AMRUTA PARULEKAR

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Education

Indian Institute of Technology Bombay — Mumbai, India
Dual Degree: B.Tech in Electrical Engineering with M.Tech in Artificial Intelligence — *(Grade: **9.13/10.0**)*
Minor in Computer Science — *Sep '20 – Jun '25 (Expected)*

Research Interests

Harnessing AI and ML techniques including Natural Language Processing, Computer Vision, Automatic Speech Recognition and Generation, Image Processing and Generation for diverse applications such as healthcare, education and industrial safety.

Publications

1. **A. Parulekar** et al. "**Combining Datasets with Different Label Sets for Improved Nucleus Segmentation and Classification**"(Paper), published and presented at Bioimaging (BIOSTEC) 2024, Rome.
2. S.A.Nasser, A.Sharma, A.Saraf, **A.M.Parulekar**, et al. "**Transforming Breast Cancer Diagnosis: Towards Real-Time Ultrasound to Mammogram Conversion for Cost-Effective Diagnosis**"(Paper), to Ultrasonics Journal

Poster Presentations

1. **A. Parulekar** et al. "**A Computer Vision Pipeline for Laryngoscopic Image Standardization through Histogram Matching**"(Poster), presented at COSM 2024, Chicago.
2. H.C.Shah, A.D.Amarpurkar, T.Jacob, **A.M.Parulekar**, et al. "**Artificial Intelligence-based Eosinophil Count in Gastrointestinal Tract Biopsy**"(Poster), accepted to Gastroenterology Journal

Research Experience

Structure from Motion with NeRF for Vocal Fold Surgery Assistance — *May'23 - Jul'23*
Research Internship (MITACS scholarship) | Guide: Prof. Lueder Kahrs — *University of Toronto*
- Worked on the use of **Neural Radiance fields**(NeRF) for 3D visualization of vocal folds in sub-glottic stenosis patients
- Performed automated **vocal fold motion tracking** using Image processing techniques and the **AGATI** Software
- Developed an **end-to-end preprocessing pipeline** and a fully annotated dataset of laryngoscopic images for further use

Speech Generation Models for Automatic Dubbing of Agriculture Education Videos — *Aug'24 - Ongoing*
Dual Degree Project (nationwide project BharatGPT) | Guides: Prof. Preethi Jyothi, Prof. Ganesh Ramakrishnan — *IIT Bombay*
- Improving upon length constrained **neural machine translation** for an audio-dubbing pipeline for agriculture education
- Adapting **neural codec language models** like **Vall-E** and **SpeechX** for voice and emotion transfer in low resource dialects

Nuclei Instance Segmentation and Classification for Histopathology Images — *Aug '22 – Nov '23*
Bachelor's Thesis-I (With TATA Cancer Research Hospital) | Guide: Prof. Amit Sethi — *IIT Bombay*
- Designed a **novel loss function** to consolidate hierarchical class labels of datasets viz. **PanNuke, MoNuSAC and CoNSeP**
- Achieved improvement on test sets and **Domain Generalization** on unseen datasets for segmentation and classification
- Mitigated class imbalance, staining variability and trained **UNet** and **Stardist** to detect eosinophilia with **85%** accuracy

Multilingual Automatic Speech Recognition for Low Resource Languages — *Jan '24 - Ongoing*
Research Assistant (nationwide project BHASHINI) | Guides: Prof. Preethi Jyothi, Prof. Pushpak Bhattacharya — *IIT Bombay*
- Modifying Meta's **SeamlessM4T** for automatic speech recognition in low resource languages like **Maithili** and **Konkani**
- Harnessing computationally efficient techniques like **parameter-efficient finetuning** and **Low-rank adaptor** tuning

CT reconstruction from Ultrasound Images of Breast Cancer using GANs — *Aug '22 - Aug '23*
Research Assistant (With TATA Cancer Research Hospital) | Guide: Prof. Amit Sethi — *IIT Bombay*
- Utilized **CycleGANs** and **pix2pix** to generate CT scans from simulated ultrasound (US) images, achieving an MSE of **0.008**
- Pre-processed CTs to speed of sound images to simulate US through **wave interference equations** using **Stride** module
- Applied **Fourier Domain Adaptation** to enhance the quality of simulated images with authentic ultrasound images

