# Vikhyat Agrawal

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vikhyatt
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## Education

2020 – 2023* **Indian Institute of Technology Bombay, India** 9.08 CPI
B.Tech. *Engineering Physics*
Minor in *Artificial Intelligence and Data Science*

2018 – 2020 **Narayana Junior College, India** 87.69%
Intermediate/+2

2008 – 2018 **Bombay Scottish School, India** 94.60%
Matriculation

## Journal Publications

2023 Deep Multi-task Learning for Early Warnings of Dust Events: Evidence from The Middle East. R Sarafian, Nissenbaum D, Raveh-Rubin S, V Agrawal & Rudich Y. **NPJ Climate and Atmospheric Science** [paper]

## Research Internships

2023 **Hospital Re-admissions with Neural TPPs** *Guide: Prof. Russell Greiner | University of Alberta*
• Performed comparative analysis on censored hospital re-admission data between state of the art **Temporal Point Process models** and Individual Survival Distribution models for **survival analysis**
• Enhanced transformer-based time-series prediction TPP models (HYPRO, DualTPP) for right-censored patient data by integrating event and patient meta-data
• Implemented multi-label sequence generation for heart failure (HF) patients to predict HF hospitalization events bound to happen 3 years ahead and used metrics such as Optimal Transport Distance
• Worked on implementing Federated Learning and Differential Privacy techniques for diagnosing cardiovascular diseases using ECG data

2022 **Explainable AI for Multi-task learning** *Guide: Prof. Yinon Rudich | Weizmann Institute of Science*
• Employed meteorological data of 18 years for predicting dust storms in Israel, 24 hours ahead in time
• Developed model interpretability visualisation tools for various model outputs
• Explained model performance by implementing Explainable AI tools like **Integrated Gradients, Saliency Maps, GradientSHAP** and demonstrated cluster formation by model embeddings
• Improved Recall by 9% and Precision by 20% compared to prior state-of-the-art models in literature

## Professional Experience

2022 **Data Science Intern** *Marsh McLennan*
• Explored and reviewed various **Differential Privacy** and **Synthetic Data** generation algorithms
• Experimented and tested the limitations of data synthesizers such as GoogleDP, YData, Gretel
• Experimented, compared and quantified the performance of various generative models (CGAN, WGAN,etc) for generating synthetic tabular data and synthetic time series data
• Received a full-time employment offer from the company, however, decided to decline the position

## Projects

2023 **Grammatical Error Correction** *Academic Project, Deep Learning for NLP*
- Designed and evaluated two models for Grammatical Error Correction (GEC) on the C4 dataset
- Adapted and improved a Multi-layer Convolutional Encoder-Decoder Neural Network for GEC
- Achieved a BLEU score of 0.732 along with an F0.5 score of 0.693 using GloVe word embeddings
- Fine-tuned the T5 model for GEC and achieved a BLEU score of 0.871 and a F0.5 score of 0.832

**Transformation Optics for Material Design** *Academic Project, Electromagnetic Theory*
- Created a Simulated replication and demonstration of the Space Transformation technique in optics
- Explored the application of transformation optics to enhance optical gradient forces

**Modelling Tuberculosis in India** *National Disease Modelling Consortium*
- Modelled transmission of Tuberculosis (TB) transmission dynamics using differential equations
- Estimated key indicators of data by calibrating model parameters to equilibrium
- Adapted a Bayesian Synthesis framework to capture real-life uncertainty in the model inputs
- Recreated the code-base of existing literature in collaboration with the original authors

2022 **2-D Ideal Gas on Arduino** [code] *Academic Project, Microprocessors lab*
- Designed and implemented a real-time simulation of a 2-D ideal gas using Arduino
- Visualised it by dynamically representing gas particles on an LED Matrix as the container for gas
- Devised an approach to calculate and display real-time pressure and temperature of the simulated gas and implemented collision detection algorithms to track the number of particle-wall collisions
- Expanded the project's scope for showcase at Techfest, Asia's Largest Science & Technology Festival

**Traffic Sign Classification using CNNs** [code] *Winter in Data Science, Analytics Club*
- Enhanced proficiency in image augmentation methods and applied a customized LeNet Convolutional Neural Network (CNN) architecture to the German Traffic Sign Recognition dataset
- Performed object detection and classification on this dataset with 43 different types of traffic signs

**Assesing Solar Wind Synergy in India** *Supervised Learning Project*
- Assessed the Spatio-temporal synergy between wind and solar energy resources for India
- Quantitatively assessed hybrid solar-wind power plant feasibility as an alternative to coal plants
- Used parallel computing frameworks (e.g., DASK, XArray) for resource-intensive computations

