RUDRAJIT DAS

First Year Computer Science PhD Student

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EDUCATION

• PhD in Computer Science

University of Texas at Austin (Advisor: Prof. Inderjit Dhillon, Co-advisor: Prof. Sujay Sanghavi)

Aug 2019 –

• Combined Bachelor's and Master's (B.Tech + M.Tech) Degree in Electrical Engineering - **GPA: 9.52/10**

Indian Institute of Technology (IIT) Bombay (Advisor: Prof. Subhasis Chaudhuri, Director of IIT Bombay)

June 2014 – May 2019

Thesis: *Some Probabilistically Provable Theoretical Aspects of Neural Networks and Algorithmic Aspects of Large-Scale Optimization* [Link] - **Awarded the Undergraduate Research Award (URA-03) for exceptional work in final thesis**.

RESEARCH INTERESTS

Mainly interested in the design of efficient and provable machine learning and deep learning algorithms.

PUBLICATIONS & COMPETITIONS

- ***On the Separability of Classes with the Cross-Entropy Loss Function***
  Rudrajit Das and Subhasis Chaudhuri - Pre-print [Arxiv Link].
- ***Extremal Eigenvalue Analysis of the Hessian and a Learning Rate Choice for Stochastic Gradient Descent***
  Rudrajit Das and Subhasis Chaudhuri - Pre-print.
- ***On the Convergence of a Biased Version of Stochastic Gradient Descent***
  Rudrajit Das, Jiong Zhang and Inderjit Dhillon - Accepted for poster presentation in "Beyond First Order Methods in ML" workshop in **NeurIPS 2019**.
- ***Nonlinear Blind Compressed Sensing under Signal-Dependent Noise***
  Rudrajit Das and Ajit Rajwade - Accepted in **IEEE International Conference on Image Processing (ICIP) 2019** [IEEE Xplore Link].
- ***Sparse Kernel PCA for Outlier Detection***
  Rudrajit Das, Aditya Golatkar and Suyash Awate - Accepted for **oral presentation** in **IEEE International Conference on Machine Learning and Applications (ICMLA) 2018** [Arxiv Link], [IEEE Xplore Link].
- ***iFood Challenge, FGVC Workshop, CVPR 2018***
  Parth Kothari*, Arka Sadhu*, Aditya Golatkar*, **Rudrajit Das*** (* denotes equal contribution). Finished 2nd & 3rd in the public and private leaderboards respectively, with team name "Invincibles" [Leaderboard Link]. Invited to present our method at **CVPR 2018** [Slides Link].

KEY RESEARCH PROJECTS

- ***Biased SGD for Faster Training of Deep Networks*** (Sep 2019 - Present)
  Proved that the biased SGD algorithm proposed in "AutoAssist: A Framework to Accelerate Training of Deep Neural Networks" by Zhang et al. achieves $O(1/k)$ and $O(1/\sqrt{k})$ convergence for strongly convex and convex loss functions respectively, which is the same as that of vanilla SGD but with fewer gradient computations. Looking to extend this to other gradient-based optimization algorithms.
- ***Adversarial Robustness in NLP*** (Sep 2019 - Present)
  The problem of finding adversarial examples in NLP by replacing words with their synonyms or sentences with their paraphrases is a discrete optimization problem. Working on formulating it (approximately) as a continuous optimization problem which can be solved using gradient-based methods.
- ***A Randomized Algorithm to Detect and Escape Saddle Points*** (Aug 2018 - Mar 2019)
  Proposed a novel randomized algorithm to detect and escape saddle points without requiring to compute the Hessian. Its complexity is logarithmic wrt the dimension and approximately linear wrt the inverse of the magnitude of the minimum (negative) eigenvalue of the Hessian. [Link]
- ***On the Existence of Sparse Bases for Deep Learning Kernels*** (Aug 2018 - Sep 2018)
  Derived a probabilistic proof to suggest the possibility of the existence of sparse bases for the final layer of binary classification networks before sigmoid with the cross-entropy loss using only a few (transformed by the "kernel") training points. The number of training points constituting the sparse basis is much lesser than the dimension of the transformed input. [Link]
- ***Multiple Instance Learning in Breast Cancer Histology Images*** (Feb 2018 - Dec 2018)
  Worked on self-supervised learning using the proxy tasks of colorization with different loss functions, to learn good embeddings which can be used for deep attention based multiple instance learning. Experiments suggest that self-supervision using the proxy task of colorization with the MS-SSIM loss provides a good initialization for segmentation leading to faster training as well as lesser overfitting. [Report]

