Shivam Patel

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Research Interests

Probability Theory, Machine Learning, Reinforcement Learning, Algorithms, Game Theory

Education

Indian Institute of Technology Bombay 2020–Present
Bachelor of Technology, Electrical Engineering
CPI : 9.52/10; Department Rank 8^{th} amongst 203 students
Minors in Artificial Intelligence and Data Science; Minor CPI : 9.50/10

Scholastic Achievements

- Achieved an All India Rank **219** in JEE Advanced among 0.225 million candidates (2020)
- Secured an All India Rank **551** in JEE Main among 1 million candidates (2020)
- Recipient of the prestigious **KVPY fellowship** by the Department of Science, Govt. of India (2020)
- Stood amongst the top **458** students in the National Standard Examination in Physics (NSEP) (2020)
- Secured a top **331** position in the National Standard Examination in Astronomy (NSEA) (2020)
- Accorded the **National Genius Award** by the National Genius Search Foundation (2017)

Internships and Research Projects

Electronic Tilt Estimation using Neural Networks *May 2022 - July 2022*
Artificial Intelligence Intern Reliance Jio Infocomm Ltd., Hyderabad

- Worked on multifaceted dynamic cellular tower distribution and network coverage in dense localities
- Utilised time-space weighted average of consumer demand data to design Neural Networks for **optimal electronic tilt prediction** of cell tower antennas, for pan-India deployment across multiple megacities
- Effectuated model analysis using Shapley Additive exPlanations (**SHAP**) and partial dependency plots
- Characterised discrete tilt prediction using regression and classification approaches, obtaining **MAE** of **0.59**° through regression model, and **0.07**° **MAE, 98.4% accuracy** through classification models

Stochastic Climate Modelling *April 2022 - July 2022*
Prof. Sandeep Juneja | Research Internship Tata Institute of Fundamental Research, Mumbai

- Studied **Statistical**, **Empirical** and **Dynamical** methods for long and short time-scale climate prediction
- Designed **Ensemble Multiple Linear Regression** and **Projection Pursuit Regression** models for statistical climate prediction, incorporating feature selection based on climatological arguments
- Explored published literature on dynamic climate modelling, with a special emphasis on modelling the Indian Summer Monsoon Rainfall using local and globalised **General Circulation Models**

Anomaly Detection in Semi-Periodic Sequential Data *July 2022 - Present*
Prof. Nikhil Karamchandani *IIT Bombay*

- Working on time series anomaly detection with unidirectional anomalies in noisy environments
- Adopting a predictor-discriminator framework, focusing on accumulator and gaussian tail discriminators
- Applying Fourier, LSTM and Bidirectional RNNs predictors for time series data with multiple covariates

Navigation Using Spiking Neural Networks *July 2022 - August 2022*
Prof. Udayan Ganguly | Summer Undergraduate Research Program *IIT Bombay*

- Analyzed SNN modules for emulating biological chemotaxis and klinokinesis navigation in *C. elegans*
- Modelled **biological navigational behaviour** using **Leaky Integrate and Fire (LIF)** spiking neurons
- Simulated deterministic and empirical navigational algorithms in variable concentration media

Technical Projects

Foundations of Intelligent Learning Agents *July - Nov '22*
Prof. Shivaram Kalyankrishnan | Course Assignments *IIT Bombay*

- Implemented **UCB, KL-UCB** and **Thompson Sampling** for sub-linear regret minimization, alongwith **Thompson Subsampling** and **Quantile regret minimization** for finite feedback exploration problems
- Formulated inequality constraints from **Bellman Equations** for policy evaluation by linear programming
- Executed MDP planning through **Howard's Policy Iteration**, alongwith **Value Iteration** evaluator

Autoencoder Architectures for Image Colorization and Noise Reduction *Mar - April '22*
Prof. Biplab Banerjee | Course Project (Perfect Grade) *Introduction to Machine Learning*

- Designed CNN based autoencoder architectures, obtaining **RMSE** scores of **0.052** for **CIFAR-10 image colorization** and **0.096** for **MNIST Digits noise reduction** applications on unit range inputs
- Qualitatively explained data specificity of autoencoders of same model on different image classes
- Surveyed literature on image reconstruction pipelines based on image to image translation paradigms
- Examined noise reducing capabilities of **conventional PCA** against **autoencoders** for salt pepper noise

