Sagar Prakash Barad

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Fifth-year (10th semester) Master's student at the National Institute of Science Education and Research (NISER), Bhubaneswar, India, majoring in Physical Sciences with a minor in Computer Sciences.

Education

National Institute of Science Education and Research — Bhubaneswar, Odisha
Int MSc (BS-MS) in Physics; ***GPA: 3.84/4.0*** — *Dec 2020 – present*
Minor in Computer Science — *Ongoing*

Delhi Public School — Sambalpur, Odisha
High Secondary Education; ***: 93.4 %*** — *June 2017 – May 2019*

Research Experience

Selective, Replay-Consolidation Memory for Robust Continual Learning — Master Thesis Project
Guide: Dr.Subhankar Mishra, School of Computer Sciences, NISER Bhubaneswar — *Semtember 2024 – Ongoing*

- **Built a memory-augmented Transformer with entropy-gated slot attention and hybrid replay (KL, latent, contrastive, prioritized, EWC, GEM) to tackle catastrophic forgetting in continual learning.**
- Achieved **93.5% accuracy** with **1.5% forgetting** on **Wikitext-103**, **LQA**, **Split-/Permuted-MNIST**, outperforming strong baselines.

Graph Reordering and Selective Pruning for Efficient Vision Models — 9th Semester Research
Guide: Dr.Subhankar Mishra, School of Computer Sciences, NISER Bhubaneswar — *Semtember 2024 – Ongoing*

- Proposed Graph Reordering and Selective Pruning (GRaSP) to prune redundant node features in GNNs, enhancing efficiency for resource-constrained systems.
- Applied GRaSP to VisionGNN, achieving significant latency reduction while retaining high accuracy on ImageNet and CIFAR-10 benchmarks.
- Demonstrated GRaSP's superiority over constrained and unstructured pruning methods for scalable vision applications, currently under review at ICCV 2025.

Local and Global State Space Models — Research Project
Guide: Dr.Subhankar Mishra, School of Computer Sciences, NISER Bhubaneswar — *June 2024 – Ongoing*

- LoGo combines Mamba's scalable, sub-quadratic memory with Transformer's perfect memory, using Mamba's hidden state as global memory for Transformers' input.
- The architecture uses Mamba-130M and GPT2-small on the wikitext dataset for next-token prediction, with a trainable adapter between models.
- Issues include impractical pre-training, tokenizer synchronization, and unstable adapter training, with solutions for some challenges but unresolved issues in training and GPT2's zero-shot performance.

Quaternion Message Parsing Neural Networks — Research Project
Collaborators: Dr.Subhankar Mishra, Dr.Rucha Joshi, and Dr.Nidhi Tiwari (Microsoft, India) — *Jan 2024 – May 2024*

- Quaternion Message Parsing Neural Networks (QMPNNs) offer greater expressiveness than their real-valued counterparts at 1/4th the parameter size.
- Verified the existence of Graph Lottery Tickets (GLTs) in QMPNNs and conducted an in-depth analysis of their pruning characteristics.
- Submitted key findings to and accepted at PAKKD 2025.

Enhancing Detection Transformers with Graph Embeddings — Research Project
Collaborators: Dr.Subhankar Mishra & Dr.Rucha Joshi (NISER Bhubaneswar) — *Aug 2023 – Dec 2023*

- Attempted a patch-wise graph node representation of images for Detection Transformers.
- Trained vision model demonstrated superior inter-patch and intra-patch representations for downstream visual tasks. Results are available here.

Adiabatic Quantum Computing with Carbon Nanotube Qubits — Research Project
Guide: Dr.Balakrishnan Ashok, CSSMP, IIIT Bangalore — *Jun 2023 – July 2023*

- Worked on double-walled carbon nanotube model as suitable qubit design, achieving successful qubit coherence and stability in simulation tests.

- Implemented and analyzed Kuramoto models to synchronize N-linked double pendulums, exploring dynamics with and without added noise.

Estimation of Electronic Band Gap Energy From Material Properties Research Project

Guide: Dr.Subhankar Mishra, School of Computer Sciences, NISER Bhubaneswar *Feb 2023 – June 2023*

- This work presents a novel architecture for predicting material band gaps and their types without encoding complex material structures or relying on DFT calculations, instead utilizing readily calculable material properties.
- Published the findings in IEEE Xplore.

