Parth Pujari

Github | Email

Interests

Algorithms, Computer Architecture, Algebra, Image Processing, Music theory and Sound design

Education

Indian Institute of Technology, Bombay - *India* (2021-2025)
Bachelor of Technology - Computer Science & Engineering **GPA: */5**
Minor in Mathematics

Achievements and Honors

JEE (Advanced) - Joint Entrance Examination for admission into Indian Institutes of Technology. (2021)
Secured a nationwide rank of **537** out of more than **100,000** students.

Attained a percentile of 99.75 in the **JEE Main** examination out of 0.9 million candidates. (2021)

Awarded **Branch Change** to Computer Science and Engg. (17 in 1400) for academic excellence. (2022)

Stood in the top **1 percentile** in the **BITSAT** examination out of over **300,000** students (2021)

Internships

Optiver

Software Engineering Intern | FPGA Software (Amsterdam, 2024)

- Worked as a software engineering intern in the FPGA/Hardware-Software trading team
- Built a **production like environment** for the FPGA lab, managing HW/SW processes and networking on the dev machines, creating a mock stock exchange, test setups and back-tests

Projects

AI/ML and Data Science

Denoising Diffusion GANs - *Machine Learning and AI*, **IIT Bombay** | GitHub (2023)

- Implemented in **PyTorch** multimodal conditional **Generative Adversarial Networks** over the denoising diffusion GANs structure based on the following paper for CIFAR-10 and Stacked MNIST datasets

Stable Diffusion - Seasons of Code, WnCC | GitHub (Summer '23)

- Used **PyTorch** to implement the vanilla and **variational autoencoders** for the FashionMNIST dataset.
- Created a working implementation of the **Denoising Diffusion Probabilistic Models** (DDPM) paper using Hugging Face's U-Net and used it for non conditional generation of images on the FashionMNIST datset.
- Implemented latent diffusion using the **diffuser's VAE** and U-Net for high resolution image generation

Image Processing - *Advanced Image Processing* (2024)

- Implemented image denoising and deblurring for very low SNR images using Poisson Inverse methods
- Used the **Plug and Play approach** based on [paper] using Gaussian denoisers like BM3D to deblur images
- Implemented image inpainting, denoising and debluring using **Regularized Partial Differential Equations**

Deep Learning Biology Models - *iSURP-Prof. Venkatesh K.V.* | GitHub (2022)

- Utilised meta data and developed classification models for hypertension detection in adolescents
- Utilised multilayer perceptrons, LASSO regression and random forest classification models for the same
- Researched on CNNs, NLP and video feature encoding techniques on autism screening using video analysis
- Achieved accuracy of 86% on hypertension detection and autism screening on adolescents

Generating Representative Images via PCA - *Data Analysis*, **IIT Bombay** | GitHub (2022)

- Used MATLAB to implement a program that used a dataset of images of various fruits and using **Principal Component Analysis** (PCA), sampled random images to generate new, representative images of fruits.
- Analysed handwritten digit images from the **MNIST** Database and optimally reduced their dimensionality.

Algorithm Design

Hybrid A* algorithm - under **Innovation Cell, IIT Bombay** | GitHub (2023)

• Formulated a novel pipeline to develop a path planning algorithm based on **Reeds Shepp and Dubin's curves** in C++ using Pontryagin's Minimum Principle and implemented it on the **Robot Operating System**
• Modified the A* path finding algorithm, modifying its heuristic and using a tree structure to create self branching paths
• Used self branching paths to allow it to operate on continuous space and provide **holonomic** pathways in unstructured environments and improving its time complexity
• Implemented **C∞**, **clothoid spiral** based smoothening and **numerical optimisation** on the generated paths to make them feasible for vehicles with minimum turning radii and constraints on angular accelerations

Railway Planner - course Project | *Data Structures*, **IIT Bombay** (2022)

• Developed a large Railway Planner in C++ using algorithms such as Merge Sort, KMP and Quicksort.
• Utilised Data Structures such as AVL Trees, Hash tables, Tries and Priority queues to handle large data.
• Utilized modified **Dijkstras**, **spanning tree**, **Bellman Ford**, **Kosaraju's**, **Ford Fulkerson's** and other algorithms to plan efficient journies based on user preference
• Included features like adding journeys, reviews, search engine features like auto completion and ratings.

Computer Architecture and Compiler Design

C Compiler Design- *Implementation of Programming Languages* **IIT Bombay** (2024)

• Created a C compiler in C++ using **Lex** and **Yacc** for lexical analysis and syntax parsing
• Created a context free grammar, abstract syntax trees for C and intermediate representations for assembly
• Created a **MIPS** code generator with integer and float operations and nested namespaces

Branch Predictors in Graph Analytics - | *Computer Arch.* **IIT Bombay** | GitHub (present)

• Implementing the **Tagged Geometric Length Predictor** (TAGE) and the **L-TAGE** branch predictor on the **ChampSim** simulator based on a paper by INRIA : link
• Comparing its results with the hashed perceptron branch predictors on standard graph algorithm traces like connected components, single source shortest path problems, page rank, BFS, etc.
• Improving bad speculation, specific cases of branch mispredictions, instructions per cycle, etc. using optimizations in the TAGE predictor.

