

# Chinmay Talegaonkar

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## RESEARCH INTERESTS

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My major research interests lie in the domain of Signal Processing with emphasis on applications of Optimization, Machine learning and Compressed Sensing in fields like Neuroscience, Bio-informatics and Image Processing. I am also interested in Stochastic Modelling, Monte Carlo methods, and Reinforcement Learning

## EDUCATION

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**Indian Institute of Technology Bombay**, Mumbai, India  
BTech. in Electrical Engineering

Jul'15-Present

- **Major CGPA:** 9.00/10
- **Minor Degree:** Dept. of Computer Science & Engineering

## PUBLICATIONS

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- **Chinmay Talegaonkar**, Ajit V. Rajwade  
*Performance Bounds For Tractable Poisson Denoisers With Principled Parameter Tuning*  
To be presented at the **IEEE Global Conference on Signal and Information Processing (GlobalSIP)**, 2018

## EXPERIENCE

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**NVIDIA - Compute Developer Technology Team**  
*Optimizing Capsule Networks and DBSCAN*

May'18-Jul'18  
Bangalore

- The internship involved working on two separate problems. In the first project we investigated the problem of optimizing the performance of **Capsule Networks**, a *Deep Learning* architecture on **PyTorch** and **CUDA**. To reduce **uncoalesced memory accesses** and **shared memory bank conflicts** in the batched **GEMM** operations, we developed customized CUDA kernels for optimizing the routing layer & backward propagation implementation. We also used **mixed precision** training for the Capsule Layer to get faster convergence rates with FP16 data types. Using these techniques we achieved a cumulative **speed up** of **2x** compared to the naive implementation on PyTorch. We dispatched our customized kernels as a PyTorch extension.
- The second project involved parallelizing the end-to-end implementation of **DBSCAN** and porting the algorithm for GPUs using CUDA. We used **CUTLASS** kernels to optimize the performance of the algorithm by formulating the **distance matrix** computation of the dataset as a GEMM operation. To handle clustering of larger datasets, a feature for batched clustering was augmented. Our implementation of DBSCAN under this project was included in the recently released **NVIDIA Rapids** library which is a GPU accelerated platform for Machine Learning and Data Science.

**Parallelizing Monte Carlo Simulations**  
*Prof. Dirk Kroese*

May'17-Jul'17  
University of Queensland, Australia

**Monte Carlo** methods are highly parallelizable and hence using NVidia GPUs for computations gives a massive speed up compared to a CPU. Using a GPU on a single machine is easier than using a distributed computing framework like **MPI**. This project involved devising a data-parallel implementation of the **Cross Entropy method** using CUDA. We Solved the **Max-Cut** problem & maximized the output of a non-convex peak detector using Cross Entropy optimization. Obtained an amortized **speed up** of **3000x** on a **NVidia Kepler GPU** as compared to a CPU for maximizing the output of the peak detector function. Report and code [here](#).

## RESEARCH PROJECTS

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**Fourier Phase Retrieval from Clipped Poisson Corrupted Measurements**  
*Prof. Ajit Rajwade*

Aug'18-Present  
Computer Science Engineering, IIT Bombay

The problem of **Fourier Phase Retrieval**, i.e. recovery of a signal given only the Fourier magnitudes comes up in many fields like Astronomy, Optical Imaging and Crystallography. Our work aims to extend the existing semi-definite convex optimization based **lifting** schemes for handling both Poisson noise and clipping of the magnitude measurements and prove performance bounds for our methods. We are also looking into **compressive phase retrieval** from Poisson corrupted measurements of signals that are sparse in canonical basis. So far we have achieved good results for recovery from Poisson corrupted measurements in a compressive, non-compressive as well as clipped scenario by solving our modified objective functions using **CVX**. We further intend to make our algorithms scalable for datasets using **iterative proximal gradient** based approaches, since CVX is not scalable for large images.

## Denoising using Variance Stabilization Transforms

Prof. Ajit Rajwade

Jan'18-May'18

Computer Science Engineering, IIT Bombay

The project was aimed at denoising Poisson corrupted images using a tractable **Anscombe Transform** based **Residual magnitude** estimator for recovering compressive measurements. Since the estimator is based on the variance stabilization approach, it is well suited for handling Poisson noise. Moreover it reduces the effort of parameter tuning required by regularized **negative log-likelihood** based methods since the parameter used in our estimator depends only on the signal length. We obtained comparable reconstructions to the existing methods like **SPIRAL-Tap** and also derived reconstruction error bounds for denoising using this algorithm. We also analyzed the effect of sparsity and intensity, and verified that the performance of the algorithm is in accordance with the derived performance bounds.

