Aditya Modi

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Overview

My research interests lie in machine learning and optimization. Specifically, I'm interested in **statistical learning theory** tools applied to **interactive learning** and **sequential decision making** frameworks like reinforcement learning, bandits and active learning. My previous work has revolved around kernel methods, perceptron models and semi-supervised learning.

Last updated: Feb '17

Education

University of Michigan, Ann Arbor (US) *Sept '16 to present*
PhD in Computer Science

- Pursuing MS/PhD in Computer Science. Current CGPA **4.0/4.0**.
- Advisors: Prof. Satinder Singh Baveja(Prof., EECS, UM) and Prof. Ambuj Tewari (Asst. Prof., Statistics, UM)

Indian Institute of Technology Kanpur, India *July '12 to June '16*
B.Tech. in Computer Science and Engineering

- Graduated with Cumulative Performance Index (CPI) of **9.4/10.0**.

Scholastic Achievements

- Awarded the **Academic Excellence award** for the years **2012-13, 2014-15** by **IIT Kanpur** for exceptional performance.
- Selected for **Machine Learning Summer School (MLSS), Cadiz, 2016** with travel scholarship.
- Recipient of **O.P. Jindal Engineering & Management Scholarship (OPJEMS) 2012** award given to around 100 students from top engineering and management institutes in India.
- Awarded the **Ram Parkash Chopra Memorial Scholarship** for the academic year 2014-15, given for academic performance and aptitude.
- Secured **All India Rank 132** in IIT-JEE 2012 out of around 500,000 students.
- Secured **All India Rank 150** in AIEEE 2012 out of around 1.2 million students.
- Received honourable mention in **ACM International Collegiate Programming Competition Asia Amritapuri** (2014-15, 2013-14) and **Kanpur regionals** (2013-14).
- Selected in **Top 1%** of **Indian National Astronomy Olympiad (INAO)**, **Indian National Physics Olympiad (INPhO)** and **Indian National Chemistry Olympiad (INChO)** for the year 2011-2012.
- Awarded **National Talent Search Scholarship** by Ministry of Human Resources & Development, India (2008).

Internship and Research Projects

Data-dependent Importance weighted Active Learning *Sept '16 to Ongoing*
Graduate student research assistant, Univ. of Michigan
Advised by: Prof. Ambuj Tewari (Asst. Professor, Statistics, Univ. of Mich.)
Prof. Barzan Mozafari (Asst. Professor, EECS (CSE), Univ. of Mich.)

- AIM: Formulate an active learning algorithm with data-dependent bounds for general loss functions.
- Investigated the Importance Weighted Active Learning framework and its variants.
- Identified key issues in the analysis which misstates the extension to infinite function classes (finite VC dimension).
- Proved the convergence properties for IWAL in case of infinite binary hypothesis classes.
- Performed experiments to observe the sensitivity of importance weights to nature of functions being learnt.

Local Latent Perceptrons for Large Scale Multiclass Learning *Aug '15 to Feb '16*
Research Project, IIT Kanpur
Advised by: Prof. Vinay Namboodiri (Asst. Professor, IIT Kanpur) [Preliminary Report]

- AIM: Formulate a local learning algorithm which is computationally efficient on large-scale.
- Proposed a latent perceptron model inspired from Locally Linear SVM (LLSVM) and a mixture of experts model.
- Online model for locally linear classification with a coupled update algorithm for local and empirical loss measure.

- Surveyed existing literature on mistake bounds, online-to-batch conversion techniques and optimization techniques (SGD, cutting plane methods, PegaSoS, CCCP etc).
- Finding: Initial experiments yielded decent performance over covertype, MNIST datasets.

Active Semi-supervised Performance Evaluation *May '15 to July '15*

Research Intern, Microsoft Research India

Mentored by : Sundararajan Sellamanickam, Principal Applied Scientist, Microsoft Research India [Report]

- AIM: Evaluate performance of a classifier model and calibration in case of sparsely labelled test set.
- Proposed a semi-supervised density modelling routine inspired from entropy regularisation aimed to counter misspecification in score model.
- Used a deterministic annealing scheme with L-BFGS to find the optimal parameters.
- Compared variations of the model for evaluation using various metrics - ROC curve, PR curve, F-measure etc.
- Performed Demsar's statistical significance test for comparing the methods observing improvement for some metrics.

Relaxed Hierarchical learning using SVM's *Aug '14 to Nov '14*

Research Project(CS395) under Prof. Vinay Namboodiri (Asst. Professor, IIT Kanpur) [Report]

- AIM: Improvise known hierarchical learning methods to create an accurate and computationally efficient classifier.
- Studied various models of SVM's and multiclass classification and associated theoretical analyses.
- Worked on improvisation of a hierarchical SVM framework given by Koller et al. in ICCV '11. Explored methods for sharing information between nodes using orthogonality or manifold properties.
- Performed tests on Caltech-256 and AWA dataset with overfeat and decaf feature extractors.

Optimized Video Surveillance System *May '14 to July '14*

Summer Project under Prof. Harish Karnick (Professor, IIT Kanpur)

- AIM: Build an improvised video surveillance system **to be set up at IIT Kanpur campus**.
- Implemented a real-time system for adaptive background subtraction using Gaussian Mixture Model in openCV.
- Worked on ensemble model of MOG using chromaticity coordinates and spatial frame features for varying illumination.

