ARITRA MUKHOPADHYAY

Student, School of Physical Sciences (SPS), NISER

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ABOUT ME

    I am an **Integrated MSc** student (Physics major, **CS minor**) at the **National Institute of Science Education and Research** (NISER). My interests lie at the intersection of **Machine Learning, Computational Physics, and Programming**. A **self-taught programmer**, I have expanded my expertise to applied ML research, particularly in physics-driven AI solutions. Currently, I am working with **Prof. Anamitra Mukherjee** on leveraging **machine learning to optimize many-body simulations**, reducing computational costs for complex physical systems.

PROJECTS & ACHIEVEMENTS

Published Papers and Microsoft Collaboration
SMLab and Microsoft Research India

📅 June 2023 - July 2024   📍 NISER

Worked on making more efficient (lottery tickets) pruned models using quaternion neural networks on large models. This led to some novel work which got published in the Northern Lights Deep Learning Conference in January 2024. On the basis of this work got to work with MSR India and built some efficient models for industrial purposes. During this time I managed to make some really efficient transformer models which resulted in a second paper which again got accepted in NLDL this year.

Won the ML4SCI Hackathon
ML4SCI Hackathon

📅 Nov 2021 - Jan 2022   📍 Online

Dominated the **Higgs Challenge** in the prestigious **ML4SCI Hackathon**, leveraging my skills in **machine learning and big data analytics** to achieve a groundbreaking **ROC AUC of 0.88** on a dataset with over 11 million data points. Pioneered an ensemble approach, combining five neural networks (NNs) and XGBoost to accurately predict the presence of the Higgs boson in this highly competitive challenge. The competition demonstrated exceptional ability in **ensemble modeling, feature engineering, and large-scale data processing**, propelling our team to first place. This victory highlights my expertise in handling complex datasets, optimizing models, and applying advanced machine learning techniques to solve real-world scientific problems. **[More]**

Machine Learning Internship
Prof. Kripabandhu Ghosh

📅 Dec 2021 - Jul 2022   📍 IISER Kolkata

PUBLICATIONS

👥 Conference Proceedings

- **A. Mukhopadhyay**, R. B. Joshi, N. Tiwari, and S. Mishra, "Transformers at a fraction," in *NLDL 2025*, 2024. [Online]. Available: https://openreview.net/forum?id=1U0kkt7ymn.
- **A. Mukhopadhyay**, A. A, and S. Mishra, "Large neural networks at a fraction," in *Northern Lights Deep Learning Conference 2024*, 2023. [Online]. Available: https://openreview.net/forum?id=xVbMj75YDD.

MOST PROUD OF

Microsoft Academic Partnership Grant (MAPG) 2023

📅 July 2023 - June 2024

Selected for the competitive and prestigious Microsoft Academic Partnership Grant (MAPG) 2023. Collaborated with leading researchers at Microsoft Research India to optimize transformer models for improved efficiency and performance, focusing on reducing computational costs while maintaining high accuracy. Gained hands-on experience in cutting-edge deep learning techniques and model optimization.

SKILLS

Machine Learning | Deep Learning | Git
Large Language Models (LLMs) | Python
Natural Language Processing (NLP) | PyTorch
Computer Vision | Applied AI | Transformers
Efficient Neural Networks | Hugging Face
Information Retrieval | Quantum Computing
Model Optimization

Problem-solving | Research-oriented
Analytical Thinking | Self-motivated
Collaboration | Innovation | Critical Thinking

Gained hands-on experience in cutting-edge **Natural Language Processing (NLP)** and **Information Retrieval** systems as part of a research-focused internship. Worked on complex algorithms for document sorting based on query relevance, optimizing search and retrieval processes across vast corpora. Enhanced understanding of various NLP techniques, including tokenization, vectorization, and semantic understanding. Developed scoring algorithms for document ranking, achieving a significant improvement in performance with a MAP score of 0.21 for the AILA dataset (previous maximum: 0.14). Contributed to several impactful advancements in **AI-driven information retrieval systems**, demonstrating expertise in **machine learning deployment** in real-world applications. **[More]**