IITB-RISC Microprocessor Design *Mar - April '22*
Prof. Virendra Singh | Course Project *Microprocessors*

- Designed an **8-register, 16-bit RISC** microprocessor with a Turing complete 17 instruction ISA in VHDL
- Developed the **flowcharts** and **datapath structure** for single and multicycle models from scratch
- Simulated the designed microprocessor models on Cyclone-IVE FPGA, implemented on Quartus software
- Utilised **data forwarding** and **stalling techniques** in six stage pipelined microprocessor to obtain a near perfect cycles per instruction ratio of unity, with clock rate adjusted to maximum time consuming step

Machine Learning for COVID-19 Data Analysis *Oct - Nov '21*
Prof. Amit Sethi, Prof. Manjesh K Hanawal | Course Project *Programming for Data Science*

- Obtained an **R2 score** of **0.854** on total COVID-19 casualty prediction using regularized linear models
- Performed **Hypothesis Testing** by utilising the χ^2 **Contingency Test** to validate the influence of medical parameters on the ICU admission of any patient, across all age groups and chronic illnesses
- Implemented **Multilayer Perceptron Neural Net** to predict the need of ICU admission of any patient based on blood and body parameters, obtaining a test **Accuracy** of **90.65%**, and **F1-Score** of **0.905**

Visualising Deep Neural Networks *Dec '21 - Jan '22*
Winter in Data Science *Analytics Club | IITB*

- Explored **Attribution Approach** for interpreting Deep Neural Networks, with a qualitative focus on image recognition neural architectures, by acquiring ground truth labels and studying the model activation maps
- Studied the applications of **Class Activation Maps, Occlusion Sensitivity Maps** and **Saliency Maps** to visualise CNN functioning for intuitive understanding of image classification and detection algorithms

Positions of Responsibility

Undergraduate Mentor *April '22 - July '22*
Summer Of Science | Machine Learning *Maths and Physics Club*

- Mentored a group of **5 undergraduate freshman** students towards exploring Machine Learning
- Provided mentees with regular assistance and insights on various topics in their respective fields of interest

Core Investment Member *July '21 - May '22*
Institute Investment Team | IITB *Finance Club*

- Part of a dynamic 28 membered institute wide team, which focuses on **financial instruments, algorithms** and **indicators** with the goal of maximising profit forecasts through research and analysis models
- Created an **Investment Strategy Model** by utilising 52-wk High-Low markup and Market Cap for companies to determine distribution of investment across shortlisted companies, for varying risk levels
- Discovered **primary level markers** in financial ecosystems, trading systems analyses and risk management

Technical Skills

Programming	Python, C++, VHDL, MATLAB
Python Libraries	NumPy, Pandas, Matplotlib, Seaborn, Scikit-learn, Pytorch, Tensorflow
Tools	GitHub, AutoCAD, LaTeX, Microsoft Office

Courses Undertaken

Electrical Engineering	Markov Chains and Queuing Systems, Probability and Random Processes, Communication Systems, Electromagnetic Waves, Control Systems, Digital Systems, Signal Processing-1, Analog Circuits, Microprocessors, Electronic Devices
Mathematics and Physics	Calculus-1, Calculus-2, Linear Algebra, Differential Equations-1, Complex Analysis, Differential Equations-2, Quantum Physics and Applications, Basics of Electrodynamics and Magnetism
Computer Science	Foundations of Intelligent Learning Agents, Introduction to Machine Learning, Programming for Data Science
Humanities	Economics, Game Theory and Economic Analysis, Philosophy

Extracurricular Activities

- Completed 80+ hours of service under **National Service Scheme (NSS)**, Green Campus div. *(2020-21)*
- **Madhyama Prathama** in **Musical Arts in Tabla**, Akhil Bharatiya Gandharva Mahavidhyala *(2016)*
- Secured 3^{rd} **position in Physics Bazinga Quiz (IITB)**, as part of a four membered team *(2021)*
- **Chess master** in the U-11 and U-13 categories, **ranked** 5^{th} in Gujarat state in U-13 charity cup
- **Active birdwatcher** since 7 years, have observed and studied over **250 species of birds**