ARUNABH GHOSH

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EDUCATION

Indian Institute of Technology Bombay, Mumbai, India — *July '19*
B.Tech in Electrical Engineering (*Minor* in Computer Science & Engineering)
Major CGPA: 8.68/10

Thesis: **Tomographic reconstruction of symmetric and heterogeneous structures** [Thesis Report]
Advisors: Ajit Rajwade (Computer Science & Engineering), Subhasis Chaudhuri(Electrical Engineering)

- Developed a technique for reconstructing the conformations of a heterogeneous object from its projections.
- The number of conformations were identified after passing the projection data set through a graph-Laplacian based dimensionality reduction followed by single linkage hierarchical clustering to classify the projections.
- Designed a function to account for multiple axes of symmetry and optimized it using stochastic gradient descent. Demonstrated improvement in reconstructions over cases in which symmetry was not considered.

PUBLICATIONS

- **Arunabh Ghosh**[†], R. Chaudhry[†], A. Rajwade. "Ab initio tomography with object heterogeneity and unknown viewing parameters", *Submitted to IEEE ICIP 2019* (Preprint)
- R. Chaudhry[†], **Arunabh Ghosh**[†], A. Rajwade. "Noise and Outlier-Resistant Tomographic Reconstruction under Unknown Viewing Parameters", *Submitted to IEEE ICIP 2019* (Preprint)
- Y. Sanghvi, M. Shah, **Arunabh Ghosh**, K. Reddy, A. Goyal, V. Rajbabu. "Real Time Beat Tracking using Novelty Curve", Submitted to *IEEE Signal Processing Cup 2017* (Paper)

([†] equal contribution)

EXPERIENCE

Bayesian approach to cryo-EM structure determination — Jun'18 - Jul'18
Visiting research student under Victor Panaretos — *EPFL, Switzerland*

- Framed the problem of structure determination of biological molecules in the Bayesian optimization framework.
- Designed algorithms in the Fourier domain to implement the Radon transform and back projection operation.
- Analyzed and implemented a stochastic gradient descent routine for an ab-initio reconstruction from projections in unknown directions. Refined this initial model using an expectation maximization routine. [Project Page]

Oppia Foundation — May'17 - Aug'17
Google Summer of Code student under Jared Silver, Rachel Chen — *Mumbai, India*

- Selected for Oppia as part of the Prestigious Google Summer of Code which had an acceptance rate of 7%.
- Implemented efficient algorithms and scalable database models to track the progress of the learner in real-time.
- Computed complex statistical information using parallel programming architectures like Map-Reduce model.
- Received a certificate from Google after deploying my work worldwide to thousands of learners. [Project Page]

PROJECTS

Tomographic reconstructions under unknown angles and shifts — Dec'17 - May'18
Research project under Ajit Rajwade — *Computer Science & Engineering, IIT Bombay*

- Developed an algorithm for reconstructing an object from its projections without any knowledge of the angles or any prior structural information, in the presence of noise, unknown shifts, and outliers among the projections.
- Used the Helgason-Ludwig Consistency Conditions to obtain an initial estimate for the angles and the shifts.
- Explored a sparsity-based optimization technique to obtain accurate reconstructions of object. [Project Page]

Low-rank matrix completion — Aug'18 - Oct'18
Research project under P.Balamurugan — *Industrial Engineering & Operations Research, IIT Bombay*

- Implemented two low-rank matrix completion algorithms based on Singular Value Thresholding and ADMM.
- Modified the optimization framework of the latter algorithm to impose a sparsity constraint in the DCT basis.
- Solved the compressed sensing problem and achieved a notable improvement in reconstruction. [Project Page]

[1] Use URL arunabh98.github.io in case hyperlinks do not work

The Music Box Oct'18 - Nov'18
Computer Graphics under Parag Chaudhuri *Computer Science & Engineering, IIT Bombay*

- Created a movie in OpenGL, where character animation was executed using keyframe interpolation, components were modeled using hierarchical modeling and lighting was implemented using the Phong illumination model.
- Implemented an interface to create Bezier curves along which the camera is moved during animation. [Video]

Estimating unknown projection angles using Graph Laplacian Jan'18 - May'18
Advanced Image Processing under Ajit Rajwade *Computer Science & Engineering, IIT Bombay*

- Implemented a graph Laplacian-based algorithm for the reconstruction of an object from its projections taken at random unknown directions. The eigenvectors of the Laplace-type operator reveal the projection orientations.
- Using these estimates, the object is accurately reconstructed from its tomographic projections. [Project Page]

Genre Identification Jan'18 - May'18
Machine Learning under Preethi Jyothi *Computer Science & Engineering, IIT Bombay*

- Trained a random forest to predict the genre of a song using hyperparameters tuned by Bayesian Optimization.
- Achieved an accuracy of **56%** and an F1 score of **0.5065** on the Million Song Genre Dataset. [Project Page]

Localizing Fiducials for Neuroregistration Nov'17 - Dec'17
Inter-IIT Technical Championship *IIT Madras, Chennai*

- Developed an algorithm to estimate the location of fiducials affixed onto the skull from MRI images, provided in the DICOM format by using mean-shift segmentation and iterative closest point matching. [Project Page]

Face Swapping Sep'17 - Oct'17
Digital Image Processing under Ajit Rajwade *Computer Science & Engineering, IIT Bombay*

