

Vansh Kapoor

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Research Interests

Reinforcement Learning, Online Optimization, Machine Learning, Stochastic Modeling, Game Theory

Education

Indian Institute of Technology Bombay (IITB) (Nov'20 - Present)

Bachelor of Technology in Electrical Engineering

GPA: 9.75/10 (Department Rank 6th amongst 200+ students)

Honors in Electrical Engineering; Honors CPI: 10/10

Publications

V. Kapoor, J. Nair, "POMDPs With State Sensing Cost" (Working Manuscript)

Research Experience

Partially Observable MDP With State Sensing Cost (Jan'23 - Present)

Guide: [Prof. Jayakrishnan Nair](#)

R&D Project

- Conducted research on a POMDP with state sensing cost where an agent has to pay an **additional cost for sensing** its current state, but has the freedom to take actions **without knowing** its present state
- Designed a computationally **efficient algorithm** and formulated **four theorems** to calculate the optimal value function and policy within any specified maximum error threshold ϵ by exploring a finite set of policies

Google Research

(Jun'23 - Present)

Guide: [Dr. Manish Jain](#), [Prof. Nikhil Karamchandani](#)

Bachelor's Thesis Project

- Collaborating with Google AI Research to design effective models for analyzing **contagion processes**, particularly focusing on nullifying **coordinated bot attacks** that seek to spread rumors on social platforms
- Utilizing Online Learning techniques to assess **each user's reliability** and subsequently employing modern **deep learning-based cascade models** to enable precise control of information propagation

Professional Experience

Google Silicon Engineer Intern

(May'23 - Jul'23)

Guide: [Rohit Jindal](#), [Ravi Mangal](#)

gChips Hardware Intern

- Carried out **toggle coverage analysis** by implementing the Smart Exclusion feature using Python-based automation flows based on tied-off or unconnected signals for **optimizing** the **design verification** process
- Developed automated checkers for autonomous **data retention flip-flops** for low-power mode applications

Scholastic Achievements

- Received the **Undergraduate Research Award (URA01)** from IIT Bombay in recognition (2023) of outstanding research for work done on Partially Observable MDPs
- Awarded AP Grade (Advanced Performer: **top 1% students**) in **Advanced ML**, Intro to ML (2023) **Image Processing**, EM Waves, Analog Circuits, Power Engineering and Biology
- Awarded **Branch Change** to Electrical Eng. (**12 among 1300+**) for academic excellence (2021)
- Secured **All India Rank 991** in *JEE Advanced, 2020* among 1.1 million aspirants (2020)
- Appointed as **FIITJEE Brand Ambassador** with **Reward Scholarship** (4 years at IITB) (2020)

Teaching & Mentoring Experience

Graduate Teaching Assistant

(Aug'23 - Dec'23)

EE 605: Error Correcting Codes

IIT Bombay

- Assisted the instructor in creating and grading course assignments and quizzes for a batch of 40+ students
- Held weekly office hours and remained available throughout the week for online assistance with any questions

FIITJEE Brand Ambassador

(Oct'20 - Present)

FIITJEE

- Mentored senior high school students through personalized online sessions and helped them choose their fields of engineering by making them aware of their future career options
- Addressed seminars and workshops for current and prospective FIITJEE students during summer vacations

AI & ML Projects [↗](#)

Deep Recurrent Q-Learning for Partially Observable MDPs [↗](#)

(Jul'23 - Dec'23)

Guide: [Prof. Amit Sethi](#)

EE782: Advanced ML

- Implemented the **RL-LSTM-Q network**, integrating Transfer Learning for feature extraction, a customized LSTM for temporal recurrence, and a self-crafted reward function for faster convergence towards optimality
- Utilized **Bootstrapped Sequential Updates** and evaluated its performance on flickering Atari 2600 games

RL in Billiards and Football Half-field Offense [↗](#)

(Aug'23 - Dec'23)

Guide: [Prof. Shivaram Kalyanakrishnan](#)

CS747: Foundations of Intelligent Agents

- Implemented an agent employing **Monte-Carlo Tree Search (MCTS)** in a game of Billiards for potting all solid balls in minimal attempts, even in the presence of noisy angle and force inputs to the cue ball
- Executed MDP Planning to devise an optimal strategy for half-field football offense, using VI, LP, and HPI

Faulty Multi-Arm Bandits [↗](#)

(Jun'23 - Nov'23)

Guide: [Prof. Shivaram Kalyanakrishnan](#)