2021 **Integrated Visual Perception Projects** [code] *Learner's Space, IIT Bombay*
- Implemented a Numeric digit classifier which recognizes handwritten digits by implementing customized convolutional neural networks with an accuracy of 98.25% using the MNIST handwritten digit dataset
- Implemented a Sudoku Solver which reads a Sudoku from an image and solves it using backtracing
- Designed an Image Stitcher which stitches multiple images to form a single panorama image

**Analysing Spatiotemporal COVID-19 Data** *Guide: Prof. Mithun Mitra | IIT Bombay*
- Evaluated and Assessed the success of Contact Tracing Program deployed by MCGM(Government)
- Cleansed large spatio-temporal COVID-19 government data and visualised its spread
- Extracted key insights by modelling the spread by using a tree-based transmission graph model

**Ranking Football Club Performance** [code] *Academic Project, Programming for Data Science*
- Analyzed Premier League Data of 4 seasons and created a team/individual performance index
- Compared the standings obtained due to the performance index with the actual league standings and got Kendall Tau Correlation coefficient of 0.68

## Projects (continued)

**Analysis of Ion Multiplicity Fluctuations** *Academic Project, Data Analysis and Interpretation*
- Reported the event-by-event fluctuations of charged particle multiplicities and their distributions as a function of centrality in p-p collisions, generated by PYTHIA 8 Monte Carlo event generator
- Analyzed and visualised data of millions of events on ROOT data analysis framework by CERN

## Teaching

2021-23 Teaching Assistant at IIT Bombay for the following courses

| Semester | Course |
|---|---|
| Fall 2022 | DS203: Programming for Data Science |
| Spring 2022 | PH 108: Basics of Electricity & Magnetism |
| Spring 2023 | PH 111: Introduction to Classical Physics |

- Teaching responsibilities included discussion of **weekly problem sets**, **grading** the exam papers, and conducting weekly tutorial quizzes

## Leadership and Involvement

2022 **Technical Team Member** *Data Analytics and Visualisation Team*
- Provided data-driven solutions to external organizations and insights into university grading data
- Collaborated with Prof. Sunita Sarawagi from CSE, IIT-B for projects leveraging public Indian datasets by investigating demographics data by the government to predict crime indicators

**Mentor for Artificial Intelligence** [drive] *Summer of Science, Maths and Physics Club*
- Mentored 10 freshers by providing curated handpicked resources in the field of artificial intelligence

**Mentor for Applied ML in Astronomy** [code] *Summer of Coding, Web and Coding Club*
- Instructed and assessed 6 undergraduates on topics in Machine Learning and Deep Learning
- Assisted them in crafting intelligent algorithms for Kaggle's Stellar Classification challenge

**Department Academic Mentor** *Department of Physics*
- Mentored 6 sophomores, actively involved in bridging the student-faculty gap and making their academic experience better by writing blogs about the department and writing course reviews

## Scholastic Achievements

2023 Secured **Department Rank 8** out of 66 students

Awarded the **MITACS Globalink** fellowship for pursuing undergraduate research in Canada

2020 Secured **All India Rank 590** in **JEE Advanced** among 150,000 aspirants

Secured **99.8 percentile** in **JEE Main** amongst 0.92 million candidates

## Technical Skills

| | |
|---|---|
| Programming | Python, C++, FORTRAN, R |
| Software | MATLAB, LTSpice, Git, AutoCAD, Google Cloud, AWS, Azure |
| Machine Learning | PyTorch, TensorFlow, Captum, OpenCV, Scikit-learn, NumPy, Pandas, Scipy |

## Courses Undertaken

| | |
|---|---|
| Machine Learning | Deep Learning for Natural Language Processing, Foundations of Intelligent and Learning Agents, Advanced Topics in Machine Learning*, Introduction to Machine Learning, Programming for Data Science, Data Analysis and Interpretation |
| Mathematics | Calculus, Linear Algebra, Differential Equations, Complex Analysis, Numerical Analysis |
| Physics | Introduction to Special Theory of Relativity, Thermal Physics, Classical Mechanics, Quantum Mechanics, Waves & Oscillations & Optics, Photonics, Advanced Simulation Techniques in Physics, Electromagnetic Theory, Statistical Physics, Introduction to Condensed Matter Physics, Introduction to Nuclear & Particle Physics*, Introduction to Atomic and Molecular Physics*, Methods in Analytical Techniques in Physics* |
| Others | Contemporary Issues in Data Policy and Management*, Introduction to Science and Technology Studies, Earth's Climate: Past, Present and Future, Digital Systems, Economics, Philosophy, Electronics Lab (Microprocessors) |

** to be completed by November 2023*

## References


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