- Developed an algorithm to swap the faces of people with standard faces to protect the privacy of individuals.
- Selected the most optimal standard face to swap with by comparing features like face shape and skin tone.
- Blended the faces realistically using linear RGB transformations and Poisson Image Editing. [Project Page]

Solar and Vibration Powered Portable Charger Jan'18 - Apr'18
Electronic Design Laboratory under Joseph John *Electrical Engineering, IIT Bombay*

- 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. [Project Page]

Robust Audio Watermarking Jan'18 - Apr'18
Digital Signal Processing under Vikram Gadre *Electrical Engineering, IIT Bombay*

- Implemented a method to embed a watermark into the maximal coefficient of discrete cosine transform of the moving average sequence. Used a synchronization code to detect and locate the watermark. [Project Page]

Analysis of Stochastic Random Walks Aug'17 - Oct'17
Probability & Random Processes under Gaurav Kasbekar *Electrical Engineering, IIT Bombay*

- Theoretically analyzed the statistics of random walks and empirically verified the results using simulations.
- Demonstrated that the Rayleigh distribution can be modeled using a large collection of random walks. [Report]

Processor Design July'17 - Nov'17
Microprocessors under Virendra Singh *Electrical Engineering, IIT Bombay*

- Designed and implemented a 6-stage pipelined multicycle RISC processor in VHDL, consisting of arithmetic, logical and branching instructions, and tested on DE0-Nano FPGA board. Implemented the NMRU scheme and developed fully associative cache, data-forwarding, etc. to maximize the theoretical throughput. [Code]

Real-time beat tracking challenge Nov'16 - Dec'16
IEEE Signal Processing Cup under Rajbabu Velmurugan

- Developed an algorithm to track the beats of a musical recording in real-time by processing chunks of audio.
- Designed a function that peaks on note onsets and used it to dynamically update the tempo. [Project Page]

Direct-sequence spread spectrum Aug'17 - Oct'17
Communication Lab under Jayakrishnan Nair *Electrical Engineering, IIT Bombay*

- Implemented a DSSS spread spectrum modulation technique in GNU Radio and demonstrated its resistance to interference by showing that only the intended receiver is able to decrypt the sent message. [Project Page]

Fighting Ebola Feb'17 - May'17

Data Structures & Algorithms under Ganesh Ramakrishnan *Computer Science & Engineering, IIT Bombay*

· Simulated the proliferation of Ebola in a social network modeled by a graph and devised a solution to save as many people as possible using a Minimax algorithm with Alphabeta pruning to reduce computational time.

SCHOLASTIC AND TECHNICAL ACHIEVEMENTS

- Secured an **All India Rank** of **135** in JEE Advanced 2015 out of **150k** candidates. *May '15*
- Secured a percentile of **99.99%** percentile in JEE Main 2015 among 1.5 million candidates. *Apr '15*
- **Silver Medal** in the Medical Imaging Challenge at the 6th Inter IIT Technical Meet, 2018. *Dec '17*
- **Best Tech Prize** at Yahoo Japan Hackathon for developing an augmented reality game platform. *Mar '17*
- Awarded **Gold Medal** in National Science Olympiad by SOF for securing a state rank of **7**. *May '14*
- Won the **2nd runners-up** position in Institute Astronomy Quiz, 2016, IIT Bombay. *Oct '16*
- Secured the **fourth position** in Bazinga 2016, Institute level Physics championship, IIT Bombay. *Aug '16*

RELEVANT COURSES

- **Electrical Engineering:** Information Theory & Coding, Estimation & Identification†, Digital & Analog Comm., Digital Signal Processing, Control Systems, Network Theory, Microprocessors, Power Systems
- **Computer Science:** Machine Learning, Computer Graphics†, Advanced Image Processing, Digital Image Processing, Design & Analysis of Algorithms†, Data Structures & Algorithms, Computer Programming
- **Inter-Disciplinary:** Calculus, Linear Algebra, Probability & Random Processes, Complex Analysis, Economics, Ordinary & Partial Differential Equations, Quantum Physics, Data Analysis & Interpretation

(† *courses to be completed by the end of Fall 2018*)

MENTORING AND LEADERSHIP

Department Academic Mentor, IIT Bombay Apr '18 - present

· Mentor to six students for their academic and general concerns, and helping them cope with the curriculum.

· Mentor to additional 3 students in an academic rehabilitation program helping them get back on track.

Web Convener - Institute Technical Council, IIT Bombay 2015-2016

· Conducted various boot camps and sessions for Python, Git in collaboration with Web and Coding club.

· Developed various web projects, which included the **Knowledge Sharing Platform** and the primary site.

Teacher - Oppia, Teach for India Oct'16-Aug'17

· Created courses on Oppia for Electromagnetism which has been played by over *9000* students worldwide.

· Volunteered to teach mathematics to underprivileged children under the Teach for India initiative.

TECHNICAL SKILLS

Strong: Python(with Numpy, OpenCV, OpenGL and Keras), C/C++, VHDL, MATLAB
Familiar: Arduino, Django, Java (Android), AngularJS, Embedded C
Tools: Quartus, Keil, NGspice, GNU Radio, Android Studio, AutoCAD, SolidWorks, Git, Octave, LaTeX

REFERENCES

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