

# Shivam Patel

🌐 patel-shivam.github.io • in shivam-patel02 • 📧 patel-shivam

## 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<sup>th</sup> 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

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### Foundations of Intelligent Learning Agents

Prof. Shivaram Kalyankrishnan | Course Assignments

July - Nov '22

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

Prof. Biplab Banerjee | Course Project (Perfect Grade)

Mar - April '22

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

Prof. Virendra Singh | Course Project

Mar - April '22

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

Prof. Amit Sethi, Prof. Manjesh K Hanawal | Course Project

Oct - Nov '21

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  $\chi^2$  **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

Winter in Data Science

Dec '21 - Jan '22

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

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### Undergraduate Mentor

Summer Of Science | Machine Learning

April '22 - July '22

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

Institute Investment Team | IITB

July '21 - May '22

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

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<b>Programming</b>	Python, C++, VHDL, MATLAB
<b>Python Libraries</b>	NumPy, Pandas, Matplotlib, Seaborn, Scikit-learn, Pytorch, Tensorflow
<b>Tools</b>	GitHub, AutoCAD, $\text{\LaTeX}$ , Microsoft Office

## Courses Undertaken

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<b>Electrical Engineering</b>	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
<b>Mathematics and Physics</b>	Calculus-1, Calculus-2, Linear Algebra, Differential Equations-1, Complex Analysis, Differential Equations-2, Quantum Physics and Applications, Basics of Electrodynamics and Magnetism
<b>Computer Science</b>	Foundations of Intelligent Learning Agents, Introduction to Machine Learning, Programming for Data Science
<b>Humanities</b>	Economics, Game Theory and Economic Analysis, Philosophy

## Extracurricular Activities

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- 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<sup>rd</sup>** 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<sup>th</sup>** in Gujarat state in U-13 charity cup
- **Active birdwatcher** since 7 years, have observed and studied over **250 species of birds**