CV - RUDRAJIT DAS

EDUCATION

Indian Institute of Technology (IIT) Bombay — Mumbai, India
Combined B.Tech & M.Tech in Electrical Engineering - Current **GPA**: ***9.50/10*** — *July '14 - Aug '19*
Minor in Computer Science & Engineering

FIELDS OF INTEREST

Applied Probability and Statistics, Optimization, Large-Scale Data Analysis and Algorithms.

PUBLICATIONS & COMPETITIONS

- *Nonlinear Blind Compressed Sensing under Signal-Dependent Noise*
  Rudrajit Das and Ajit Rajwade - Accepted in **IEEE ICIP 2019**.
  [Main Paper Link], [Supplementary Material Link]
- *Sparse Kernel PCA for Outlier Detection*
  Rudrajit Das, Aditya Golatkar and Suyash Awate - Accepted for **oral presentation** in **IEEE ICMLA 2018**.
  [Arxiv Link], [IEEE Xplore Link]
- *On the Separability of Classes with the Cross-Entropy Loss Function*
  Rudrajit Das and Subhasis Chaudhuri - Submitted to **NeurIPS 2019**. Currently under review.
  Manuscript available on request.
- *Extremal Eigenvalue Analysis of the Hessian and a Learning Rate Choice for Stochastic Gradient Descent*
  Rudrajit Das and Subhasis Chaudhuri - Submitted to **SIAM Journal on Mathematics of Data Science (SIMODS)**.
  Currently under review. Manuscript available on request.
- *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 - `https://www.kaggle.com/c/ifood2018/leaderboard`.
  Invited to present our method at **CVPR 2018**. [Slides Link]

INTERNSHIPS

Institute for Biomechanics, ETH Zürich — **Zürich, Switzerland**
Research Intern under Dr. Patrik Christen, D-HEST — *May '17 - July '17*

- Constructed a **linear model** for **bone re-modelling**, obtained a **closed form solution** for it and analyzed its stability using **eigenvalue analysis** which was **not done earlier**. Also built a **directed graphical model** to capture the random nature of the process and simulated it.
- Developed an **automated 2D-3D image registration framework** for histology images from scratch, which included **devising an efficient sampling strategy** to obtain the 2D projection across any plane of the 3D image, **formulating a good cost function** to mitigate the problem of **several local minima** and choosing a **suitable optimization algorithm**.

Altisource Business Solutions Private Limited — **Bengaluru, India**
Software Engineering Intern — *May '16 – July '16*

- Developed a notification system using Pagerduty and worked on the UI of the company's monitoring dashboard built using JBoss Dashbuilder. Used Spring Framework for backend coding and Hibernate for database handling.

ADDITIONAL RESEARCH PROJECTS

A Randomized Algorithm to Detect and Escape Saddle Points — *Aug '18 - Mar '19*
Guide : Prof. Subhasis Chaudhuri, EE Department, IIT Bombay

- 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 Binary Classification Kernels — *Aug '18 - Sep '18*
Guide : Prof. Subhasis Chaudhuri, EE Department, IIT Bombay

- Derived a **probabilistic proof** to suggest the possibility of the **existence of sparse bases** for the **final layer** of binary

classification networks before sigmoid (i.e. the transformed input which is linearly separable & "**kernel**" being the transformation function) with the cross-entropy loss using only a few (transformed) 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 (MIL) in Breast Cancer Histology Images *Feb '18 - Dec '18*

Guide : Prof. Amit Sethi, EE Department, IIT Bombay

- 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 MIL**. Additionally, preliminary experiments on 3 medical datasets indicate 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] [Code]
- Tried **Bayesian Learning** for MIL using features extracted from **auto-encoders** and obtained **results comparable to state of the art** for the **Bisque** data set. But it did not generalize well. [Report]

Sentence Compression using LSTMs *Mar '18 - May' 18*

Guide : Prof. Sunita Sarawagi, CSE Department, IIT Bombay

- Designed a simple **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 '17 – Oct '17*

Guide : Prof. Suyash Awate, CSE Department, IIT Bombay

- 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. Implemented it and obtained almost a **linear speed up** over MATLAB's "eigs" function with **negligible error** in the obtained eigenvectors and eigenvalues. [Code] [Report]

KEY ACADEMIC PROJECTS

Using the Kernel Trick in Compressed Sensing *April '18 - May '18*

Guide : Prof. Animesh Kumar, EE Department, IIT Bombay

- Extended the method proposed in the paper **"Using the kernel trick in compressive sensing: Accurate signal recovery from fewer measurements."** to the case of directions sampled from a **Bernoulli distribution**, thus making it more **hardware realizable**. Also provided a **theoretical proof** for this extension. [Report] [Presentation]

