have developed a Facebook app among Facebook users designed as an online survey related to some social and personal questions. The app was hosted for about 26 days and it invoked participation from about 1000 Facebook users. Further analysis of the collected real-world data is currently in progress. Some of the technologies used in the project include Google Cloud Datastore APIs, PHP, Javascript and Facebook app development APIs.

- Mentored 4 course projects on Prediction markets (in winter terms of 2011, 2012, 2013 and 2015) as part of Game Theory Course at IISc. In particular, these projects involved groups of 3-4 master's degree students at IISc studying the various mechanisms used in prediction markets namely the logarithmic, quadratic, spherical scoring rules.
  These projects also involved deploying real-world prediction markets based on the open-source implementation (Zocalo) in IISc. Connections of prediction markets with online learning algorithms were also explored.

- Mentored course project on "Incentive Design, Peer Review and Social Networks in Online Educational Forums". In this project we look at some of the most common problems associated with Online Educational Forums, more specifically MOOCs. We try to design incentives to maintain regular and consistent participation in the forums. We also take a game theoretic approach to design mechanisms for truthful peer evaluation. Using the data from the forums we try to build a social network among the participants and analyse the same to gain useful incite that helps us modify our incentives and evaluation mechanisms accordingly.

- Mentored course project on "NECTAR : Nash Equilibrium CompuTation Algorithms and Resources". In this project, we implemented algorithms for some of the game theoretic problems like computation of different mechanism design problems, converting Bayesian games to normal form games and computation of Core, Shapley value and Nucleolus of co-operative games.

- Worked as 'Project Associate' for the project 'Resource Management in Networks' sponsored by Department of Science and Technology, India during the Aug 2005-Aug 2006 and Jan 2009-April 2009 at IIT Madras.
  Details: Meghadoot Hybrid Wireless Network is packet-based wireless network architecture

for lowcost rural community networks conceived at the High Performance Computing and Networking lab (HPCN), IIT Madras.

- Final year B.E project: Involved in the Redesign and Enhancement of the Expert System Shell - 'NipuNa', using the horseshoe model of re-engineering along with object-oriented methodologies, at Centre For Artificial Intelligence And Robotics (CAIR), Bangalore.

PROGRAMMING EXPERIENCE

[Mathematical Software:] Matlab, Mathematica
[Programming languages:] C, C++, Java, Javascript, Shell-scripting, Python
[Web Technologies:] J2EE (JSP, Servlets), MySql, Oracle, AJAX, PHP, Applets, HTML
[Other:] LaTeX, XML

COURSE WORK

- Completed (during PhD program in IISc, Bangalore)

  Topics in Game Theory - Repeated Games and Subgame Perfect Equilibrium, Extensive Form Games, Evolutionary Stable Strategies, Basic Mechanism Design Concepts.
  Design and Analysis of Algorithms - Network Flow Algorithms, Randomized Algorithms, Some Problems in Combinatorial Geometry like Convex Hull, etc.
  Real Analysis - Basic Topological Concepts, Calculus of Single/Several Variables.
  Game Theory - Nash Equilibrium Computation, Correlated Equilibrium, Concepts like Core, Shapley value, Bayesian Games, Mechanism Design Concepts - Incentive Compatibility and some fundamental Impossibility theorems like Gibbard-Satterthwaite theorem, etc.
  Computational Methods of Optimization - First/Second Order Conditions for Local Extrema, Conjugate Gradient, Steepest Descent, Newton/Quasi-Newton methods to Solve Unconstrained Optimization Problems, Constrained Optimization - KKT conditions, Linear Programming - Simplex method and its analytical foundations.

- Courses Audited (during PhD program in IISc, Bangalore)

  Linear Algebra - *Teaching Assistant (Aug-Nov 2010) under Prof. R. Vittal Rao, CEDT, IISc*
  Probability Theory - *Audit (Jan-Apr 2011)*
  Data Mining - *Audit (Jan-Apr 2010)*
  Calculus on Manifolds - *Audit (Jan-Apr 2010)*

DETAILS OF RESEARCH EXPERIENCE

M. S.(by Research) Thesis:

My master's thesis investigated two research problems. The details are given below.

Research Problem 1 (Master's Thesis):
Domain: MAC Layer in Ad Hoc Wireless Networks
Title: Modelling co-operative MAC layer misbehaviour in IEEE 802.11 ad hoc networks with heterogeneous loads
Abstract:

Misbehaviour due to back-off distribution manipulation has been one of the significant problems faced in IEEE 802.11 wireless ad hoc networks which has been explored recently by the research community. In addition, collusion between misbehaving nodes adds another dimension to this security problem. We examine this problem in a three-node network scenario wherein two nodes are assumed to be malicious colluding adversaries causing unfair channel access to the other legitimate node. The misbehaving nodes, through back-off ma-

nipulation, will try to minimize the channel access share got by the legitimate node and at the same time maximize the detection delay to detect such an attack. We explore this problem and its solution, analytically, in a non-saturated setting, by modelling a single IEEE 802.11 node as a discrete time Markov chain (DTMC) and suggest a measure for evaluating fairness in the network. We then propose an attacker-detector non-linear optimization model through which the joint optimal attacker distribution is evaluated by applying results from the area of variational calculus. We finally use the sequential probability ratio test (SPRT) for estimating the average number of samples for detecting colluding adversaries in the network. We validate all the models using MATLAB and verify the model results by sampling values from the evaluated optimal attacker distribution using a robust statistical library called UNU.RAN.

