Curriculum Vitae

Ishank Juneja

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Education

Indian Institute of Technology Bombay, India 2016 - Present
Dual Degree (B.Tech and M.Tech) in Electrical Engineering

- Concentrations: Probability and Statistics, Controls, and AI.
- Minor: Computer Science.
- GPA: 9.66/10, Ranked **2nd** in class of over 70 Dual Degree students.

Publications and Preprints

- Correlated Age-of-Information Bandits
  Ishank Juneja, Santosh Fatale, and Sharayu Moharir
  Under review at the IEEE Wireless Communications and Networking Conference (WCNC)
- A New Approach to Correlated Multi-Armed Bandits
  Ishank Juneja, Devanshu Singh Gaharwar, Dhruv Varshney, and Sharayu Moharir
  2020 International Conference on Communication Systems and Networks (COMSNETS)
  Recipient of Best Poster Award

Research Work

• Exploiting Correlation in Online Sequential Decision Making [Aug' 19 - Present]
Guide: Prof. Sharayu Moharir, Electrical Engineering, IIT Bombay Master's Thesis

About: The project deals with modelling and exploiting correlation between the successes and failures of multiple communication channels. Performance is determined by a metric relevant to time-sensitive applications called Age-of-Information (AoI). A generalization of the Multi-Armed Bandit (MAB) model is used as the decision framework.

- ◇ Designed an MAB algorithm for regret minimization under a correlated MAB framework and demonstrated its superior performance on certain bandit instances.
- ◇ Proposed a variant of the successive-elimination algorithm for best-arm identification under the correlated MAB framework. Analyzed the sample-complexity for our $(0, \delta)$-PAC algorithm.
- ◇ Proved instance independent lower bounds and matching upper bounds on AoI-regret for correlation-aware variants of the UCB and Thompson Sampling policies.
- ◇ Achieved significantly improved performance on AoI-regret by exploiting underlying correlation.

• Video Stabilization for a Spherical Mobile Robot [May' 20 - Present]
Guide: Prof. Leena Vachhani, Systems and Control Engineering, IIT Bombay Research Project

About: Camera stabilization equipment prevents physical disturbances from distorting video footage. However, the correction is not perfect since low frequency disturbances from actions like rolling on an irregular surface creep into a mechanically stabilized recording and degrade the viewing experience. The problem can be alleviated using software-based video stabilization.

- ◇ Implemented a linear-programming based offline video-stabilization technique that estimates and smoothens the underlying camera trajectory and performs a fresh rendering of the video.
- ◇ Devised a novel objective and additional constraints to use the technique in a windowed fashion allowing for parallelism and a fixed delay between live input and output video.

• **Sample Efficient Exploration in Reinforcement Learning** [Oct' 19 - Present]
Guide: Prof. Shivaram Kalyanakrishnan, Computer Science, IIT Bombay Research Project

About: For reinforcement learning to be effective and tractable, knowledge about the environment must be gained within a reasonable number of time steps. The project looks at reward function synthesis and assistance from a near-optimal *expert-policy* as two possible approaches.

◇ Ran experiments to compare the number of samples required by an agent to learn an optimal policy via Q-learning when it uses potential-based reward-shaping and optimal reward-search on an environment having a sparse intrinsic-reward.

◇ Designed an algorithm combining Exp3 and policy roll-outs to weight and combine knowledge from the learned environment model and an external expert policy. Tested it on the RiverSwim MDP.

• **Digital Immunoassay Based on Particle Motion Analysis** [May' 19 - July' 19]
Central Research Laboratories, Sysmex Corporation, Kobe, Japan Summer Internship

About: Biochemical immunoassay technology detects proteins and other macromolecules in low concentrations. Our team worked on a novel biochemical immunoassay that estimates molecular concentrations by tethering down proteins and analyzing their motion through statistical methods.

◇ Applied Gaussian-Mixture-Models on experimental data to derive an accurate calibration curve.

◇ Sped up the data processing pipeline through the use of efficient Python data structures. Brought down time taken for parameter extraction from 30min to 2min for a typical experiment.

• **Image Segmentation in Baby-Monitor Footage** [Dec' 17]
Baby Monitor Division, Cradlewise, Bangalore Winter Internship

About: Each year thousands of infants succumb to suffocation arising from unsafe sleep positions. The project aimed to alleviate this problem using computer vision. Cradlewise is an early stage startup whose smart crib was recently featured in TIME Magazine's 100 best inventions of 2020.

◇ Devised methods to segment body sections in baby images and establish safe and unsafe situations based on the relative positions of the segments associated with the head and torso.

◇ Utilized three dimensional point-cloud information to improve flagging accuracy.

