Ashish Bora

Contact

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Research Interests

Applications of **Probability, Optimization and Algorithms** in the domains of **Machine Learning, Data Mining, Scalable and Stochastic Algorithms**

Education

University of Texas at Austin *2015-Present*
Pursuing Masters and Doctorate in Computer Science

Indian Institute of Technology Bombay, India *2011-2015*
Bachelor of Technology (Honors) in Electrical Engineering Major GPA : 9.64/10.0
Minor in Computer Science Minor GPA : 9.60/10.0

Publications

- [In Review] **Ashish Bora**, Vivek S. Borkar, Dinesh Garg and Rajesh Sundaresan, **Edge Conductance Estimation Using MCMC**
- **Ashish Bora**, Arjun Rao and Bipin Rajendran, **Mimicking the worm - an adaptive spiking neural circuit for contour tracking inspired by C. Elegans Thermotaxis**, *International Joint Conference on Neural Networks, IEEE World Congress on Computational Intelligence 2014*

Research Experience

Graduate Research Assistant *Sept'15-Present*
Guides: Prof. Sujay Sanghavi and Prof. Joydeep Ghosh, UT Austin
- Investigating **Deep Learning** models to identify potential research directions
- Experimenting with basic architectures in **Theano**

Edge Conducatance Estimation using MCMC *Jul'14-May'15*
Guides: Prof. Vivek Borkar, IIT Bombay and Prof. Rajesh Sundaresan, IISc Bangalore
- Devised an MCMC based algorithm for efficient estimation of effective edge conductances
- Our algorithm is **memory efficient**, makes **very few computations** per step, uses only **local information**, and can be easily **distributed** and **parallelized**
- Provided probabilistic guarantees on algorithm performance (**PAC guarantee**) by deriving sample complexities using tools from theory of **Markov Chains** and **Concentration Inequalities**

Bio-inspired Spiking Neural Networks for 2-D contour tracking *May'13-Jan'14*
Guide: Prof. Bipin Rajendran, IIT Bombay
- Developed a framework for simulating Spiking Neural Networks using the aEIF model in Matlab
- Inspired by C. Elegans thermotaxis, designed a model for exploration and tracking dynamics
- Designed a SNN with time-dependent **adaptive plastic synapses** to realize these dynamics
- Our neural circuit can identify isotherms with a **∼60% higher probability** than the theoretically optimal memoryless Levy foraging, and sparse spiking enables **energy-efficient** implementations

Professional Experience

Summer Analyst, Goldman Sachs *May'14-July'14*
Controllers Modeling, Finance Division, Bangalore, India

Finding **Nearest Consistent Correlation Matrix** from combination of many incomplete and inconsistent (some principal sub-matrices of interest being non positive semidefinite) data sources

- **Proved convergence, feasibility & non-optimality** of an existing heuristic algorithm
- Using tools from **Convex geometry**, **reduced the problem** to finding projection onto an intersection of finitely many simple, convex, compact sets in an Hilbert Space
- Deployed **Dykstra's Cyclic Projection** to get an algorithm that **provably converges** to the **optimal solution**. Designed various regtests for checking correctness and optimality
- Achieved **40x Speed Gain** by leveraging **Cholesky decomposibility** criterion

Technical Skills

- **Programming Languages:** Python, C++, MATLAB
- **Packages and Tools:** Theano, CVX

Scholastic Achievements and Awards

- Received the **Undergraduate Research Award** for the work on Bio-inspired Neural Networks
- Awarded an **AP grade** (given for exceptional performance) in two courses : *Linear Algebra* and *Advanced Probability and Random Processes*
- Scored a perfect Semester Performance Index in 3 out of 8 semesters at IIT Bombay
- Secured **All India Rank 58** in *AIEEE-2011* out of about 1.1 million candidates
- Secured **All India Rank 400** in *IITJEE-2011* out of about 460,000 candidates
- Recipient of the *National Talent Search Scholarship 2007* awarded to **less than top 1%** applicants

Technical Projects

Automatic Traffic Surveillance System using Traffic Videos *Autumn 2013*

- Achieved adaptive, robust **background estimation** via online Gaussian Mixture Model fitting
- Achieved **moving object detection** using background subtraction, thresholding, median filtering, morphological closing and connected component analysis
- Developed an algorithm for **predictive tracking** of vehicles in the video by clustering instances of same vehicle across frames. Obtained the **total number of unique vehicles** in the video

Video stabilization *Spring 2014*

- Robust estimation of sequence of affine transformations between **SIFT** feature points of consecutive frames using **RANSAC**
- **Mean filtering** to remove High-frequency noise

Approximate solvers for some NP-Hard problems *Summer 2013*

- **Graph Coloring**: Branch and Bound, Constraint Programming and Local Search Techniques
- **Travelling Salesman Problem**: Greedy Heuristic followed 2-OPT neighborhood Local Search

Other Projects

- Support Vector Machine based **Spam Filter** using SpamAssassin Corpus
- Designed and implemented the **physics engine for the game of carom** in C++ involving predictive collision mechanics, friction and special handling near holes
- Designed and fabricated a portable **shaking movement to electricity** conversion device
- Implemented rate 1/2 Trellis Coded Modulation with **Viterbi Decoder** for error correction
- Created an application to **draw the development surface** of the intersection of various solids
- Modeled High Volume Stock Procurement as a **Markov Decision Process**
- Created a **Robotic Graph Plotter** using stepper motors driven by Arduino

Relevant Coursework

Probability:	Measure Theory, Advanced Probability and Random Processes, Markov Chains and Queuing Systems, Markov Decision Processes
Optimization:	Linear and Integer Programming, Stochastic Optimization, Discrete Optimization, Convex Optimization
Algorithms:	Data Structures and Algorithms, Discrete Structures, Design and Analysis of Algorithms, Randomized Algorithms
Machine Learning:	Foundations of Machine Learning, Neural Networks for Machine Learning, Probabilistic Graphical Models
Applications:	Image Processing, Computer Vision, Speech Processing

Leadership

- **Department Academic Mentor:** Responsible for ensuring healthy academic environment and helping students to gain confidence in academics
- **Teaching Assistant (Linear Algebra):** Conducted weekly problem solving and doubt clarification sessions for about 40 freshmen

Other interests and activities

- Like to solve mathematical puzzles and play table tennis
- Stood first in Math and Logic General Championship 2012 open for everyone at IIT Bombay
- Hobbyist guitarist, Performed in Surbahaar, the annual music night at IIT Bombay
- Open source contributions to the Textbook Companion Project hosted by FOSSEE, IIT Bombay
- Part of IIT Bombay's Guinness World Record for maximum number of people simultaneously solving the Rubik's Cube