# Tathagat Verma

Final Year Computer Science Undergraduate, IIT Bombay

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## Education

**Indian Institute of Technology Bombay**, Mumbai, India — *July 2018 - July 2022(expected)*
*BTech.* in *Computer Science and Engineering* with *Honors* — CPI - **9.64/10**

**Research Interests**: Deep Generative Models, Graph Neural Networks, Medical Image Processing, Natural Language Processing

## Scholastic achievements

- Secured **All India Rank 53** in **JEE Advanced** out of 200,000 candidates *2018*
- Secured **All India Rank 34** in **JEE Main** out of 1.2 million candidates *2018*
- Recipient of the **Quadeye Excellence Scholarship**, awarded on the basis of academic achievements *2021*
- Amongst top **30** in India selected for the **International Astronomy Olympiad** Selection Camp *2018*
- Amongst top **35** in India selected for the **International Mathematical Olympiad** Training Camp *2017*
- Awarded **Advanced Performer (AP)** grade in **3** courses for exceptional performance *2018-21*
- Amongst top 300 students selected for the **Indian National Physics** and **Chemistry Olympiads** *2018*
- Recipient of the **Kishore Vaigyanik Protsahan Yojana** (KVPY) fellowship by **Govt. of India** *2017*

## Publications

1. Title: **VarScene: A Deep Generative Model for Realistic Scene Graph Synthesis** **[paper]**
   Authors: ***Tathagat Verma***, *Abir De, Yateesh Agrawal, Vishwa Vinay, Soumen Chakrabarti*
   Conference: International Conference on Machine Learning 2022
   Status: Under review

## Research experience

**VarScene: A Deep Generative Model for Realistic Scene Graph Synthesis** — *Autumn 2021*
*Guides: Prof. Soumen Chakrabarti, Prof. Abir De* | *R&D Project* — *InfoLab, IIT Bombay*

- Developed a deep generative model for novel scene graph synthesis using **VAE** and **Graph Neural Networks**
- Designed a goal oriented decoder for minimizing the maximum mean discrepancy between graph distributions
- Developed code in **PyTorch** and used the Visual Genome and Visual Relationship Detection datasets
- Significantly outperformed baselines on the Fréchet Inception Distances (**FID**), Inception Scores (**IS**) and achieved better results on the Shortest Path, Weisfeller Lehman and Neighborhood Subgraph Pairwise Distance kernels

**Deep Learning for Medical Image Quality Enhancement** — *Spring 2021, Autumn 2021*
*Guide: Prof. Suyash Awate* | *R&D Project, Bachelor's Thesis Project* — *IIT Bombay*

- Enhanced the quality of MRI images with sub-sampling and Gaussian noise in the frequency domain and PET images with Poisson noise in the sinogram domain under the weakly-supervised regime
- Trained models using the **RED-CNN** and **UNet** architectures with Bayesian learning in **PyTorch**
- Utilized intermediate VGG-16 layers for **style based losses** and Fourier and Wavelet transform loss functions

## Internships

**Image functionality in the Whiteboard Android Application** — *Summer 2021*
*Microsoft India (R&D) Pvt. Ltd.* | *Software Engineer Intern* — *Noida, India*

- Integrated **Microsoft Lens SDK** into Whiteboard Android, to support image and OCR tools provided by Lens
- Worked in **Java Android** backend, building the bridge to send images from native Android to the web application
- Developed code in **React** for the web application, making the UI component for triggering image workflow

**Attribute Value Extraction from Product Descriptions** — *Summer 2020*
*Coupa Software India Pvt. Ltd.* | *Data Science Intern* — *Pune, India*

- Developed unsupervised and semi-supervised methods for extracting attribute values from product descriptions
- Implemented an **RNN** model for sequence tagging using **CRF**, **BiLSTM** and attention mechanisms
- Optimized hyper parameters using **Bayesian Optimization**, reducing time required for tuning the model
- Automated taxonomy creation by clustering on co-occurrence graphs using the **Chinese Whispers Algorithm**

**Business Monitoring and Alerting Systems** *Summer 2019*
*Delta Exchange* | *Software Engineer Intern* *Mumbai, India*

- Made real time predictions for prices of multiple Crypto Derivative contracts by implementing ARIMA model
- Developed a dashboard using **Django** to monitor Business Performances, now being used on a daily basis
- Used **MySQL** database along with APIs and **WebSockets** of various exchanges for obtaining real time data