CS747: Foundations of Intelligent Agents

- Derived and implemented an asymptotically optimal algorithm based on **Bayesian inference** for a faulty bandit instance, which has a non-zero probability of providing faulty outputs uniformly sampled from 0 to 1
- Implemented variants of **Thompson Sampling** and **KL-UCB** for solving a **Batched Bandit Problem**

Real-Time Rapid Multi-Face Detection [↗](#)

(Jan'23 - May'23)

Guide: [Prof. Amit Sethi](#)

EE769: Introduction to Machine Learning

- Implemented the **Haar** features-based **Adaboost Cascade Classifier** approach utilizing the Integral Image representation technique for rapid computation of Haar features for **classifier learning**
- Integrated Python code with a **live webcam**, enabling **real-time face detection** using bounding boxes

Generative AI & Stock Trading System [↗](#)

(Jul'23 - Dec'23)

Guide: [Prof. Amit Sethi](#)

EE782: Advanced ML

- Enhanced the **CGAN** model to generate diverse images a given individual by utilizing a Siamese Discriminator
- Set up an **LSTM-based** stock trading system for high-frequency trading using multiple-stock price inputs

Biomedical Image Segmentation [↗](#)

(Aug'22 - Dec'22)

Guide: [Prof. Amit Sethi](#)

EE610: Image Processing

- Coded a U-Net based architecture tailored for binary semantic segmentation for distinguishing between nucleus and non-nucleus regions of the cell in stained tissue images by employing the TensorFlow+Keras
- Applied **watershed segmentation** on the probability map produced by UNet for the segmentation of individual nuclei, demonstrating its effectiveness on test images containing **overlapping** or **touching nuclei**

Reading Projects

Convex Analytic Method for Average Cost Problem

(Jan'23 - Apr'23)

Guide: [Prof. Vivek Borkar](#)

EE736: Stochastic Optimization

- Presented Convex Analytic method for proving optimality of deterministic stationary policies and denseness of performance of stationary policies in context of infinite horizon average cost stochastic control

Consensus and Bipartite Consensus

(Nov'22 - Jan'22)

Guide: [Prof. Dwaipayan Mukherjee](#)

Winter Project

- Explored results on Bipartite Consensus in networks of multi-agent systems with antagonistic interactions
- Explored conditions for the control parameter in Consensus among linear systems with diverse state-space

Other Projects

Raptor Codes

(Aug'22 - Dec'22)

Guide: [Prof. Nikhil Karamchandani](#)

EE605: Error Correcting Codes

- Simulated **digital message transmission** by implementing Raptor codes while modeling Internet as a BEC
- Delivered a **concise talk** showcasing the significance of Raptor codes as a contemporary coding technique

Multi-Faceted Image Enhancement

(Aug'22 - Dec'22)

Guide: [Prof. Amit Sethi](#)

EE610: Image Processing

- Implemented a research-based approach for denoising using correlations of **neighboring wavelet** coefficients
- Designed a **Wiener-based motion deblur** filter to reveal the license plate characters in shaky car images

Implementation of Communication Systems

(Aug'22 - Dec'22)

Guide: [Prof. Jayakrishnan Nair](#)

EE341: Communication Lab

- Designed an **equalization filter** to negate the effect of ISI on messages suffering from multipath reflection
- Performed analysis of **analog modulation schemes** (DSB-SC and SSB) using an **IQ modulator board**

Technical Skills

Programming Languages	Python, MATLAB, R, JavaScript, C++, HTML, Embedded C
Libraries	PyTorch, SciPy, PyTorch-Geometric, OpenCV, NLTK, TensorFlow, NumPy, Pandas, Seaborn, Scikit-Learn, Pillow, SymPy
Software	Scilab, SolidWorks, GNU Radio, Git, Spice, AutoCAD, Keil

Courses Undertaken

Applied Probability	Stochastic Optimization, Markov Chains and Queuing Systems, Advanced Probability and Random Processes*, Advanced Concentration Inequalities*, Game Theory & Algorithmic Design
AI and ML	Advanced Topics in ML, Foundations of Intelligent & Learning Agents, Image Processing, Online Learning & Optimization*, Advanced ML*
Controls & Communication	Number Theory and Cryptography, Control Theory [†] , Communication Networks, Communication Systems [†] , Signal Processing, Error Correcting Codes, Probability & Random Processes, EM Waves
Digital & Analog	Electronic Design Lab, Digital System and Circuits [†] , Analog Circuits [†] , Power Engineering [†] , Electronic Devices [†]
Mathematics & Physics	Calculus I & II, Linear Algebra, Complex Analysis, Differential Equations I & II, Quantum Physics, Electromagnetism, Economics

[†] includes lab component * to be completed by Apr'24