

# Ranajoy Sadhukhan

Research Fellow, Microsoft Research India

✉ rsadhukhan900@gmail.com • 📞 +91-933-051-5315 • in LinkedIn • 🎓 Google Scholar

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## RESEARCH INTEREST

Machine Learning, Information Retrieval, Computer Vision, Natural Language Processing.

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## EDUCATION

- **Indian Institute of Technology Kharagpur** 2016-2021  
*Dual-degree(B.Tech+M.Tech) in Electrical Engineering, Specialization in Signal Processing* GPA : 9.39/10  
*Minor in Computer Science & Engineering* GPA : 9.92/10

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## PUBLICATIONS

- **Taxonomy Driven Learning Of Semantic Hierarchy Of Classes**  
by **Ranajoy Sadhukhan**, Ankita Chatterjee, Jayanta Mukhopadhyay, Amit Patra  
*In IEEE International Conference of Image Processing 2022* [Paper] [Code]
- **Knowledge Distillation Inspired Fine-Tuning of Tucker Decomposed CNNs and Adversarial Robustness Analysis**  
by **Ranajoy Sadhukhan**, Abhinav Saha, Jayanta Mukhopadhyay, Amit Patra  
*In IEEE International Conference of Image Processing 2020* [Paper] [Code]

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## RESEARCH EXPERIENCE

- **Memory-Efficient ANNS for Dense Retrieval** August '21 - Present  
*Advisors - Dr. Harsha Vardhan Simhadri & Dr. Pratyush Kumar* Microsoft Research India
  - Conducted extensive ablation studies of the existing supervised Product Quantization (PQ) based Approximate Nearest Neighbor Search (ANNS) methods on MS-Marco dataset. Identified the essential modifications that ensure MRR score comparable to full-precision one with 64x compression ratio.
  - Proposed a novel graph ANNS-adaptive PQ learning algorithm for dense retrieval to outperform the state-of-the-art memory-efficient ANNS methods at low latency regimes.
- **Improving Graph-based ANNS** Feb '22 - Present  
*Advisors - Dr. Harsha Vardhan Simhadri & Dr. Manik Varma* Microsoft Research India
  - Developed an improved index building strategy for DiskANN, a C++ based fast, scalable graph ANNS algorithm, to enable better performance on out-of-distribution queries. The proposed method offers up to 45% latency improvement over the state-of-the-art at comparable recall on 100 Million scale databases.
  - Working on jointly learning encoder model and graph-based ANNS data-structure to obtain better accuracy and efficiency in Extreme Classification tasks.
- **Depth Estimation & Panoptic Segmentation** May - July '20  
*Advisor - Pankaj Kumar Bajpai* Samsung R&D Institute Bangalore
  - Developed an efficient and light-weight Deep Neural Network for the joint task of monocular depth estimation and panoptic segmentation of road scene images. The network was subsequently compressed using structured pruning techniques to make it small enough (6 MB) for real-time operation.
  - Devised adaptive batch sampling strategy and novel ways of combining task specific losses to alleviate the issue of asymmetrically annotated datasets with an uneven number of annotations per modality.
- **Medical Image Analysis** May - July '19  
*Advisor - Dr. Mirza Faisal Beg* Simon Fraser University — MITACS Globalink Internship
  - Developed a high throughput image Quickcheck generation pipeline using bash scripting language for displaying information within CT images and to help the raters to check the images and their segmentation annotations for quality control.
  - Created a Python module for sanity checking ground truth labels of hundreds of ABACS images created by the lab volunteers, to alleviate manual analysis.

## ACADEMIC RESEARCH

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- **HSD-CNN : Hierarchically Self Decomposing CNN** Feb '20 - May '21  
*Advisor - Dr. Jayanta Mukhopadhyay* *Master's Thesis Project*
  - Developed algorithms to hierarchically decompose a pre-trained classifier network into light-weight sub-networks, suitable for limited-class applications.
  - Proposed a novel hierarchy-aware loss function for pre-training the original CNN to facilitate a semantically meaningful hierarchical decomposition. The resulting sub-networks can provide up to 4x speed-up with 75% reduction in parameters in limited-class classification tasks without requiring further fine-tuning.
  - **Published as a full paper at ICIP '22**
- **Model Compression of Deep Neural Networks** Dec '18 - Jan '20  
*Advisor - Dr. Jayanta Mukhopadhyay* *Bachelor's Thesis Project*
  - Devised a novel method for fine-tuning Tensor Decomposed CNNs based on Knowledge Distillation, providing better accuracy and robustness against white-box adversarial attacks than the state-of-the-art tensor decomposition methods.
  - **Published as a full paper at ICIP '20.**
- **Segmentation of nuclei from Pathological Images** Jun '18 - Dec '18  
*Advisor - Dr. Debdoot Sheet* *Summer Research Project*
  - Achieved an accuracy of **70.2%** in **MICCAI 2018 Challenge - Digital Pathology: Segmentation of Nuclei in Images** as per their evaluation metric (Dice coefficient - 78% and Ensemble Dice coefficient - 62.4%). Implemented a modified RelayNet architecture and pre-processing techniques like Color Deconvolution to achieve an improved Dice score of **83.2%**.
- **Prediction of Student Performance** Nov '18 - Dec '18  
*Advisor - Dr. Sudhir Kumar Barai* *Soft Computing Term Project*
  - Developed an **Adaptive Neuro Fuzzy Inference System(ANFIS)** to predict student performance based on their academic and non-academic records. The model gave an accuracy of **99.8%** on KaggleXAPI-Educational Mining Dataset.

## SOFTWARE SKILLS

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- **Programming Languages:** C/C++, Python, MATLAB, Bash
- **Libraries:** Pytorch, OpenCV, Scikit-Learn, Numpy, Pandas, OpenMP
- **Frameworks:** Git, Simulink, Ruby on Rails, LTspice

## KEY COURSES UNDERTAKEN

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- **Computer Science:** Algorithms-I, Advanced Machine Learning, Advanced Image Processing and Computer Vision, Computer networks, Computer architecture and Operating Systems.
- **Mathematics:** Linear Algebra for Machine Learning , Probability and Stochastic processes, Transform Calculus, Mathematics-I(Differential Calculus, Complex Analysis), Mathematics-II(Integral Calculus).
- **Electrical:** Analog Electronics, Digital Electronics, Embedded systems, Digital Signal Processing, Statistical Signal Processing, Analog Signal Processing, Mixed Signal Circuits and Systems on-chip.

## ACHIEVEMENTS

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- Selected for the highly decorated **Mitacs Globalink Research Internship Program** and **DAAD Research Internship Program** (2019).
- Awarded **Merit-cum-Means scholarship, IIT Kharagpur**, for academic excellence among 1400 students (2016).
- Secured an All-India-Rank of 3730 in JEE Advanced amongst 150,000 candidates (2016).
- Secured an All-India-Rank of 1457 in JEE Mains amongst 13,00,000 candidates (2016).
- Stood 4th in Advanced Mathematical Ability Test organized by **Calcutta Mathematical Society** (2015).
- Part of Bronze winning team, unit 3 at National Social Services(NSS) Annual Camp, 2016.