## Key technical projects

**Blockchain Simulation and Applications** *Autumn 2021*
*Guide: Prof. Vinay Ribeiro* | *Blockchains, Cryptocurrencies and Smart Contracts* *Course Project*

- Implemented a peer-to-peer cryptocurrency network simulation in **C++** following the **Bitcoin** protocols
- Simulated selfish and stubborn mining attacks, analyzing the effects of hash power and network connectivity
- Developed a decentralized payment application on top of **Ethereum** in Solidity, utilizing smart contracts

**Adversarial Attacks and Robust Deep Learning Models** *Spring 2021*
*Guide: Prof. Sunita Sarawagi* | *Advanced Machine Learning* *Course Project*

- Implemented the $L_2$ attack, $L_\infty$ attack with first and second order norms and the $L_0$ Pointwise attack
- Trained 3 robust models using the methods; Analysis by Synthesis, Stability training and Adversarial training
- Developed code in **Keras**, doing a comparative study using the MNIST dataset on all models & across all attacks

**Foreshadow Attack and its Variants** *Spring 2021*
*Guide: Prof. Bernard Menezes* | *Advanced Network Security and Cryptography* *Course Project*

- Studied the **Foreshadow** attack and its impact on **Intel SGX** and **VM** systems due to speculative execution
- Simulated the proof-of-concept attack on **Linux** kernel with **x86** processor in the absence of Intel TSX

**Topical Poetry Generation** *Autumn 2020*
*Guide: Prof. Pushpak Bhattacharyya* | *Speech and Natural Language Processing* *Course Project*

- Developed a program to generate any number of poems on a user supplied topic and rhyme scheme
- Used the CMU Pronunciation Dictionary and **Fastext** word embeddings to obtain topical rhyming words
- Created **Finite State Acceptors** to accept word sequences following the iambic pentameter stress pattern
- Extracted fluent poems from the FSA with **RNN** language models trained on the Gutenberg Poetry Corpus

**Route Optimization Algorithm** *Winter 2019*
*Inter IIT Technical Meet* *IIT Roorkee*

- Proposed solution for the Vehicle Scheduling Problem in the setting of buses, winning **gold** medal among 20 teams
- Reduced the problem to multiple instances of the Travelling Salesman Problem(**TSP**) using $k$-means clustering
- Generated routes while taking real time traffic into account using **Google Maps APIs** in Python

## Other projects

**E-Commerce Recommender System** *Spring 2021*
*Guide: Prof. Umesh Bellur* | *Database Management* *Course Project*

- Built an E-Commerce recommendation website using **Neo4j** graph database and **Node.js** runtime environment
- Included the features of user history, trending products and text similarity metrics to generate recommendations

**Compiler for C-like Language** *Spring 2021*
*Guide: Prof. Uday Khedker* | *Implementation of Programming Languages* *Course Project*

- Built compiler for a C-like language, constructing Three Address Code and Register Transfer Language incrementally
- Implemented the scanner in **lex**, parser in **yacc** and conversion of abstract syntax tree to TAC and RTL in C++

**Medical Image Segmentation using Deep Learning models** *Spring 2020*
*Guide: Prof. Suyash Awate* | *Medical Image Computing* *Course Project*

- Performed segmentation of neuronal structures from electron microscopy images on the ISBI 2012 dataset
- Implemented and trained the **Deep Multilevel Contextual Network** and **U-Net** models with variations
- Performed ablation studies for U-Nets, achieving results comparable to state of the art models
- Developed code in Keras and implemented weight maps to learn border pixels in cases of touching cells

**Portal for Selecting and Evaluating Teaching Assistants** *Autumn 2019*
*Undergraduate Academic Council* *IIT Bombay*

- Revamped the selection portal for Teaching Assistants being used in the Institute by faculty and students
- Developed a **full-stack** application with backend in Django, MySQL DB and frontend with HTML and JavaScript

