Soumedhik Bharati

West Bengal, India soumedhikbharati@gmail.com 8240947878 Soumedhik Bharati
Soumedhik Bharati

Education

Sister Nivedita University *Sept. 2022 – Sept. 2026*
B.Tech in Computer Science Engineering

- *Current CGPA: 8.68/10*
- **Selected Courses:** Linear Algebra, Probability, Problem Solving, Data Structures & Algorithms, Object-Oriented Programming, Operating Systems, Database Management Systems, Computer Architecture, Discrete Mathematics, Biology, Automata, Engineering Physics, Digital Electronics

Research Experience

Xu Lab, Carnegie Mellon University *Sept 2025 – Present*

- Engineered a few-shot transfer learning pipeline by fine-tuning a 1.2B parameter spatio-temporal Transformer, pre-trained on a 100,000+ hour clinical EEG corpus. Achieved a **12%** absolute improvement in zero-shot seizure prediction, requiring **95%** less labeled data than training from scratch.
- Implemented a self-supervised contrastive learning objective during pre-training, producing a **3x** more robust latent space and reducing downstream fine-tuning convergence time by **80%** on 5 distinct neurological datasets.

Sister Nivedita University *Mar 2024 – Present*

- Designed HCAT-Net, a novel architecture for ordinal EEG emotion classification from 1D time-series data. The model integrates 1D ResNet blocks with a hierarchical Transformer encoder using Rotary Positional Embeddings (RoPE) and a cross-attention fusion layer to model multi-scale temporal dependencies. Introduced a custom Balanced Ordinal Loss function combining cross-entropy with a scaled MAE, achieving state-of-the-art results on the "EEG Brainwave Dataset" with a **99.8% test accuracy**, **100% ROC-AUC**, and a **99.7% MCC** (presented at CIACON 2025).
- Proposed a novel DNA sequence encoding technique and integrated it into a hybrid CNN-BiLSTM architecture, achieving 97.2% classification accuracy across 6 classes while reducing memory overhead and model parameters by 35% compared to traditional one-hot baselines (under review).
- Implemented CADET, a BiLSTM-based essay evaluation architecture with multi-head attention, achieving state-of-the-art performance with QWK of 0.98, MSE of 2.88, and R^2 of 0.96 on the ASAP dataset (under review).
- Engineered a Reinforcement Learning agent to optimize employee training curricula de novo, without reliance on historical data. Formulated the problem as a POMDP and implemented an Actor-Critic agent with a hybrid reward function to solve the multi-objective task of maximizing skill gain under a hard budget constraint. The optimized policy achieved an **82% success rate** and a budget overrun frequency of only **18%** in a deterministic environment, outperforming four alternative reward-shaping strategies (manuscript in preparation).
- Developed and benchmarked a novel multi-scale UNet architecture for single-image dehazing, integrating Mamba state-space models and Ghost Convolutions which achieved a **55% reduction in trainable parameters** and a significant decrease in computational load (GFLOPs) compared to baseline UNet architectures. It attained state-of-the-art (SOTA) performance on the **RESIDE-6K** benchmark dataset, while demonstrating competitive, near-SOTA results on challenging real-world haze datasets including O-HAZE, I-HAZE, and NH-HAZE, validating its efficiency and generalization capabilities (manuscript in preparation).

Indian Institute of Technology Kharagpur (Completion Certificate) *May 2025 – July 2025*

- Developed a novel Information Retrieval (IR) reranking pipeline utilizing Large Language Models with a multi-stage caching mechanism to accelerate large-scale, reproducible experiments (manuscript in preparation).
- Engineered a novel parallelism strategy that outperformed top-down partitioning and sliding window approaches by 33% and 66% respectively in inference time, while maintaining or improving core IR evaluation metrics such as NDCG@k and MAP.
- Employed High-Performance Computing (HPC) infrastructure (Param Vidya cluster) using SLURM-based shell scripts for distributed training, inference, and large-scale benchmarking.

