Sandeep Kumar **Routray**

ENGINEER | SAMSUNG RESEARCH, SEOUL

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Education

Indian Institute of Technology, Kanpur   *Kanpur, India*
BACHELOR OF TECHNOLOGY, MAJOR IN ELECTRICAL ENGINEERING WITH MINOR IN MACHINE LEARNING   *July 2017 - May 2021*
- **GPA: 9.8/10**
- Awarded **Academic Excellence Award 2017-18, 2018-19, 2019-20** Equivalent to Dean's List
- Awarded **Prof. Samares Kar Memorial Gold Medal** for the best undergraduate project in Electrical Engineering

Research Interests

Self-supervised/weakly-supervised approaches to tackle vision problems like object-centric representation learning, dense scene-level representations and understanding hierarchical relationships between objects in a scene.

Publications

CONFERENCE PROCEEDINGS

[1] Soumya Ranjan Dash[*], Sandeep Routray[*], Prateek Varshney[*] and Ashutosh Modi, "CS-NET at SemEval-2020 Task 4: Siamese BERT for ComVE", in *Proceedings of the Fourteenth Workshop on Semantic Evaluation, International Committee for Computational Linguistics (ICCL)*, Barcelona, Spain, Dec 2020. (Paper)

[2] Nitish V. Deshpande[*], Sandeep K. Routray[*] and Abhishek K. Gupta, "Spectral Efficiency in Poisson Cluster Based HetNets with Users-Basestations Correlation", in *IEEE International Conference on Advanced Networks and Telecommunications Systems (ANTS)*, Delhi, India, Dec. 2020. (Paper), (Video)

[*] *indicates equal contribution*

Research Experience

Object-centric Self-supervised Representation Learning   *Vector Institute, Canada*
RESEARCH FELLOW, **PROF. SANJA FIDLER**   *Jan 2021 - Present*
- Ongoing research on representation learning that focuses on objects: idea is based on learning object prototypes that is leveraged for constructing a contrastive loss. Also, investigating efficient ways to mine positives and negatives that takes into account the context present in an image. Early results indicate about 1% mIoU improvements over existing benchmarks.

Using Geometrical Cues for Dense Self-supervised Representation Learning   *Vector Institute, Canada*
RESEARCH FELLOW, **PROF. SANJA FIDLER**   *Aug.2020-Dec.2021*
- Proposed a framework that utilizes geometrical cues from deformed-grid representations of images and hierarchical grouping to learn dense features in a self-supervised manner.
- Attempts to train using CityScapes dataset was unsuccessful due to resource constraints and feature collapse for minor/small objects.

Minimax Optimization in Non-Euclidean Space Using Bregman Divergence
(Slides)   *IIT Kanpur, India*
UNDERGRADUATE PROJECT, **PROF. KETAN RAJAWAT**   *Aug 2020 - Dec 2020*
- Designed an $\mathcal{O}(1/k^4)$ algorithm for minimizing smooth and strongly convex functions in non-Euclidean norm space using Nesterov's Accelerated Gradient Descent Algorithm (AGD) and a clever restarting strategy.
- Designed an $\mathcal{O}(1/k^2)$ *conceptual* algorithm for smooth minimax optimization in non-Euclidean norm space using the above result.
- Proposed an *inexact* and *implementable* version of the above algorithm; but attempts at a proof of convergence was unsuccessful.

Common Sense Validation And Explanation (Paper)   *IIT Kanpur, India*
UNDERGRADUATE PROJECT, **PROF. ASHUTOSH MODI**   *Jan 2020 - May 2020*
- Designed a Siamese architecture and incorporated various transformer-based text encoders like BERT, RoBERTa, ALBERT.
- Enabled efficient inter-relational information extraction among input sentences and eliminated logical fallacies in output.
- Achieved an accuracy of 94.8% for Validation task and 89% for Explanation task. Results published in SemEval-2020.

Throughput Analysis of HetNets Using Poisson Cluster Process (Slides) (Video)   *IIT Kanpur, India*
UNDERGRADUATE PROJECT, **PROF. ABHISHEK GUPTA**   *Mar 2020 - Dec2020*
- Used Poisson Point Process (PPP) and Poisson Cluster Process (PCP) to model base stations and users correlation in a K-tier HetNet.
- Derived an expression for the Laplace Transform of the interference and used it to calculate the average throughput.
- Verified theoretical predictions using Monte Carlo simulations of throughput for special cases of Thomas and Matern Cluster Process.

