

# 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 image processing, computational imaging and neuroscience. 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**  
*B.Tech. 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, P. Khirawadkar, Ajit V. Rajwade**  
"Compressive Phase Retrieval under Poisson Noise" [ [Paper](#) ]  
Submitted to the **26<sup>th</sup> IEEE International Conference on Image Processing (2019)**
- **Chinmay Talegaonkar, Ajit V. Rajwade**  
"Performance Bounds For Tractable Poisson Denoisers With Principled Parameter Tuning" [ [Paper](#) ]  
Accepted for oral presentation at the **6<sup>th</sup> IEEE Global Conference on Signal and Information Processing (2018)**

## EXPERIENCE

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

May'18-Jul'18  
Bangalore

- The internship involved two separate projects. The first project focused on 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 implementation of the routing layer & backpropagation in the network. We also used **mixed precision** training for the Capsule Layer to get faster convergence rates with FP16 data types. Using these techniques yielded **twice** the cumulative **speed up** compared to the naive implementation on PyTorch. We dispatched our customized kernels as a PyTorch extension.
- The second project was aimed at parallelizing the end-to-end implementation of **DBSCAN** and porting the algorithm for GPUs using CUDA. We used **CUTLASS** to formulate distance matrix computation of the dataset as a GEMM operation. We also augmented batched clustering in our implementation to handle larger datasets. 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 GPUs for such computations gives a massive speed up compared to a CPU. Also, 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 [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 at low intensities for recovery from Poisson corrupted measurements in a compressive, non-compressive as well as the clipped scenario by solving our modified objective functions using CVX. We plan to submit our work to **ICIP 2019**. The next step is to make our algorithms scalable for large images using **iterative proximal gradient** based approaches, since CVX is not scalable for large matrices.

## Denoising using Variance Stabilization Transforms

Jan'18-May'18

Prof. Ajit Rajwade

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. The reconstructions we obtained are comparable to the existing negative log likelihood based methods like **SPIRAL-TAP**. We also derived reconstruction error bounds for denoising using this algorithm and analyzed the effect of sparsity and intensity on the reconstructions to verify the algorithm's behaviour in accordance with the derived performance bounds.

## Detecting Non-Thermal emission in IRAS16164-5046

Dec'17

Prof. Sarita Vig

Indian Institute of Space Science and Technology

We 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](#).

## MISCELLANEOUS PROJECTS

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### Multi-Agent Game Play using Reinforcement Learning

Aug'18-Nov'18

Prof. Shivaram Kalyan Krishnan

CS 747: Reinforcement Learning

The project involved training an agent for playing against other agents in the **Pommerman** gaming environment. We modified the feature space of the problem setup to improve the agent's gameplay using Proximal Policy optimization (**PPO**). For enhancing the agent's performance, we leveraged experience replay and imitation learning principles in the form of the Deep Q learning from demonstrations (**DQfD**) using tensorflow, which allowed our agent to learn strategies played by an efficient rule based agent and then improve upon them. Report [here](#) and video [here](#).

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

May'17-Jul'17

SINE Lab, IIT Bombay

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](#).

### Gridless Estimation of Saturated Signals

Sep'18-Nov'18

Prof. Debraj Chakraborty

EE 638: Estimation and Identification

Compared the performance of atomic norm minimization and a compressed sensing formulation for recovering a signal composed of decaying sinusoids from noiseless clipped measurements. Report [here](#).

### Face Swap using Poisson Blending

Sep'17-Nov'17

Prof. Ajit Rajwade

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 images. Code [here](#).

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

Aug'17-Dec'17

Prof. Virendra Singh

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

Sep'17-Nov'17

Prof. Gaurav Kasbekar

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 (**RBMs**) and **Contrastive Divergence**. Report [here](#).

### Portable Cell Phone Charger

Jan'18-Apr'18

Prof. Joseph John

EE 344: Electronics Design Lab

Designed a **Buck-Boost converter** to regulate power generated by harvesting solar and vibrational energy. Applied electromagnetic induction and piezoelectricity principles to generate vibrational energy. Report [here](#).

## ACADEMIC ACHIEVEMENTS

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- 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 was awarded a **Silver Medal** amongst 250 students from over 40 nations. [2013]
- Awarded a **branch change** to Electrical B.Tech. 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]

## 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, L<sup>A</sup>T<sub>E</sub>X, CUDA, AIPS

## RESPONSIBILITIES

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- **Event Manager, Inter IIT Tech meet** (2018-Present) - Member of the organizing team of the **7<sup>th</sup> Inter IIT Tech meet** to be held at IIT Bombay. Responsible for conducting an astrophysics themed hackathon.
- **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.

## REFERENCES

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### Prof. Ajit Rajwade

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

### Prof. Dirk Kroese

Professor  
School of Mathematics & Physics,  
University of Queensland, Australia  
E-mail ◊ [Webpage](#)<sup>1</sup>

### Prof. Varun Bhalerao

Assistant Professor  
Department of Physics,  
IIT Bombay  
E-mail ◊ [Webpage](#)

### Thejaswi Rao

Compute DevTech Engineer  
NVidia, Bangalore  
E-mail ◊ [LinkedIn](#)

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<sup>1</sup>Incase the links to the report and code are not accessible in PDF, refer to the same CV (long) hosted on <https://chinmay0301.github.io/>