Genomics-based Survival Analysis for Lung Cancer using Multimodal Data — *Jan '24 - Aug '24*
Bachelor's Thesis-II (With TATA Cancer Research Hospital) | Guide: Prof. Amit Sethi — *IIT Bombay*
- Created neural **cox proportional hazards models** for genomic data using **graph neural networks** and neural ranking
- Employed **Discriminator-based domain adaptation** and transfer learning to use mouse data to fortify human **TCGA** data
- Attained **0.88 concordance index** by combining gene subset selection and **multi-instance learning** on LUAD image data

Accident prediction in Nuclear Power Plants using Reactor Transients — *Nov '23 - Jan '24*
Research Internship | Guide: Prof. Gopika Vinod — *Bhabha Atomic Research Centre*
- Countered dataset size with dimensionality reduction, like **multi-dimensional scaling** and **linear discriminant analysis**
- Optimized a custom neural network along with machine learning methods like **random forest** for accident prediction

Scholastic Achievements

- Awarded two **Undergraduate Research Awards** by IIT Bombay for exceptional contributions to scientific research (*2023-24*)
- Awarded the **Best Mentor Award** under the department academic mentorship program at IIT Bombay (*2024*)
- Presented our paper and was nominated for the **Best Student Paper Award** at Bioimaging 2024, Rome(BIOSTEC) (*2024*)
- Scored **332/340** in the Graduate Records Exam (GRE) and **115/120** in the TOEFL (*2024*)
- Awarded the **MITACS scholarship** through the Globalink Research Internships program, Canada (*2023*)
- Received **Best Project Award** - Electronics Design Lab, **Best Presentation Award** - Automatic Speech Recognition (*2023*)
- Received **AP grades (top 1 percent)** in Image Processing, Biology, and Public Health Informatics courses (*2021-23*)
- Within the **top 1.15 percent** in JEE Advanced-2020 (Engineering) out of 0.15 million aspirants (*2020*)
- Within the **top 0.3 percent** in JEE Mains-2020 (Engineering) out of 1.2 million candidates (*2020*)
- Secured the **National Talent Scholarship** (NTSE), exclusively granted to the **top 0.2%** students of the nation (*2018*)
- Felicitated with the **Times of India - NIE Student of the Year award** for excellence in academics (*2017*)
- Secured the **Silver Medal** in the Dr. Homi Bhabha Young Scientist Competition and **Gold Medal** in Ganit Pradnya (*2016-17*)

Professional Experience

Data Science Intern *May '22 - Jul '22*

JIO Data Science Platform *Reliance JIO*

- Built an **Automated Machine Learning platform** and its User Interface using **Python, Pyspark** and the **FastAPI** class
- Worked on building Computer Vision capabilities for **detection and classification** of personnel wearing safety PPEs in plant operation areas and researched **human action recognition** in videos using **LSTM recurrent neural networks**
- Learnt how to build and run images in **Docker** and wrote **Cypher** queries to create graphs in **Neo4j**

Technical Projects

Defence for Face-morphing Adversarial Attacks on Facial Recognition Systems *Jan '23 - Apr '23*

Course project | CS726 : Advanced Machine Learning | Guide : Prof. Sunita Sarawagi *IIT Bombay*

- Achieved a **200x better** MSE loss on unknown faces, by utilizing a **discriminator** trained on morphed face images
- Obtained **80% success** rate, on attacking SOTA Face Recognition models, **OpenFace** and **FaceNet512**, by morphing two face images by interpolating their semantic and stochastic embeddings produced by **Diffusion Autoencoders**

Toxicity Removal in Large Language Models *Jan '24 - Apr '24*

Course project | CS772 : Deep Learning for Natural Language Processing | Guide : Prof. Pushpak Bhattacharya *IIT Bombay*

- Built **LSTM** and **Transformer** models from scratch and a **BERT-based transformer** model to predict sentence toxicity
- Used **feature engineering** to capture sentiment and successfully rank responses of an LLM to a prompt on their toxicity

