JIAN VORA

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RESEARCH INTERESTS

Statistical machine learning, Deep generative models, Probabilistic reasoning, Optimization

EDUCATION

Indian Institute of Technology Bombay　　　　　　　　　　　　　　　　Mumbai, India
Bachelor of Technology in Electrical Engineering　　　　　　　　　　　　*July 2017 – Present*
- Overall GPA : 9.73/10.0
- Minor Degree : Computer Science and Engineering

PUBLICATIONS AND PREPRINTS

- Compressive Signal Recovery Under Sensing Matrix Errors And Measurement Gains [pdf]
  Jian Vora, Ajit Rajwade
  Submitted to ICASSP 2021 [Under Review]

RESEARCH EXPERIENCE AND INTERNSHIPS

Low Rank Joint Probability Density Tensor Recovery [Undergraduate Thesis] 🔗　　Ongoing
Guide: Prof. Ajit Rajwade, Department of Computer Science and Engineering　　　　*IIT Bombay*
- **Introduction:** *Density estimation without assuming any structure is mission impossible due to exponential number of parameters in the number of variables. Can we estimate the joint pmf tensor from marginals given the fact that the tensor has a low rank because the random variables can be assumed to be reasonably (in)dependent?*
- Employed the **canonical polyadic model** for representation of a low rank joint probability density tensor as a Naive Bayes model with the latent variable taking a bounded number of states (rank of the tensor)
- Formulated the problem statement was to recover the core pmf tensor from 1D projection densities of data in the form of $\theta^T X$ for various θ. This was infact the **Radon Transform** of the tensor at an angle θ and hence reconstruction used ideas of filtered backprojection and the low rank CPD model.
- Simulated the recovery algorithm followed by using EM for refinements of the estimates over a variety of common densities and found better rate of convergence over standard histogramming or Kernel Density estimate

Multimodal Generative Modeling with Tractable Inference [Intern]　　　　April 2020 – Ongoing
Guide: Prof. Guy Van den Broeck, Antonio Vergari, StarAI Lab　　　*University of California, Los Angeles*
- **Introduction:** *Can we learn the joint distribution of various modalities and allow for tractable inference over a variety of queries? What if we learn these modalities independently and use a generative model to glue them?*
- Trained regularized autoencoders for each modality independently and employed a **probabilistic circuit** on the joint latent space as a generative model allowing linear time exact inference in the size of the circuit for a variety of queries like evidence, marginalisation, conditional and approximate MAP queries
- Optimised the leaves to allow for heterogenous statistical data types and explored various schemes for end-to-end training with the joint training of the autoencoders of all the modalities and the circuit on the latent space
- Explored various multimodal settings such as image-image(MNIST-SVHN), image-attributes(CelebA) and image-text(CUB) getting better results over a variety of metrics over the baseline VAE based multimodal probabilistic models like MVAE, MMAVE while also allowing for tractable inference[1]

Multimodal Density Estimation from Linear Projections [RnD Project] 🔗　　Aug. 2020 – Ongoing
Guide: Prof. Vivek Borkar, Department of Electrical Engineering　　　　　　　　　*IIT Bombay*
- **Introduction:** *High dimensional data can be assumed to follow a mixture of log-concave densities which helps in modelling heavy tails as well. Can we learn this density by projecting the data onto a lower dimensional subspace?*
- Proved that random lower dimensional projections of mixtures of log concave densities is gaussian mixture model in a total variation sense by using the intital result by Eldan and Klartag for a single isotropic log concave density
- Surveyed and implemented **subspace clustering** methods to find the directions where the densities concentrate before fitting a GMM on the projected space followed by invoking the JL Lemma

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[1]Preprint to be out soon. To be submitted at **ICML 2021**.