Collaborative Research with University of Lille *Feb 2025 – Present*

- Developed a deep learning surrogate model to rapidly predict the coherent evolution of a quantum system, bypassing direct numerical integration of the Schrödinger equation. The model maps a set of Hamiltonian control parameters and an initial wavefunction to the final evolved quantum state using a feedforward architecture with batch normalization and optimized dropout regularization.
- Achieved an **R^2 of 0.94** against the ground-truth solver and demonstrated the superiority of a Huber loss function

for handling heavy-tailed error distributions in the state space.
- Conducted in collaboration with postdoctoral researchers at the University of Lille (France); manuscript currently under review.

Work Experience

Exalt.ai *Jun. 2025 – Present*

Product Engineer

- Deployed a production-scale RAG pipeline for a high-traffic news summarization service, implementing a hybrid retrieval strategy fusing BM25 sparse lexical search with dense vectors from a Faiss index, and employing a ColBERT-style re-ranker to enhance contextual relevance and mitigate hallucination.
- Fine-tuned multiple large language models (LLMs) for domain-specific tasks, including news summarization and sentiment analysis, achieving a 22% improvement in summarization accuracy and a 15% reduction in model inference time through parameter-efficient fine-tuning (PEFT) techniques.
- Implemented model quantization and distillation techniques to optimize LLM performance for edge devices, resulting in a 40% reduction in model size while maintaining 90% of the original model's performance.

Raapid.ai (Joining Letter) *Apr. 2025 – Jun. 2025*

R&D Intern

- Developed a novel deep learning model for Hierarchical Condition Category (HCC) code extraction from unstructured clinical notes, improving accuracy by 12% over the existing baseline.
- Contributed to the enhancement of a proprietary knowledge graph by implementing an automated entity-linking module, increasing data consistency and coverage by 18%.
- Optimized data processing pipelines for large-scale medical records, reducing data ingestion and preprocessing times by 25% through parallel processing and optimized query design.

Projects

Automatic Essay Grading System (SIT ICOE Hackathon Winner)

- Engineered a novel BiLSTM architecture with multi-head attention for automated essay evaluation.
- Developed custom hierarchical attention layers to improve model focus on essay coherence.
- Designed a domain-specific pre-processing pipeline for better data handling.
- Achieved state-of-the-art performance with MAE of 1.166 and QWK score of 0.674 on the ASAP dataset (n=12,978 essays).
- Outperformed previous SOTA models by 8.3% in coherence assessment metrics.

Image Enhancement using Autoencoders

- Architected a multi-scale convolutional autoencoder with sub-pixel convolution layers for single-image super-resolution.
- Incorporated skip connections for enhanced feature preservation.
- Engineered a novel hybrid perceptual loss function combining SSIM-based structural similarity metrics with deep feature representations.
- Achieved a 42.8% improvement in PSNR over traditional interpolation methods.
- Implemented advanced training optimizations, resulting in state-of-the-art performance (31.2 dB PSNR, 0.897 SSIM) on the DIV2K benchmark dataset.

Multi-Modal Face Tracking and Analysis System

- Created an end-to-end deep learning pipeline integrating VGG16 transfer learning with custom heads.
- Utilized Albumentations for data augmentation (15+ techniques) to enhance model generalization.
- Achieved real-time performance (30+ FPS) with localization accuracy of 95.2% (IoU > 0.5).
- Reduced model size by 47% through architecture optimization, maintaining efficiency.

Assistive System for Blind People (Intel OneAPI Hackathon Winner)

- Built a multi-task computer vision system for visually impaired assistance using Intel OneAPI optimizations.
- Integrated YOLOv9 for real-time obstacle detection (98.3% accuracy) and MIDAS for depth estimation (MAE $<$ 10cm).
- Used ResNet50 for Indian currency denomination recognition, achieving 99.4% accuracy.
- Achieved 25 FPS on edge devices with a 14.2MB model size and $<$ 40ms latency, demonstrating a 92% success rate in real-world testing with 50 visually impaired users.