- ***Sentence Compression using Deep Learning*** (Mar 2018 - May 2018)
  Built a 3-layer bidirectional LSTM model for sentence compression by formulating it as a binary classification problem (which words to retain/delete). Compared it with the method proposed in "Sentence Compression by Deletion with LSTMs" by Google NLP Research & got marginally better results. [Code] [Report]
- ***Speeding up Kernel PCA (KPCA)*** (July 2017 – Oct 2017)
  Used the improved Nyström method to obtain a low rank approximation to the Gram matrix. Using this, developed a fast algorithm for eigenvector computation in KPCA, improving time complexity from $O(n^2p)$ to $O(np^2)$, where n is the number of data points and $p << n$ is the rank of the approximated Gram matrix. Obtained almost a linear speed up over MATLAB's "eigs" function with negligible error in the obtained eigenvectors and eigenvalues. [Code] [Report]

INTERNSHIPS

PRAIRIE Artificial Intelligence Summer School (PAISS) - Grenoble, France (July 2018)

- One of the few undergraduates selected for this AI summer school, co-organized by Inria and NAVER LABS Europe. Attended lectures & practical sessions conducted by leading experts in Computer Vision, NLP, Robotics, Reinforcement Learning, Meta Learning, Unsupervised Learning, etc. Presented a poster (can be found here) entitled "Existence of Sparse Basis for Deep Learning Kernels?"

Institute for Biomechanics, ETH Zürich - Under Dr. Patrik Christen, D-HEST (May 2017 - July 2017)

- Proposed a stable linear model (with closed form solution) and a fuzzy boolean network for bone re-modelling. Also developed an automated 2D-3D image registration framework for histology images from scratch. Devised an efficient sampling strategy to obtain the 2D projection of the 3D image across any plane and a good cost function to deal with the highly non-convex nature of the problem.

Altisource Business Solutions Private Limited - Bengaluru, India (May 2016 - July 2016)

- Developed a notification system using Pagerduty, a popular incident management software, and worked on the user interface of the company's monitoring dashboard built using JBoss Dashbuilder.

KEY COURSES

- **UT Austin** - Deep Probabilistic Modeling*, Natural Language Processing*.
- **IIT Bombay** - Advanced Machine Learning, Computer Vision, Advanced Image Processing, Medical Image Processing, Speech Processing, Optimization, Markov Chains, Estimation & Identification, Applied Linear Algebra, Advanced Concentration Inequalities, Probability & Random Processes, Complex Analysis, Differential Equations.

  * currently ongoing and to be completed by Dec 2019

TECHNICAL SKILLS

- **Languages**: Python, MATLAB, C++/C, Java
- **Deep Learning**: PyTorch, Keras

ACADEMIC ACHIEVEMENTS

- Offered NeurIPS 2019 Travel Award.
- Selected by the CS department of UT Austin to receive a Professional Development Award for travel to NeurIPS 2019.
- Awarded the Undergraduate Research Award (URA-03) for exceptional work in final thesis at IIT Bombay.
- Awarded the only AP (Advanced Performer) grade in the Applied Linear Algebra course.
- Stood first in the Foundations of Machine Learning course in a batch of 170 students, and was one of the 10 students in a batch of 450 and 166 students to receive an AA grade in the Differential Equations course and the Advanced Machine Learning course, respectively.
- Received a bronze medal and a cash prize for securing 3rd rank in IIT Bombay Maths Olympiad 2015.
- Awarded Merit Certificates in National Standard Examination in Physics & Chemistry 2014 for being within top 300 students across the country. Also selected for Indian National Physics Olympiad 2014 and Indian National Chemistry Olympiad 2014.
- Received a Letter of Appreciation from the Education Minister of Maharashtra for being within top 1% of the state in the Higher Secondary Examination 2014. Also awarded a scholarship of Rs 80,000 per year for five years, for higher education under the INSPIRE scheme by the Government of Maharashtra.

EXTRA CURRICULAR ACTIVITIES

- Ranked 1st among all freshmen and 2nd overall in Maths Olympics 2014 conducted by the MnP Club, IIT Bombay.
- Presented a poster on X-Ray CT images in MHRD-TEQIP-KITE workshop (initiative of the Government of India).
- Keen interest in watching and playing cricket, was part of my school cricket team.
- Passionate foodie and interested in learning about new cultures.
- Fond of freshwater fishing.