Multi-armed Bandits and Markov Decision Processes for Gaming *Aug '23 - Nov '23*

Course project | CS747 : Reinforcement Learning | Guide : Prof. Shivaram Kalyanakrishnan *IIT Bombay*

- Implemented variants of **Thompson Sampling** and **KL-UCB** for solving a Batched Multi-armed Bandits Problem
- Executed Markov Decision Process planning to devise an optimal strategies for half-field football offence and a billiards game, using **Value iteration**, **Linear Programming**, **Howard's Policy Iteration** and **Monte-Carlo Tree search**

Neuromorphic Computing and Spiking Neural Networks for Real Time Learning *Aug '23 - Nov '23*

Course project | EE746 : Neuromorphic engineering | Guide : Prof. Udayan Ganguly *IIT Bombay*

- Modelled the activity of spiking neurons like **Izhikevich** and **Hodgkin-Huxley** to determine the energy cost of a spike
- Analysed the effects of time varying **Poisson distribution-based** stimuli on the **AEF RS** neurons with distinct synapses
- Designed a neuronal circuit in **Spiking Equilibrium** using **45 nm CMOS** technology for Low Power Real time Learning

Wavelet transforms for image super-resolution and restoration *Aug '22 - Nov '22*

Course project | EE610 : Image Processing | Guide : Prof. Amit Sethi | Secured an AP grade *IIT Bombay*

- Accomplished **image denoising** using neighbouring **wavelet coefficients** and thresholding and reported **PSNR** and **SSIM**
- Employed techniques like **Wiener filtering**, Histogram manipulation, Support vector regression for image restoration

Automated Recognition, Processing and Sentiment Analysis of Speech *Jan '23 - Apr '23*

Course project | CS753 : Automatic Speech Recognition | Guide : Prof. Preethi Jyothi | Best Presentation Award *IIT Bombay*

- Created an **LSTM-RNN-based** ASR model using **MFCCs** and compared it to a **CNN** baseline using a **confusion matrix**
- Evaluated and then fine-tuned a pre-trained **CRDNN** model and utilized it to design a **sentiment detection** model
- Achieved word error rate of **0.37** and sentiment detection accuracy of **76%** for our model on the **Hugging Face** dataset

Transformer based model for Seizure detection in EEG data *Aug '23 - Nov '23*

Course project | DH302 : Public Health Informatics | Guide : Prof. Kshitij Jadhav | Secured an AP grade *IIT Bombay*

- Implemented a **novel 4-channel selection** method, reducing EEG data requirement of a time series transformer to **17%**
- Utilized **Data Uncertainty Learning** and Data Leakage prevention methods coupled with a **Hybrid Vision Transformer**
- Hypothesized and established age and gender correlation in the prediction of seizures on the **CHB-MIT EEG** database

Facial Feature Detection using the Fastai Library *Jan '22 - Apr '22*
Course project | DS303 : Introduction to Machine Learning | Guide : Prof. Biplab Banerjee *IIT Bombay*
- Applied the **cnnlearner** Transfer Learning method of the **Fastai** library, initialized with **Resnet18**, on the **LFW** dataset
- Executed facial detection and used the **inter-feature distances** between 15 extracted features to recognize faces

Hierarchical Multi-Label Object Detection to Analyze Panoramic Dental X-rays *Jan '24 - Apr '24*
Course project | DH602 : Machine Learning and Statistical Methods in Healthcare | Guide : Prof. Kshitij Jadhav *IIT Bombay*
- Developed a pipeline having a **Co-DETR-based** tooth detection model and an **Efficient-net-based** disease classification model with focal loss, **intelligent data subset selection** and geometric augemntations to counter **class imbalance**
- Used **Haar-wavelet** transform for compression and feature extraction, successfully giving a **50%** training time reduction

Cardiovascular Disease Prediction Using Data Science Techniques *Aug '21 - Nov '21*
Course project | DS203 : Programming for Data Science | Guide : Prof. Amit Sethi *IIT Bombay*
- Harnessed **Exploratory Data Analysis** and preprocessing to identify the major factors responsible for cardiac diseases
- Tuned various **Hyper-parameters** of several Machine Learning and Deep Learning models using **GridSearchCV**
- Compared the prediction accuracy scores of **KNN, SVM, RF, Decision Trees, Naïve Bayes** and Neural Networks