Extractive Text Summarization *Sep '17 - Nov '17*

Guide : Prof. Ganesh Ramakrishnan, CSE Department, IIT Bombay

- Implemented the paper **"A Simple but Tough-to-Beat Baseline for Sentence Embeddings"** and used the embeddings to select key sentences (modelled it as a binary classification problem) in a document (**extractive summarization**) by **ensembling neural networks**. Also designed a **CNN** architecture which further **improved results**. [Code] [Report]

Image segmentation using Grab Cut Algorithm *Feb '17 - April '17*

Guide : Prof. Suyash Awate, CSE Department, IIT Bombay

- Implemented **Grab Cut** which employs Gaussian Mixture Models (**GMMs**) along with the **Graph Cut** algorithm, for interactive extraction of foreground in a complex environment with reduced user interactions. Simulated it on medical and natural images, obtaining good results. [Code] [Report]

Real Time Tracking of Non-Rigid Objects *Feb '17 - April '17*

Guide : Prof. Ajit Rajwade, CSE Department, IIT Bombay

- Built a **real time object tracking model** for videos using **mean shift algorithm** with **Bhattacharya coefficient** to determine the object trajectory. It was **robust** to partial occlusion, clutter, rotation & camera position and worked successfully in real world videos. [Code] [Report]

Visible Light Communication(Li-Fi) *Jan '17 - April '17*

Guide : Prof. Kumar Appaiah, EE Department, IIT Bombay

- Built an optical channel to transfer **Manchester encoded** data stream. **Synchronously** transferred encoded data at **100 kbps** over a distance of **3 m**. Also built an **asynchronous system** with a data rate of **30 kbps** over **0.5 m** distance.

Flow Based Image Extraction *Sep '16 - Nov '16*

Guide : Prof. Suyash Awate & Prof. Ajit Rajwade, CSE Department, IIT Bombay

- Implemented a non-photorealistic rendering method to give **stylized effect** to images. Applied a **flow based difference of Gaussian filter** for line extraction and then a **flow based bilateral filter** for region smoothing. [Code]

Min-cut based approach to find pathways in regulatory networks *Dec '15 - Jan '16*
Guide : Prof. Supratik Chakraborty, CSE Department, IIT Bombay

- Worked on implementing an **efficient semi-automated approach** for finding pathways in systems biological regulatory networks using **min-cuts**. Implemented the **Gusfield algorithm** to construct the **Gomory Hu tree** of the equivalent undirected graph which was used to approximately obtain the min-cut edges between **all pairs of nodes** of the graph (since there are only $(n-1)$ **distinct** min-cut values) instead of naively performing $O(n^2)$ min-cut computations.

ACADEMIC ACHIEVEMENTS

- Awarded the only **AP (Advanced Performer)** grade in **Applied Linear Algebra** for securing the highest marks and for outstanding performance in the course.
- Stood **first** in Foundations of Machine Learning Course in a batch of **170** students and was one of the **10** students in a batch of **166** students to receive an **AA** grade in Advanced Machine Learning course.
- 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 2014 and National Standard Examination in Chemistry 2014 for being within **top 300** students across the country.
- 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.

RELEVANT COURSES

- **Computer Science :** Advanced Machine Learning, Foundations of Machine Learning, Computer Vision, Advanced Image Processing, Algorithms for Medical Image Processing, Digital Image Processing, Discrete Structures, Design & Analysis of Algorithms, Data Structures & Algorithms, Computer Networks.
- **Electrical Engineering :** Optimization, Recent Topics in Analytical Signal Processing, Wavelets, Markov Chains, Advanced Signal Processing, Estimation & Identification, Speech Processing, Applied Linear Algebra, Advanced Concentrations Inequalities, Digital Signal Processing, Probability & Random Processes, Control Systems.
- **Mathematics :** Calculus, Linear Algebra, Complex Analysis, Differential Equations.

TECHNICAL SKILLS

- **Languages :** Python, MATLAB, C++/C, Java, Octave, VHDL, Arduino.
- **Others :** HTML, CSS, Javascript, Jekyll, LaTeX.

TEACHING EXPERIENCE

- Teaching Assistant for **Applied Linear Algebra** & **Advanced Topics in Signal Processing** (2018).

EXTRA CURRICULAR ACTIVITIES

- Ranked 1st among all freshmen & 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 Indian Government).
- Recently started blogging about my research.
- 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.