Blind Calibration of Perturbations in Compressed Sensing [RnD Project]   Dec. 2019 – June 2020
Guide: Prof. Ajit Rajwade, Department of Computer Science and Engineering   *IIT Bombay*
- **Introduction:** *Very often the hardware sensing systems are uncalibrated which leads to errors in reconstructing the signal. Can we calibrate these errors blindly and recover the signal correctly from compressive measurements?*
- Calibrated frequency offsets(gradient delays) and sensor gains(person in motion) in linear compressive measurement framework which occur in MRI signal acquisition for faithful signal reconstruction using a single snapshot
- Proposed a **3-way alternating minimization** algorithm for estimating the signal, gains and frequency perturbations simultaneously using the SQ-LASSO estimator; successfully simulated on MATLAB
- **Proved uniqueness** of the solution up to a scalar and obtained **theoretical bounds** on the error of signal reconstruction by modelling the problem as a GMMV problem with additive signal dependent noise

Spatio-Temporal Action Detection and Classification in Videos [Intern] ⌕   May 2019 – July 2019
Guide: Dr. Martin Klinkigt, Hitachi Central Research Laboratory   *Tokyo, Japan*
- **Introduction:** *Most of the work on action detection has been on trimmed and center cropped videos around the object doing the action. Can we do this on actual untrimmed videos with large temporal length variability of the actions as well different spatial scale of the object under consideration with only limited data?*
- The project was based on the TRECVid ActEV'19 challenge by NIST, proposed a stage-wise architecture of object detection followed by tracking and activity classification on the VIRAT dataset
- Experimented with end-to-end action localization and classification networks like RC3D and Action Tubelet.
- Trained a deep-learning based **Temporal Reasoning Network** for activity classification achieving an accuracy of **95%**; tested the one-vs-all classification approach and designed an event finite-state machine
- Integrated the detections from the FSM with TRN for **temporal alignment** of the activities based on a sliding-window approach resulting in excellent scores beating the previous edition's winners

Major Academic Achievements

- Awarded a branch change due to exceptional academic performance in the first year
- Selected for undergraduate **research internship** programs at **Caltech** (SURF)[2] and NTU India Connect
- Achieved **All India Rank 3** in ICSE 2015 out of 0.16 Million applicants
- Secured **All India Rank 645** in JEE Advanced 2017 among 0.17 Million candidates
- Bagged the **silver medal** in Homi Bhabha Balvaidnyanik (top 0.4%) search for scientific and research aptitude
- Stood among the **nationwise top 1%** in National Standard Examination in Physics (NSEP)
- Awarded the **Inspire Scholarship** by Govt. of Maharashtra for being in the top 1% in Class XII Examinations

Key Technical Projects

StyleGAN for Music Generation | *EE782: Advanced Machine Learning*   *Fall 20*
- Converted audio signal to an spectrogram using recent work on generative modelling of audio data such as GanSynth and implemented a conditioning class feature in StyleGAN appended to the isotropic noise vector
- Modified the current StyleGAN architechture in order to allow for style transfer in audio signals

Shortest Path in a Maze | *CS747: Foundations of Intelligent and Learning Agents*   *Fall 20*
- Modelled a 2D maze as an MDP with appropriate states, actions, rewards and transition probabilities
- Implemented various algorithms like Howard's Policy Iteration, Value Iteration and Linear Programming to find the best policy to be followed to minimize the number of steps between 2 given points while following the constraints

Class D Amplifier | *EE344: Electronic Design Lab*   *Spring 20*
- Designed the entire pipeline of MOSFET driven switching amplifier for a given set of specifications
- Simulated an LC low pass filter for signal recovery; incorporated a MOSFET driver to counter dead times

Iris Recognition and Classification | *CS663: Digital Image Processing*   *Fall 19*
- Segmented pupil and iris from a dataset of eyes using binary thresholding and circular hough transform
- Implemented PCA for dimensionality reduction followed by LDA for classification achieving an accuracy of 86%

Multicycle & Pipelined RISC Processors | *EE309: Microcontrollers, EE224: Digital Systems*   *Fall 19*
- Designed and implemented 6-stage pipelined and multicycle RISC processors in VHDL, consisting a total of 16 arithmetic,logical and branching instructions, and tested it on Altera DE0-Nano FPGA board
- Developed a robust model to handle hazards by integrating data forwarding and stalling units to reduce latencies

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[2]rescinded due to the pandemic