Image-to-Music Synthesis System *Live Demo*

- Engineered a modular image-to-music synthesis pipeline by developing: (1) a multi-modal feature extractor that fuses 512-D semantic embeddings (Vision Transformer, CLIP) with quantitative color (K-means histograms), edge (Canny/Sobel), and texture (GLCM) statistics; (2) a cross-attention network to map visual features to latent

musical parameters (key, mode, tempo); (3) diffusion-based generators for chord, rhythm, and melody synthesis, constrained by rule-based music theory for harmonic coherence; and (4) a neural vocoder-style synthesizer using residual upsampling and Butterworth filtering for high-fidelity waveform generation.

- Attained sub-second encoder latency on a GPU and an end-to-end generation time of under one second per second of audio; quantified output quality by achieving high tonal consistency (±2 semitones RMSE), precise rhythmic accuracy (±5 ms timing jitter), and strong emotional alignment (¿0.85 Pearson correlation between image sentiment vectors and musical valence/arousal embeddings).

Position Of Responsibility

Core Technical Team ML Lead *Feb 2024 – Present*
Google Developer Group (GDG), SNU

- Led advanced workshops on transformer architectures and attention mechanisms, training 100+ students in deep learning implementation.
- Developed comprehensive curriculum covering PyTorch, TensorFlow, and deep learning architectures.

Machine Learning Lead (LOR) *Oct 2023 – Present*
SKEPSIS

- Led 5 research initiatives in NLP and computer vision, supervising teams of 4-6 undergraduate researchers.
- Designed and deployed a Book Recommendation System using collaborative filtering and k-means clustering, improving engagement by 20%.
- Mentored 60+ students across multiple machine learning projects, with 4 successful project completions.

Skills

Specializations: Natural Language Processing, Computer Vision, Time Series Forecasting
Programming Languages: Python, R, C, C++, SQL
Frameworks & Libraries: TensorFlow, Keras, PyTorch, scikit-learn, Pandas, NumPy, Matplotlib, Seaborn, OpenCV, SciPy, Hugging Face
Research Tools: LaTeX, MATLAB, Tableau, Power BI, Zotero, Git/GitHub

Conferences

- **9th International Conference on Data Management, Analytics & Innovation (ICDMAI)**, Participated and felicitated (ICDMAI 2025)
- **International Annual Meeting of the International Alliance of Skills Development for Belt and Road** & **BRICS Big Data and AI Working Committee**, Chongqing, China
- **IEEE International Conference on Computing, Intelligence and Application (CIACON 2025)** (Certificate), Durgapur, India — Presented paper *HCAT-Net a Novel Hierarchical Cross-Attention Transformer Network with Enriched Balanced Ordinal Loss for EEG Emotion Classification* (Record ID: 65473)

Awards and Achievements

2nd prize in the BRICS International Vocational Skills Offline Competition 2024, Shandong, China. Represented India in this prestigious competition, competing against 178 top international competitors.
Top 3 Teams Prize at the ICDMAI Offline Hackathon 2025 Competed against 1000+ teams in this prestigious event.
Best Presenter Award at IEEE CIACON 2025 Recognized for outstanding presentation of research on HCAT-Net for EEG Emotion Classification.
1st place in the SAP ICOE Hackathon 2024 Competed against 400+ teams in this prestigious event.
Selected for the India Regional Bootcamp of Google Solution Challenge 2024.
1st prize in the ML Mania Hackathon 2024, MCKV College of Engineering's Pragati 2k24.
1st place in the Intel OneAPI Hackathon 2024.
Attended and was felicitated at the 9th International Conference on Data Management, Analytics & Innovation Participated in discussions on advancements in data management and analytics.
Attended the International Annual Meeting of the International Alliance of Skills Development for Belt and Road and the **BRICS Big Data and AI Working Committee** in Chongqing, China – Participated in discussions on skills development and AI.