Neural Style Transfer for Text and Chat | Season of Code Project *May '22 - Jul '22*
Completed a Summer Project under the Web and Coding club *IIT Bombay*
- Performed text **style transfer** using the **Transformers** library, LSTM-RNNs, a **parts-of-speech tagger**, a sentence similarity checker using **cosine similarity** and a **generative model** generating formal adjectives to create a shakespearean chatbot

Jigsaw puzzle solver using Computer Vision Techniques *Jan '23 - Apr '23*
Course project | CS763 : Computer Vision | Guide : Prof. Sharat Chandran *IIT Bombay*
- Experimented with **linear programming**, **greedy algorithm** and deep learning approaches to make jigsaw puzzle solvers
- Improved the accuracy of the **deep learning** algorithm by creating a cross-entropy-based **custom loss function**

Technical Skills

Languages: Python, C, C++, Java, Latex, MATLAB, HTML, CSS, Javascript, Cypher, Assembly Language, VHDL, XML, R, SQL
Python Libraries: Numpy, Pandas, Matplotlib, PyTorch, NLTK, SK-Learn, OpenCV, Tensorflow, Transformers, Fastai, Scipy
Software: Git, AGATI, Jupyter, Docker, Stride, Quartus, GNU Radio, Spice, FastAPI, Neo4j, Keil, Flip, Putty, Fusion360, Sage

Key Coursework

Artificial Intelligence: Advanced Machine Learning, Computer Vision, Automatic Speech Recognition, Image Processing, ML for Healthcare, ML for Remote Sensing, Reinforcement Learning, Neuromorphic engineering, Natural Language Processing
Electrical Engineering : Microprocessors, Topics in Cryptology, Electronic Design, Control Systems, Digital Systems, Digital Signal Processing, Communication Systems & Networks, Analog Circuits, Power Engineering, EM waves, Speech Processing
Computer Science: Data Structures & Algorithms, Computer Networks, Design & Analysis of Algorithms, Discrete Structures
Mathematics: Calculus, Differential Equations, Complex Analysis, Linear Algebra, Probability & Stochastic Processes

Positions of Responsibility

Department Academic Mentor | Best Mentor Award *Aug '23 - Ongoing*
Student Mentorship Program: Selected based on a rigorous process of interviews, SOP, and peer reviews *IIT Bombay*
- Personally mentoring a group of **12 junior undergraduates** with their academics, career paths and research
- Part of a team of 20 mentors responsible for collecting and writing reviews and blogs for the department website

Teaching Assistantships | IIT Bombay
Facilitating smooth course organization, grading papers, mentoring students, conducting tutorials and help sessions
- **CS 753: Automatic Speech Recognition**, Prof. Preethi Jyothi, Department of Computer Science *Spring 2023*
- **ME 119: Engineering Graphics and Drawing**, Prof. Sushil Mishra, Department of Mechanical Engineering *Spring 2022*
- **BB 101: Biology**,Prof. Ambarish Kunwar & Prof. Hari Varma, Department of Biosciences and Bioengineering *Fall 2021*

Extra Curricular Activities

Volunteering	• **Mentored 5 students** for learning Image Processing in the SoS program by Math & Physics club, IITB *2023* • **Mentored 20 students** for three Artificial Intelligence projects in WiDS program by Analytics club, IITB *2023* • Women in Science and Engineering (WISE): Introducing technology to rural school girls *2023* • Took a **Biology** help session for **1000+** undergraduates at IIT Bombay *2021* • **Reader and writer** for fellow school mates in ICSE board Examination *2017* • **Youth Volunteer** for Anant Vikas project in Youth Empowerment Mission *2017* • Voluntary Services to SAATH (**Support and Aid for Thalassaemia Healing**) *2016* • Community Services for Youth Council (**NGO for serving Cancer Patients**) *2016*
Art & Music	• **Designed posters** for events conducted in the Electrical Engineering Department festival, Impulse *2023* • Completed a year-long **Keyboard** programme under the National Sports Organization (NSO) *2021* • Secured **A Grade** in state-level Elementary and Intermediate **Drawing** Examinations *2017*