Research Problem 2 (Master's Thesis):

Domain: Channel Assignment in Ad Hoc Wireless Networks

Title: A non-cooperative game-theoretic approach to channel assignment in multi-channel multi-radio wireless networks

Abstract:

Channel assignment in multi-channel multi-radio wireless networks poses a significant challenge due to scarcity of number of channels available in the wireless spectrum. Further, additional care has to be taken to consider the interference characteristics of the nodes in the network especially when nodes are in different collision domains. This work views the problem of channel assignment in multi-channel multi-radio networks with multiple collision domains as a non-cooperative game where the objective of the players is to maximize their individual utility by minimizing its interference. Necessary and sufficient conditions are derived for the channel assignment to be a Nash Equilibrium (NE) and efficiency of the NE is analyzed by deriving the lower bound of the price of anarchy of this game. A new fairness measure in multiple collision domain context is proposed and necessary and sufficient conditions for NE outcomes to be fair are derived. The equilibrium conditions are then applied to solve the channel assignment problem by proposing three algorithms, based on perfect/imperfect information, which rely on explicit communication between the players for arriving at an NE. A no-regret learning algorithm known as Freund and Schapire Informed algorithm, which has an additional advantage of low overhead in terms of information exchange, is proposed and its convergence to the stabilizing outcomes is studied. New performance metrics are proposed and extensive simulations are done using Matlab to obtain a thorough understanding of the performance of these algorithms on various topologies with respect to these metrics. It was observed that the algorithms proposed were able to achieve good convergence to NE resulting in efficient channel assignment strategies.

Ph.D. Dissertation:

My doctoral thesis investigated three research problems. The details are given below.

Research Problem 1 (Doctoral Thesis):

Domain: Social and Organizational Networks

Title: Strategic Network Formation with Localized Payoffs

Abstract:

In this investigation, we analyze a network formation game in a strategic setting where payoffs of individuals depend only on their immediate neighbourhood (localized payoff). These localized payoffs also incorporate the social capital emanating from bridging positions that nodes hold in the network. Using this simple and novel model of network formation, our study explores the structure of networks that form, when they satisfy pairwise stability or efficiency or both. We derive sufficient conditions for the pairwise stability of several interesting network structures. We characterize topologies of efficient networks by drawing upon classical results from extremal graph theory and discover that the Turan graph (or the complete equi-bipartite network) emerges as the unique efficient network under many

parameter configurations. We examine the trade-offs between topologies of pairwise stable and efficient networks using the notion of price of stability. Interestingly, we find that price of stability is equal to 1 for almost all configurations of parameters in the proposed model; and for the remaining configurations, we obtain a lower bound of 0.5. This leads to another key insight: under mild conditions, efficient networks will form when strategic individuals choose to add or delete links based on only localized payoffs. We study the dynamics of the proposed model by designing a simple myopic best response update rule and implement it on a customized network formation test-bed.

Research Problem 2 (Doctoral Thesis):

Domain: Online Labour Markets, Recommender Systems

Title: Eliciting Honest Feedback from Crowdsourced Tree Networks using Continuous Scoring Rules

Abstract:

Eliciting accurate information on any object (perhaps a new product or service) using the wisdom of a crowd of individuals in web-based platforms is an important and interesting problem. Peer prediction method is one of the known efforts in this direction but is limited to the setting where raters report discrete signals. We non trivially generalize the peer prediction mechanism to handle continuous rater reports. Further, the mechanism is extended to work in the setting of a tree network of participating nodes that would get formed when the query about the object originates at a root node and propagates to nodes in a social network through forwarding. In the proposed tree-based peer prediction mechanism, we use proper scoring rules for continuous distributions, a simple multinomial distribution sampling method as aggregation scheme for intermediate nodes and prove that honest reporting is a Bayesian Nash equilibrium when prior probabilities are common knowledge in the tree and the observations made by the sibling nodes are stochastically relevant. To compute payments, we explore the logarithmic, quadratic, and spherical scoring rules using techniques from complex analysis. Through detailed simulations, we obtain several insights including the relationship between the budget of the mechanism designer and the quality of answer generated at the root node.

Research Problem 3 (Doctoral Thesis):

Domain: Online Classrooms, Massively Open Online Courses (MOOCs)

Title: A Stackelberg Game Approach for Improving Participation in Online Educational Forums with Heterogeneous Student Population

Abstract:

Increased interest in web-based education has spurred the proliferation of online learning environments. However, these platforms suffer from high dropout rates due to lack of sustained motivation among the students taking the course. In an effort to address this problem, we propose an incentive-based, instructor-driven approach to orchestrate the interactions in online educational forums (OEFs). Our approach takes into account the heterogeneity in skills among the students as well as the limited budget available to the instructor. We first analytically model OEFs in a non-strategic setting using ideas from lumpable continuous time Markov chains and compute expected aggregate transient net-rewards for the instructor and the students. We next consider a strategic setting where we use the rewards computed above to set up a mixed-integer linear program which views an OEF as a single-leader-multiple-followers Stackelberg game and recommends an optimal plan to the instructor for maximizing student participation. Our experimental results reveal several interesting phenomena including a striking non-monotonicity in the level of participation of students vis-a-vis the instructor's arrival rate.