

# CV - RUDRAJIT DAS

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## EDUCATION

**Indian Institute of Technology (IIT) Bombay**

Mumbai, India

*Combined B.Tech & M.Tech in Electrical Engineering* - Current **GPA: 9.45/10**

*July '14 - Aug '19*

*Minor in Computer Science & Engineering*

**Thesis:** *Some Probabilistically Provable Aspects of Neural Networks with respect to their Learned Representations and Optimization* [\[Link\]](#)

## FIELDS OF INTEREST

Theoretical Machine Learning, Deep Learning, Probabilistic Analysis, Optimization, Computer Vision.

## PUBLICATIONS & COMPETITIONS

- *Nonlinear Blind Compressed Sensing under Signal-Dependent Noise*  
**Rudrajit Das** and Ajit Rajwade - Accepted in **International Conference on Image Processing (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 International Conference on Machine Learning and Applications (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 2<sup>nd</sup> & 3<sup>rd</sup> 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**. [\[Slides Link\]](#)

## INTERSHIPS

**PRAIRIE Artificial Intelligence Summer School (PAISS)**

Grenoble, France

Inria, NAVER LABS Europe

July '18

- 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](#)) titled "**Existence of Sparse Basis for Deep Learning Kernels?**".

**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

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### 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 Deep Learning 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.
- This implies that even though a large number of examples might be required to train deep learning networks, perhaps the **learnt kernel** can **generalize well** using only a **few of the training examples**. [\[Link\]](#)

### 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 Deep Learning

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  $p \ll n$  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

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### 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 using Neural Networks

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

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- 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 **3<sup>rd</sup>** 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

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- **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

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- **Languages** : Python, MATLAB, C++/C, Java, Octave, VHDL, Arduino.
- **Deep Learning** : Keras, PyTorch.
- **Others** : HTML, CSS, Javascript, Jekyll, L<sup>A</sup>T<sub>E</sub>X.

## TEACHING EXPERIENCE

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

## EXTRA CURRICULAR ACTIVITIES

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- Ranked 1<sup>st</sup> among all freshmen & 2<sup>nd</sup> 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).
- 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.