Resource Allocation in OFDMA Systems Using Reinforcement Learning (Report) *Seoul, South Korea*

INTERN, SAMSUNG RESEARCH *May 2020 - Jul 2020*
- Implemented a reinforcement learning based resource scheduler using Deep Deterministic Policy Gradient (DDPG) algorithm.
- Devised two reward mechanisms to maximize throughput while maintaining QoS requirements and fairness among users.
- Achieved lower delay and better scalability than the prevalent Proportional Fair scheduler without compromising data rates.

Work Experience

Machine Learning Engineer *Seoul, South Korea*

SAMSUNG RESEARCH *Oct 2021 - Present*
- Room type detection using WiFI signal fingerprints: Designed the CNN-based backbone, data augmentation algorithms to simulate real-world-like WiFi fingerprints, extended the framework to open-world setting to handle unseen room types.
- Converting LiDAR maps to vectorized floor plans for robot vacuum cleaners: Used classic vision algorithms for line and edge detection, a variation of parallel-RANSAC and DBSCAN, ideas from 2D-graphics.

Other Projects

A Bayesian Approach to Semi-Supervised Learning *IIT Kanpur, India*

COURSE PROJECT, PROF. PIYUSH RAI *Jan 2021 - May 2021*
- Created a dataset for the study by stimulating height variations on aerial images using traditional and GAN based approach.
- Established the need for height invariancy by benchmarking the performance of YOLOv3-tiny model on the dataset.
- Augmented the base model with an adversarial domain classifier to learn height invariant features with minimal supervision.

Height Invariant Object Detection Using Unsupervised Domain Adaptation *IIT Kanpur, India*

SUMNER INTERN, PROF. VINAY NAMBOODIRI *May 2019 - July 2019*
- Created a dataset for the study by stimulating height variations on aerial images using traditional and GAN based approach.
- Established the need for height invariancy by benchmarking the performance of YOLOv3-tiny model on the dataset.
- Augmented the base model with an adversarial domain classifier to learn height invariant features with minimal supervision.

Atari Playing Agent Using Reinforcement Learning *IIT Kanpur, India*

SUMMER PROJECT, PROGRAMMING CLUB *May 2018 - July 2018*
- Studied various reinforcement learning concepts like Markov Decision Process, Monte Carlo, SARSA, Deep Q Learning (DQN).
- Designed an Atari Playing Agent which used a multi-input convolutional neural network for estimating action value of state.
- Used DQN enhanced by memory replay for training the agent and obtained human level performance for Pong game agent.

Honors & Awards

2021	**Prof. Samares Kar Memorial Gold Medal**, Best UG project in Electrical Engineering Department.	*IIT Kanpur*
2018	**Sri R&R Chari Scholarship**, Outstanding academic performance.	*IIT Kanpur*
2017-20	**Academic Excellence Award for 3 consecutive years**, Equivalent to Dean's List	*IIT Kanpur*
2017	**All India Rank 500**, Joint Entrance Exam (JEE) Advanced among 250,000 candidates	*India*
2016	**Kishore Vaigyanik Protsahan Yojana (KVPY)**, Fellowship by Indian Institute of Science and Government of India	*Banglore, India*

Relevant Courses

Machine Learning	Fundamentals of Machine Learning, Probabilistic Machine Learning, Natural Language Processing, Machine learning for Signal Processing
Optimization	Convex Optimization, Optimization Algorithms Design & Analysis
EECS Fundamentals	Data Structures and Algorithms, Signals, Systems and Networks, Digital Signal Processing, Control System Analysis, Microelectronics, Digital Electronics, Analog & Digital Communication Systems, Antenna Theory & Transmission Lines
Mathematics	Probability and Statistics, Partial Differential Equations, Complex Analysis Basics, Linear Algebra & Differential Equations

Skills

Programming Languages	Python, MATLAB, C/C++
Software/Tools	PyTorch, Keras, TensorFlow, NumPy, OpenCV, Git