Other Projects

Asynchronicity and delay in distributed stochastic optimization *Nov '16 to Dec '16*

Course project: Prof. Long Nguyen (Associate Professor, Univ. of Michigan) for Optimization methods in Statistics (STATS 608) [Report]

- Aim of the project was to investigate delay tolerance of stochastic optimization with asynchronous updates.
- Experimented with delay adaptive modifications of Nesterov's dual averaging algorithm and stochastic mirror descent.
- Investigated the analysis of two models delay adaptive (Duchi et al. '11) and delay-sensitive (Sra et al. '15) and provided extension to both the above models for the latter.
- Simulated and studied various delay models like random delay, cyclic update and handicapped process architecture.

Active optimization of ranking surrogates *Jan '16 to Apr '16*

Course project: Prof. Purushottam Kar (Asst. Professor, IIT Kanpur) for Online Learning and Optimization (CS773) [Report]

- Aim of the project was to give an active optimization routine for optimizing precision@k measure for bipartite ranking.
- Working with perceptron learning methods given by Kar *et al.* in NIPS '15, suggested a selective sampling method.
- With a tailored notion of confidence value/margin, implemented a sampling routine similar to methods suggested by Cesa-Bianchi *et al.* for online learning.
- With an exponentially decaying sampling distribution, achieved same rate of convergence for optimization with significant improvement in query complexity over datasets like covertype, IJCNN, KDD-08, cod-rna.

Stochastic methods for MCMC methods *Jan '16 to Apr '16*

Course project: Prof. Piyush Rai (Asst. Professor, IIT Kanpur) for Probabilistic Machine Learning (CS772) [Report]

- Aim: Study and improve the stochastic gradient Langevin Dynamics (SGLD) framework by Welling et al. in ICML '11.
- Explored hybrid Monte Carlo methods and the SGLD framework along with MCMC learning for Bayesian inference.
- Suggested improvements in the method by using improved gradients via methods like Stochastic Averaged Gradient (SAG) and Stochastic Variance Reduced Gradient (SVRG).

- Experimented with synthetic and adult datasets for empirical study of the methods.

Learning with Similarity functions: Going beyond PSD kernels *Sept '15 to Nov '15*
Course project: Prof. Harish Karnick (Professor, IIT Kanpur) for Learning with Kernels (CS678) [Report]

- Aim of the project was to systematically study indefinite kernel learning algorithms.
- Explored various techniques based on RKKS, Prototype Selection, spectrum clip, spectrum flip and shift etc.
- Investigated generalised framework for learning via similarity functions given by Balcan *et al.* and its extension to supervised learning by Kar *et al.*.
- Surveyed variety of capacity measures, risk bounds and margin bounds needed for analyses in works mentioned above.

Billion word imputation challenge *Feb '15 to Apr '15*
Course project: Prof. Harish Karnick (Professor, IIT Kanpur) for Machine Learning Techniques (CS771). [Report]

- Kaggle problem: To create a language model to predict a single word removed from a sentence.
- Predicted missing word location by Markov model using n-gram, brown clustering, and an averaged perceptron model.
- Used n-gram model and also experimented with context-based models like CBOW, Gensim's Word2Vec.
- Result: Achieved accurate predictions upto 26% for word prediction and 45% for missing word location.

Workshops/Seminars attended

- **Summer School on large-scale optimization** - 10 day long workshop organised by **Indo-French Centre for Applied Mathematics** at IISc Bangalore in June-July '16. It comprised of tutorial and research talks on large-scale and robust optimization by eminent researchers like Francis Bach, Prateek Jain among others.
- **"Learning, Algorithms and Complexity"** - 5-day long symposium organised by **National Mathematics Initiative** at IISc Bangalore in January 2015. It comprised of talks and lectures with topics mostly in the sphere of computational learning theory and algorithmic statistics. The speakers were eminent researchers like Robert Schapire, Nicolo Cesa-Bianchi, Sanjeev Arora among others.
- **Machine Learning Summer School '15** at IISc, Bangalore jointly organised by Microsoft Research and IISc in June 2015. It comprised of talks and tutorials on various domains of machine learning and optimization by researchers like Suvrit Sra, Sanjoy Dasgupta, John Lafferty, among others.

Teaching Experience

Graduate Student Instructor, Machine Learning (EECS 445) *Jan '17 - to date*
Instructor: Prof. Jenna Wiens (Asst. Professor, EECS(CSE), Univ. of Michigan)

- Responsible for teaching discussion sessions, curating homeworks and projects for the course among other administrative responsibilites.

Student Mentor, Machine Learning Techniques (CS771) *Jan '16 - Apr '16*
Instructor: Prof. Harish Karnick (Professor, CSE, IIT Kanpur)
Teaching Assistant, Data Structures and Algorithms (ESO207) *Aug '15 - Nov '15*
Instructor: Prof. Shashank Mehta (Professor, CSE, IIT Kanpur)
Academic Mentor, Institute Counselling service *July ' 13 to Apr '14*

Technical Skills

- **Languages:** C/C++, MATLAB, Python, Perl, Ruby, R
- **Others:** LaTeX, Octave, Bash scripting, Weka, Git, OpenCV