## Detecting Non-Thermal emission in IRAS16164-5046

Prof. Sarita Vig

Dec'17

Indian Institute of Space Science and Technology

Analyzed the data collected by **GMRT, Pune** at 610 MHz for the star forming **IRAS region**. Performed Data reduction using **AIPS** (Astronomical Image Processing Software) to obtain the image. Using **spectral index** mapping, we detected signs of **non-thermal emission** in a bow-shock in the star forming region. We further proposed that the existence of the non-thermal radiation can be attributed to **Diffusive shock acceleration** in the bow-shock. Project presentation [here](#)

## ACADEMIC ACHIEVEMENTS

- Secured All India Rank **425** in entrance exam to the **IITs** amongst **120,000** candidates [2015]
- Represented India at the 10<sup>th</sup> **International Junior Science Olympiad, Pune, India** and won a **Silver Medal** among students from over 40 nations [2013]
- Awarded a **branch change** to Electrical Btech. for exceptional academic performance in first year [2016]
- Awarded the **Kishore Vaigyanik Protsahan Yojana** Scholarship with an **All India Rank 9** among over **50,000** candidates for aptitude in Basic Sciences and Research [2014]
- Holder of the **National Talent Search Scholarship** awarded to **1000** students in the country [2011]

## MISCELLANEOUS PROJECTS

### Parkaway - An IoT based No-Parking lock system

SINE Lab, IIT Bombay

May'17-Jul'17

Innovation Cell, IIT Bombay

Developed an admin interface using Node.js and MySQL back-end to facilitate automated real time communication through SMS between the lock and server of an IoT based No-Parking lock system. Incorporated Google Maps API with the back-end interface for real time monitoring of the locks. Code [here](#).

### Stochastic Modelling of Server Caches

Prof. Sharayu Moharir

May'17-Jul'17

Electrical Engineering, IIT Bombay

Studied the concepts of modelling file storage in server caches using Bipartite Graphs and online matching of incoming requests for the files. Devised an implementation of the **Two Suggested Matchings** algorithm based on decomposing the max-flow in a boosted bipartite graph.

### Face Swap using Poisson Blending

Prof. Ajit Rajwade

Sep'17-Nov'17

CS 663: Digital Image Processing

Used Affine Transform to align and re-scale two face images using their facial features. Implemented the **mixed gradients** variant of the **Poisson solver** to seamlessly swap the image. Code [here](#).

### Microprocessor Design - RISC architecture, Pipelining, VHDL

Prof. Virendra Singh

Aug'17-Dec'17

EE 309: Microprocessor Design

Designed and implemented a six-staged Pipelined architecture of a multicycle RISC processor using VHDL. The architecture was augmented with hazard mitigation techniques and data forwarding. Code [here](#).

### Markov Chain Monte Carlo Methods

Prof. Gaurav Kasbekar

Sep'17-Nov'17

EE 325: Probability and Random Processes

Explored algorithms like Metropolis Hastings, Gibbs Sampling and **Hamiltonian Monte Carlo**. Investigated the use of MCMC in the Restricted Boltzmann Machines (**RBM**s) and **Contrastive Divergence**. Report [here](#).

### Portable Cell Phone Charger

Prof. Joseph John

Jan'18-Apr'18

EE 344: Electronics Design Lab

Designed and created a **Buck-Boost converter** to regulate the energy harvested by solar and vibrational energy. Harvested vibrational energy using principles of electromagnetic induction and piezoelectricity. Report [here](#).

## RESPONSIBILITIES

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- **Editorial Board Member, Insight** (2017-18) - Part of **Insight**, the institute media body with an online readership of about **half a million** users/year. Spearheaded a myriad of initiatives like a **web series** about views of professors on student life in campus and reportage of various events happening in the institute.
- **Resource Person & Student Facilitator, HBCSE Olympiad Cell** - Involved in selection training of a 5 member student team to represent India at the 11<sup>th</sup> **IOAA 2017**. Assisted the Convener of the Olympiad with the back-end software and other proceedings of **IOAA 2016**, held in India.
- **Department Academic Mentor** (2018-Present) - Selected for academic & personal mentoring of sophomores on the basis of peer-review. Helping 2 junior undergraduates overcome academic difficulties.
- **Teaching Assistant** - *Quantum Physics* in Fall '16 and *Machine Learning Crash Course* in Summer '17. Conducted a special help session for Quantum Physics in Fall '18.

## COURSES UNDERTAKEN

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- **Computer Science** - Data Structures and Algorithms, Computer Networks, Operating Systems, Digital Image Processing, Advanced Image Processing
- **Machine Learning** - Intro. to Machine Learning, Optimization Techniques, Reinforcement Learning
- **Electrical Engineering** - Data Analysis and Interpretation, Signals & Systems, Digital Systems, Probability & Random Processes, Microprocessors, Communication Systems, Control Systems, Digital Signal Processing, Digital Communications, Estimation & Identification
- **Mathematics** - Linear Algebra, Calculus, Differential Equations, Complex Analysis

## TECHNICAL SKILLS

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- **Programming Languages:** C++, Python, ngspice, Bash, VHDL
- **Web Development:** HTML5, CSS3, Javascript, Angular-JS, Bootstrap, MySQL, MongoDB, Node.js
- **Softwares and Packages:** OpenCV, Git, Octave, MATLAB, PyTorch, Quartus, Slurm,  $\LaTeX$ , CUDA, AIPS

## REFERENCES

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### Prof. Ajit Rajwade

Assistant Professor  
Computer Science & Engineering,  
IIT Bombay  
[E-mail](#)  $\diamond$  [Webpage](#)

### Prof. Dirk Kroese

Professor  
School of Mathematics & Physics,  
University of Queensland, Australia  
[E-mail](#)  $\diamond$  [Webpage](#)

### Prof. Anupama Kowli

Assistant Professor  
Electrical Engineering,  
IIT Bombay  
[E-mail](#)  $\diamond$  [Webpage](#)

### Thejaswi Rao

Compute DevTech Engineer  
NVidia, Bangalore  
[E-mail](#)  $\diamond$  [LinkedIn](#)