Course Projects

• **USB Powered High Voltage Nixie Tube Clock Display** Spring 2019
Guide: Prof. Mukul Chandorkar Electronic Design Lab, EE

○ Designed an efficient DC-DC isolated voltage convertor capable of safely stepping up 5V to 200V.

○ Printed a custom circuit board for the clock display front-end. The board featured signal isolation.

○ Wrote embedded software for the on-board controller to display digits in a time-multiplexed manner.

• **Hopfield Networks as Dynamical Systems** Spring 2020
Instructor: Prof. Virendra R. Sule Non-Linear Dynamical Systems, EE

○ Formalised the Hopfield recurrent neural network as a dynamical system using a state-space model.

○ Proved convergence of the network to designated fixed-points using the Lyapunov stability criteria.

• **Deep Learning for Metric Learning and GANs** Spring 2020
Instructor: Prof. Sharat Chandran Computer Vision, CS

○ Implemented the Siamese and Triplet network architectures for Metric Learning using PyTorch.

○ Created a GAN and used it to generate hand-written digit images by training it on MNIST digits.

• **Kalman Filters for Non-Linear Estimation** Autumn 2019
Instructor: Prof. Debraj Chakraborty Estimation and Identification, EE

○ Applied Non-Linear Kalman filtering to fuse position, velocity, and aerodynamic information to track the trajectory of a spacecraft during simulated atmospheric re-entry.

○ Compared the performance of the Extended and Unscented Kalman filters on the re-entry problem.

• **Automatic Key-Word Recognition** Autumn 2019
Instructor: Prof. Preeti Rao Speech Processing, EE

- Trained a Hidden-Markov-Model word recognition program to recognize a vocabulary of 10 words.
- Achieved a classification accuracy of 70% on the Google speech commands dataset.

• **16-Bit Pipelined RISC Processor** Autumn 2018
Instructor: Prof. Virendra Singh Microprocessors, EE

- Designed a 6-stage pipelined processor in VHDL and demonstrated it on an Intel DE0-Nano FPGA.
- Implemented the IITB-RISC, 14 instruction, simplified Instruction Set Architecture (ISA) with cycle saving optimizations including data-forwarding and branch-prediction.

Awards and Scholastic Achievements

- Selected as a Robot Learning and Control Researcher at **Honda RnD** Japan. [2020]
- Awarded the Institute Academic Prize for exemplary academic performance. [2018]
- Received the Japan Student Services scholarship for visiting Hiroshima University. [2018]
- Awarded AP Grade in Electronic Devices Lab, top performing student in class of 140. [2017]
- Secured national rank **543** in IIT-JEE Advanced among 200,000 shortlisted candidates. [2016]
- Perfect **800/800** score in Chemistry, Physics and Math-II SAT Subject Tests. [2015]
- Awarded the Kishore Vaigyanik Protsahan Yojana (KVPY) fellowship. [2015]
- Stood **1st** in Mumbai and **9th** nationally in the KVS Junior Mathematics Olympiad. [2014]

Course Work and Technical Skills

- **Math and Control Engineering:** Linear Algebra, Calculus, Complex Analysis, Optimization, Matrix Computations, Optimal Control, Feedback Control, Non-Linear Dynamical Systems, Error Correcting Codes, Estimation and Identification, Advanced Concentration Inequalities
- **Artificial Intelligence:** Machine Learning, Image Processing, Computer Vision, Bandits and Online Learning, Reinforcement Learning, Speech Processing, Advances in Intelligent Agents
- **Engineering Foundation:** Network Theory, Data Structures and Algorithms, Digital Signal Processing, Probability and Random Processes, Digital Systems, Microprocessors, Operating Systems, Computer Networks, Electronic Device Physics, Electronics Design
- **Programming:** Python, C, C++, MATLAB, VHDL
- **Software Libraries:** OpenCV, PyTorch, TensorFlow, ROS, Matplotlib, PuLP

Tutoring and Mentoring

- Served as a teaching-assistant for the courses Linear Algebra, Calculus and Signal Processing-I.
- Mentored and tutored divisions of more than 50 students through weekly problem-solving sessions.
- Responsible for exam grading and related logistics for a class of 90 students.

Extracurricular Activities

- Reached 80K people through contributions on the Stack Overflow, Electrical Engineering, TEX, Ask Ubuntu and Mathematics communities on the StackExchange network.
- Have written more than 20 blog posts on my personal blog, including essays, posts on technical topics ranging from electronics design and controls to artificial-intelligence paper summaries.
- Led my team to victory in the Inter-Hostel Squash General Championship for two years in a row.
- Runner up among 32 participants in the Freshmen Squash Open.
- Held the position of Institute Sports Convenor for a period of one year. Responsible for the smooth conduction of events on the Squash courts and for other sports activities on campus.