Data Prefetching & Cache Replacement Policies - | *Computer Arch.* **IIT Bombay** | GitHub (2023)

• Implemented simulations in C++ of a **best offset data prefetcher** at the L2 cache level on the simulation software **ChampSim** based on the research paper by IRISA, INRIA and HIPEAC : link
• Tested the prefetcher on various program traces including the ones tested in the research paper (with similar results) and obtained significant improvement in prefetched miss rates and instuctions per cycle rates
• Simulated cache coherence and bus interconnection mechanisms like the **MSI** protocol
• Implemented cache replacement policies such as the least recently used, least frequently used, first in first out and random eviction and compared them analytically on various traces

Assembly Programming - | *Computer Arch.* **IIT Bombay** | GitHub (2023)

• Wrote assembly level (**MIPS-32** and **X86**) programs on algorithms such as *inplace iterative mergesort*, matrix multiplication and the extended Euclids algorithm
• Optimized the code by finding hotspot functions, bad speculation, cache bounds, etc. on **Intel VTune**
• Reverse engineered binaries and obtained data on branch predictors, random number generators, etc.

Networks and Game Development

FastChat - *Software Systems*, **IIT Bombay** | GitHub (2022)

• Built a network of TCP/IP clients interacting through servers as mediators using **Python socket** libraries.
• Obtained high throughput using load balancing servers while ensuring low latency of individual messages.
• Ensured end to end encryption using **RSA and AES** encryption libraries and PostgreSQL server databases

CodeWars-v3 - *WnCC*, **IIT Bombay** | GitHub (2023)

• Developed the backend of a multiplayer strategy game in C++ that runs on automated scripts
• Utilised the **C++ Boost** libraries for socket communication and SFML libraries for graphic integration
• Developed optimized multithreaded asynchronous servers to reduce latency

Positions of Responsibility

Insitute Web and Coding Club Convener (2022-2023)

- Worked in a team of 10 to organise 40+ events catering to the programming interests of 10K+ students
- Coded and hosted the hackathon - **CodeWars-v3** which received a participation of over 1000 students
- Conducted events on Google's Summer of Code to promote Open Source Softwares
- Organised and mentored workshops on Git and Github and created open source repositories under Hacktober Fest, moderating 30+ repositories

Teaching and Mentoring

Videogame Physics Engine - | *Summer of Code* **IIT Bombay** | GitHub (2023)

- Mentoring a select group of 8 students along with 3 co-mentors in a 3 month long project in game physics engine development and graphics implementation using **OpenGL**
- The project involves implementing broadphase **collision detection** and **collision resolution** algorithms
- Creating a game involving **randomized** world generation based **proximity graphs** and game laws
- Further integrating the game with **OpenGL** and the broadphase system, calculating convex hulls, developing wrappers for graphic libraries and merging the game with a larger project on game development

Technical Summer School - | *Web and Coding Club* **IIT Bombay** | GitHub (2022)

- Prepared and moderated a course with over 500 mentees for the Institute's Technical Summer School's Learner's Space programme on An Introduction to Web Development using **React JS and Next JS**
- Inlcuded an in depth view of HTML, CSS, JavaScript, Bootstrap, Tailwind, React JS, React components, pure components and the use of **vite** to create apps, building towards a project on a storage inventory portal
- Researched on and covered **React States**, lifecycles, hooks, the **Recoil JS library**, the use of **Next JS**

Relevant Courses

CS - Design and Analysis of Algorithms, Digital Logic Design and Architecture, Formal Methods and Logic for CS, Discrete Structures, Software Systems, Computer Networks, Operating Systems, Compilers
Maths - Commutative Algebra, Basic Algebra, Linear Algebra, Optimization Models, Differential Equations

Skills

Programming C, C++, Java, Python, Bash, MATLAB, SQL, AWK, Sed
Development HTML, CSS, JavaScript, JQuery, Bootstrap, Angular
Data Science Pandas, NumPy, Scikit-learn, Scipy, Matplotlib, TensorFlow
Tools Git, Robot Operating System (ROS), LaTeX, SolidWorks, AutoCAD, Doxygen, Sphinx

Others

International Rank 1 in Sangeet Visharad for proficiency in singing out of over **100,000** candidates (2019)
Worked as a professional classical musician at the **All India Radio for 4 years** (2016-2019)
Played basketball at the inter-school level from grades 8 to 10 for St. Mary's School, Pune