Orthogonal Frequency Division Multiplexing | *CS224: Computer Networks*   *Spring 19*
- Obtained the performance specifications of 400 Gbps OFDM and plotted the BER vs SNR curve
- Compared OFDM with Nyquist WDM and obtained the plot for variation of OSNR with distance and power

Stochastic Approximation Algorithms for PCA | *Self Project*   *Winter 19*
- Reviewed literature for stochastic learning algorithms to optimize the PCA objective efficiently
- Implemented Oja's algorithm, Incremental PCA and Matrix Stochastic Gradient for empirical comparision

Self Aiming Gun | *Institute Technical Summer Project*   *Summer 18*
- Designed a gun with 2-DoF which shoots a moving object using a Raspberry Pi as a microprocessor
- Implemented motion detection in OpenCV using the method of contour detection in a live video stream

Automated Fiducial Localisation in MRI Scans | *Seasons of Code*   *Summer 18*
- Developed an algorithm to estimate the location of fiducials (adhesive markers) affixed onto the skull
- Identified surface voxels and matching depth maps at the surface with template fiducial depth

Technical Skills

Programming Languages: C++, Python, VHDL, MATLAB, Bash, HTML, Embedded C
Machine Learning: PyTorch, TensorFlow, Caffe, OpenCV, Numpy, Pandas, Matplotlib
Software: Docker, GNUPlot, LaTeX, Git, Scilab, SolidWorks, NGSpice, Arduino, Quartus, Modelsim
Microcontrollers: Arduino, RPi, Altera DE0 Nano, CPLD and ATtiny

Key Coursework

Computer Science: Foundations of Learning and Intelligent Agents, Introduction to Machine Learning, Advanced Learning, Theoretical Machine Learning, Data Structures and Algorithms, Digital & Advanced Image Processing, Computer Networks, Cryptography and Network Security, Advances in Learning and Intelligent Agents[3], Computer Vision[3], Automatic Speech Recognition[3], Operating Systems[3]
Mathematics and Statistics: Probability and Random Processes, Data analysis, Linear Algebra, Calculus, Ordinary and Partial Differential equations, Complex analysis, Optimization for Machine Learning[3]
Electrical Engineering: Signals and Systems, Control Theory, Analog and Digital Circuits, Communication Systems, Digital Signal Processing, Microcontrollers, Network Theory, Power Electronics, Electronic Devices
Online Courses: CS229 - Machine Learning(Stanford), CS231n - Convolutional Neural Networks for Visual Recognition(Stanford), CS285 - Deep Reinforcement Learning(UC Berkeley)

Mentoring and Leadership Roles

Manager | *Electronics Robotics Club, IITB*   *2019-20*
- Led a team of **17 members** to boost the Electronics and Robotics culture across the institute
- Initiated and maintained a reading group **VisionX** for discussing and implementing recent research in the field on **computer vision** with members including professors, graduate and senior undergraduate students
- Conducted workshops and **hackathons** by various companies like Uber, Intel and Texas Instruments
- Mentored 3 month long technical summer projects taken up by freshmen and helped in their ideation

Institute Student Mentor & Department Academic Mentor | *Student Mentorship Program*   *2019-20*
- Responsible for mentoring a group of **12 freshmen students** to ensure their academic and holistic development
- Responsible for co-ordinating with the department as a senior DAMP mentor, organised a **lecture** on **mental health awareness** and stress management, mentoring students to clear off their academic backlogs

Extra Curricular Activities

- Worked with **NGO Asha** , designed and taught a basic computer and English speaking course for on campus workers to enable them to be eligible for entry level jobs which require these basic skills
- **Mentored 8 students** under Summer of Science by providing them necessary guidance in **machine learning**; spoke at a 15 day long Machine Learning bootcamp with **250+ participants** and developed assignments and projects
- Stood **1st among 25 groups** in MHRD-TEQIP-3 Activity which involved presenting the topic "Mathematics in Engineering" to professors and students of other universities
- Awarded Times NIE Award for **Budding Journalist** of the country, got a chance to interview Dr. Raghuram Rajan
- Represented Maharashtra in a **quiz** competition with the theme of Indian history at the national level

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[3]To be taken in Spring 21