Improvement on the Quaternion-based models: extension to larger datasets and models
Prof. Subhankar Mishra

📅 Jan - July 2023   📍 NISER, SM Lab

Investigated the Lottery Ticket Hypothesis (LTH) applied to large quaternion based ResNet models for datasets like Cifar100 and ImageNet. Demonstrated that quaternion models maintain better accuracy retention during pruning compared to traditional real-valued models. This research provides insights into improving deep learning model efficiency through advanced pruning and model compression techniques. **[More]**

Importance Sampling and Machine Learning Approach for Classical Ising Model
Prof. Anamitra Mukherjee

📅 Aug 2024 - Present   📍 NISER

Currently exploring innovative **machine learning techniques** to enhance classical statistical models, specifically the Ising Model. Focused on generating extensive lattice configurations at varying temperatures and Hamiltonians using **importance sampling** methods. The goal is to leverage **machine learning models** to predict physical quantities directly, significantly reducing the need for computationally expensive simulations. This approach aims to advance our ability to solve complex problems in **statistical physics** while optimizing computational resources. **[More]**

Quantum Cryptography Experience
Prof. Prasanta K. Panigrahi (IISER Kolkata) & Qkrishi

📅 Summer 2022   📍 IISER Kolkata

During the summer of 2022, I advanced my expertise in **quantum cryptography** through an internship at IISER Kolkata and an advanced course by **IISER Tirupati** and **Qkrishi**. My focus was on the theoretical and practical applications of **quantum key distribution (QKD)**, specifically **BB84** and **E91** protocols, to ensure secure communication in the presence of an eavesdropper (Eve). I explored both **symmetric and asymmetric key cryptography** within the quantum framework, leveraging the power of **quantum entanglement** and **superposition** to create unbreakable encryption keys. Using **Qiskit** and **Flask**, I simulated these quantum protocols and demonstrated their resilience against eavesdropping, providing an ultimate solution to classical cryptography vulnerabilities. **[QKD Project]** & **[Internship Report]**

EDUCATION

Integrated M.Sc. (Physics Major)
National Institute of Science Education and Research

📅 2020 - Present   📍 Bhubaneshwar

Higher Secondary Examination (12th)
Patha Bhavan High School

📅 2020   📍 Kolkata

WBCHSE Marks: $469_{/500}$ (93.8%)

Madhyamik Parikhsha (10th)
Patha Bhavan High School

📅 2018   📍 Kolkata

WBBSE Marks: $636_{/700}$ (90.86%)

CURRENTLY WORKING ON

📕 **Applying Machine Learning and Monte Carlo on the Classical Ising Model**
with Prof. Anamitra Mukherjee Implemented the Metropolis algorithm to solve the Ising model and study phase transitions in magnetic materials. With this data in hand, we can apply machine learning to determine various observables, bringing down computation costs.

HOBBY PROJECTS

Robotics and Autonomous Systems Development
RoboTech Club, NISER

📅 June - July 2021   📍 NISER

During my time in the **RoboTech Club at NISER**, I gained extensive hands-on experience in **electronics**, **robotics**, and **embedded systems**. I learned to program microcontrollers (such as **Arduino**) and worked with **single-board computers** for building advanced robotic systems. I also developed 3D models for robotic components using **SolidWorks**.

As the lead of the **Rover Team**, I spearheaded the project to train a rover using **reinforcement learning** and the **NVIDIA Isaac Sim** platform from **Omniverse**. This training was aimed at enabling autonomous navigation in diverse environments. Additionally, I was part of the team that built an **autonomous drone** from scratch, using **Pixhawk 4** as the flight controller and incorporating manual and GPS-guided flight modes. The drone's construction involved **aluminium box pipes**, **switchboard sunmica plates**, and **3D-printed parts**, which was an invaluable learning experience in both hardware and software integration. **[Drone Project]**