Chiral Induced Spin Selectivity Spin Filter Research Project

Guide: Dr.Karthik Senapati, School of Physical Sciences, NISER Bhubaneswar *Oct 2022 – Dec 2022*

- We worked on a spin filter design that uses that uses chiral-induced spin selectivity for the filtering mechanism.
- The work included sample preparation, AFM measurements, and IV characteristic analysis.

Literature survey on synthetic antiferromagnets and skyrmions Research Project

Guide: Dr.Subhnakar Bedanta, School of Physical Sciences, NISER Bhubaneswar *May 2022 – Jul 2022*

- Read the current literature on synthetic antiferromagnets and skyrmions. Then worked on simulations for skyrmion nucleation, movement, annihilation and a racetrack memory model.

Publications

- **S. P. Barad**, S. Kumar, and S. Mishra, *Estimation of Electronic Band Gap Energy From Material Properties Using Machine Learning*, International Conference on Cognitive, Green and Ubiquitous Computing (IC-CGU), Bhubaneswar, India, 2024. [10.1109/IC-CGU58078.2024.10530748]
- **S. P. Barad**, R. Joshi, and S. Mishra, *Graph Neural Networks at a Fraction*, accepted at PAKKD 2025. [arXiv]
- **S. P. Barad** and S. Mishra, *Graph Reordering and Selective Pruning for Efficient Vision Models*, under review by ICCV 2025.
- A. K. Rajeev, J. Joseph, **S. P. Barad**, and S. Mishra, *Predicting Oligomeric States of Fluorescent Proteins using Deep Learning*, under review by CODS-COMAD.

Other Projects

FV-PINNs: Combined Kuraganov-Tamodor Flux Solver with PINNs to handle solution discontinuities, validated on Shock tube problems. GitHub

$\alpha\Omega$ **Galactic Dynamo:** Studied sensitivity of finite difference schemes on solution stability and accuracy in galactic dynamos. GitHub

Topologically Ordered States in Qiskit: Reimplemented topological ordering and ground state preparation in Qiskit, simulating systems up to 31 qubits. GitHub

Monte Carlo Analysis of Ising Models: Simulated 2D and 3D Ising models to extract critical parameters. GitHub

Quantum Dot Dynamics: Developed a simulator for quantum dot properties with real-time adjustments and validated against experimental data. GitHub

Cosmological Data Analysis: Explored data analysis pipelines, focusing on mapmaking, likelihood functions, and Fisher matrices.

Chaotic Circuits: Simulated chaotic circuits (Duffing oscillators, jerk circuits) and analyzed the impact of small parameter changes on system behavior.

Mach-Zehnder Interferometer: Implemented and analyzed laser light dynamics in a Mach-Zehnder interferometer experiment with motorized quarter-wave plate.

Awards & Achievements

- Selected for the Summer Research Fellowship under SRIP at the International Institute of Information Technology, Bangalore (2023).
- Recipient of the Academic Excellence Award, School of Physical Sciences, NISER for two consecutive years (2021–2022, 2022–2023).
- Awarded the DAE-DISHA Fellowship (2020–2025) by the Department of Atomic Energy and the Department of Science and Technology, Government of India.
- Granted the SERB Travel Grant and the PAKDD 2024 Travel Award for presenting accepted research work.
- Salutatorian Award, Delhi Public School, graduated as the top-ranked student of the class.

Skills

Programming: C, C++, Python, JavaScript, MATLAB, R

Technologies: Git, Docker, OpenCV, ROS, Arduino, Simulink, LTspice, Blender, Photoshop, Illustrator

Languages: Odia (Native), English (Professional), Hindi (Professional)

Conferences Attended

- Engineered 2D Quantum Materials, July 2024, Ramanujan Lecture Hall, IISc Bengaluru.
- International Conference on Cognitive, Green and Ubiquitous Computing (IC-CGU), Bhubaneswar, India, August 2024.
- IEEE International Conference on Machine Learning and Applications (ICMLA 2023), Attendee.

References

Dr. **Subhankar Mishra**, Reader-F, School of Computer Sciences, National Institute of Science Education and Research, Bhubaneswar, India. `smishra@niser.ac.in`

Dr. **Balakrishnan Ashok**, Faculty, International Institute of Information Technology, Bangalore, India. `balakrishnan.ashok@iiitb.ac.in`