**Splitwise Clone Web Application** *Autumn 2019*
*Guide: Prof. Amitabha Sanyal | Software Systems Lab* *Course Project*
- Built a **Django** web app to automate addition and splitting of bills among stakeholders, similar to **Splitwise App**
- Designed a database in **MySQL** for efficiently implementing features like settling up expenses from all groups
- Provided statistical insights on the type of expenditures made by users, using **JavaScript** and **Highcharts**

**Slime Volleyball** *Spring 2019*
*Guide: Prof. Amitabha Sanyal | Abstractions and Paradigms for Programming* *Course Project*
- Developed the Volleyball game, simulating collisions and gravity using functional programming in **Racket**
- Utilized Racket's networking package (**TCP**) for playing the two-player game on separate systems
- Designed an algorithm using heuristic approaches to determine best possible shots for the one player game

## Technical Skills

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|---|---|
| **Programming** | C++, Python, C, Java, Bash, Solidity, Racket, Prolog, VHDL, SQL, MATLAB |
| **Packages** | PyTorch, TensorFlow, Keras, NLTK, SciPy, Pandas, Statsmodels, NumPy, PyQt, NS3 |
| **Software** | Git, LaTeX, AutoCAD, SOLIDWORKS, Android Studio, Wireshark |
| **Web Development** | HTML, CSS, JavaScript, Django, Bootstrap |

## Relevant Courses

**Artificial Intelligence**: Foundations of Intelligent and Learning Agents; Machine Learning Theory and Methods; Medical Image Computing; Advanced Machine Learning; Speech and Natural Language Processing; Artificial Intelligence and Machine Learning; Data Analysis and Interpretation

**Security**: Introduction to Blockchains, Cryptocurrencies and Smart Contracts; Advanced Network Security and Cryptography; An Introduction to Number Theory and Cryptography

**Computer Science**: Automata Theory; Implementation of Programming Languages; Computer Architecture; Operating Systems; Database and Information Systems; Computer Networks; Data Structures and Algorithms; Digital Logic Design

**Mathematics**: Calculus; Linear Algebra; Differential Equations; Introduction to Numerical Analysis

## Leadership Positions

**Institute Student Mentor** *Jun 2021 - Present*
*Student Mentorship Program* *IIT Bombay*
- Mentoring **12 freshmen**, helping them adjust to the institute environment, focusing on their holistic development
- Amongst 130 out of over 300 applicants selected through a rigorous procedure of interviews and peer reviews

**Senior Department Academic Mentor** *Jun 2020 - Present*
*Computer Science and Engineering Department* *IIT Bombay*
- Mentoring **6 sophomores** of CSE department to assist them in navigating department specific curriculum
- Working in a supportive, facilitative and developmental role for the student community in general as a mentor

**Teaching Assistant** *IIT Bombay*
- **Artificial Intelligence and Machine Learning** | *Prof. Ganesh Ramakrishnan* *Jul 2021 - Nov 2021*
- **Data Structures and Algorithms** | *Prof. Sharat Chandran* *Jan 2021 - May 2021*
- **Logic for Computer Science** | *Prof. Krishna S* *Jul 2020 - Nov 2020*

Responsible for conducting doubt sessions, preparing problem sets, programming labs and grading examinations

**Organiser in Corporate Relations** *Nov 2018 - Mar 2019*
*Entrepreneurship Cell* *IIT Bombay*
- Responsible for speaker handling and handling overall logistics in multiple events
- Part of the execution team for **The Panel Discussion** at Entrepreneurship Summit, 2019

## Extracurricular

- Won **gold** medal in Route Optimization Competition at the **Inter IIT Technical Meet, IIT Roorkee** *2019*
- Represented IIT Bombay at the **34$^{th}$ Inter IIT Aquatics Meet, IIT Guwahati** *2018*
- Awarded **second** position in **CoDecode** (coding competition) organized by Techfest, IIT Bombay *2020*
- Covered a distance of **23.2 km** swimming continuously for **12 hours** at Swimathon, IIT Bombay *2019*
- Awarded Certificate of Merit for **winning** the Inter Department Football Tournament IIT Bombay *2019*
- Awarded Diploma Certificate for competing in the **Gothia Football Cup, Gothenburg, Sweden** *2011*
- Completed 2 levels of graded examination in communication skills from **Trinity College London** *2013*
- Phonathon: Pitched to 50 alumni the events conducted by Student Alumni Relations Cell, IIT Bombay *2019*