

# MUHAMMAD HAMZA

IIT KHARAGPUR (2023-2028) | Chemical Engineering. |  
Micro Spl. in Artificial Intelligence and Applications | Dual Degree

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LinkedIn GitHub Kaggle

## INTERNSHIPS

University of Manchester | Research Intern | Prof. Anirbit Mukherjee

Oct '25 - Present

- Researching how Deep Operator Networks (DeepONet) can be used to learn solution operators for parametric PDEs on complex geometries, with current experiments and literature review targeting performance and expressivity on spheres and torus domains.
- Studying & replicating advances in size-independent generalization bounds for DeepONet architectures, focusing on the theoretical frameworks & practical implementation to enable robust operator learning for diverse scientific modeling & simulation tasks.

University of Oulu | Undergraduate Researcher | Prof. Shuai Lee

Mar '25 - Jun '25

- Formulated and solved constrained quadratic optimization (CQP) for pruning Spiking Neural Networks (SNNs), achieving **87.5% spatial sparsity while preserving 13.3% post-pruning accuracy**, using **CVXPY** with the biologically inspired constraints
- Integrated criticality-based neuron selection into the pruning pipeline by calculating layer-wise neuron importance scores, **retaining top 112 out of total 784 neurons**, and visualizing accuracy *versus* criticality thresholds to guide structured pruning decisions
- Implemented **KL-divergence-based temporal sparsity regularization**, penalizing redundant spiking across timesteps; integrated it as a weighted constraint in the CVXPY optimizer to jointly reduce structured spatial and temporal redundancy
- Conducted experiments on MNIST and CIFAR-10 with rate encoding, benchmarking accuracy degradation under varying sparsity levels (e.g.,  $63.85\% \rightarrow 20.04\%$  accuracy as sparsity increases), and comparing SNN pruning to ANN baselines

Indian Institute of Management, Ranchi | Undergraduate Researcher | Prof. Sobhan Sarkar

May '25 - Aug '25

- Engineered a scalable, modular multimodal pipeline processing **54,000+ IMDB movie reviews** and **30,000+ movie frames from 10+ movies**, achieving best metrics of **0.875 accuracy, 0.871 F1 score, 0.884 AUC, 0.912 MAP, and 0.982 NDCG**
- Integrated **BERT text encoding, ViT visual features, and CLIP-based semantic alignment** with three different fusion strategies, benchmarking all the three models on five industry-standard metrics for robust, scalable, and cross-modal comparison
- Pioneered the **utilization of Dempster-Shafer evidential fusion** in the movie review helpfulness prediction, explicitly modeling uncertainty and **robustly outperforming attention and concatenation baselines** in retrieval & uncertainty-aware reasoning
- Automated end-to-end workflow **including data cleaning, feature extraction, semantic frame selection, model training, and ablation studies**, setting new benchmarks in scalable, explainable and multimodal review analysis for the future publications

## PATENTS AND PUBLICATIONS

C=Conference, J=Journal, P=Patent, A=Accepted, T=Thesis

[A] Muhammad Hamza, et al. (2025). **Movie Review Helpfulness Prediction using Semantic Alignment and Evidential Fusion-based Multimodal Approach** Manuscript accepted for publication in *International Joint Symposium on Artificial Intelligence and Natural Language Processing (iSAI-NLP) 2025*

## PROJECTS

ML-Driven Volatility Surface Modeling for High-Frequency NIFTY50 Options | | [GitHub] | [Dataset]

June '25

- Engineered a high-frequency options volatility forecasting pipeline on **578,000+ NIFTY50 index records**, leveraging total **100+ engineered features** to model the implied volatility surface **across 50+ strikes & maturities** using advanced ML algorithms
- Achieved an **ultra-low MSE score- 0.00009** in the Implied Volatility prediction values by integrating a sophisticated batch-wise ensemble model and strike-aware feature selection, **outperforming the standard ML baselines by over 10x in the accuracy**

Handwritten Digit Recognition with Neural Networks from scratch | [GitHub]

Feb '25

- Achieved a **test accuracy of 91.8%** and a **minimum loss of 0.007** in handwritten digit classification using a fully custom-built, modular, extensible and scalable feedforward neural network architecture completely designed and implemented from the scratch
- Engineered and optimized the training pipeline, **consistently reducing the validation loss** and improving prediction accuracy

## COMPETITIONS

NK Securities Research Hackathon 2025 | [GitHub] | [Dataset]

June '25

- **Top 200 (Global Rank: 198/6000+)** in the NK Securities Research High-Frequency Trading Hackathon by accurately and efficiently modeling per-second implied volatility (IV) for NIFTY50 options after achieving a **public MSE score of 0.0000198**
- Engineered a high-frequency volatility forecasting pipeline on **more than 178,000 actual high frequency market records**, leveraging total **90+ crafted features** to reconstruct the implied volatility surface across **50+ strikes and maturities**

Convolve 3.0: A Pan IIT AI/ML Hackathon | [GitHub]

Jan '25

- Achieved a **Top 50 rank amongst 4000+ participating teams** in IIT Guwahati Hackathon '25 by designing a high-performing, explainable loan default prediction system using XGBoost with an **advanced tuning and imbalanced learning strategies**
- Outperformed thousands of teams through a robust end-to-end ML pipeline with rigorous validation, interpretability, and scalable production-ready output generation, placing us in the Top 50 amongst more than 4000 teams in a national-scale fintech challenge

Joint Entrance Examination 2023 |

Jan '23 - June '23

- Achieved an **All-India rank 5072 (top 2.8%)** amongst **180,000+ candidates** in the Joint Entrance Examination (Advanced)
- Achieved an **All-India rank 3071 (99.74%ile)** amongst **1.2 million+ candidates** in Joint Entrance Examination (Mains)

## SKILLS

**Domains:** Machine Learning, Deep Learning, Large Language Models, Natural Language Processing, Computer Vision, Hugging Face Transformers, Multimodal Learning, Reinforcement Learning, Data Science, Data Analytics

**Frameworks & Libraries:** PyTorch, TensorFlow, Hugging Face, Scikit-learn, NLTK, OpenCV, NumPy, Pandas, Matplotlib, Seaborn

**Programming Languages:** Python, C++, C, SQL