Sandeep Kumar **Routray**

MACHINE LEARNING 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

Areas: Computer Vision, Self/Weakly-Supervised Learning, Scene Understanding, Reinforcement Learning
Problems: Learning actionable representations from scene images, Understanding scenes at different levels of abstraction (from pixel level up to the image level) and the hierarchical relationships among them, Challenges in working with 3D scenes, Self-supervised approaches that jointly consider synthesis and discriminative tasks.

Publications

CONFERENCE PROCEEDINGS

[1] Soumya Ranjan Dash[*], <u>Sandeep Routray</u>[*], 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[*], <u>Sandeep K. Routray</u>[*] 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

Using Image Context for 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 self-supervised feature learning framework that uses - 1) geometrical cues from 2D-mesh decomposition of image, and 2) hierarchical grouping module to discover object-part relationships.
- 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 (Report) *IIT Kanpur, India*
COURSE PROJECT, PROF. PIYUSH RAI *Jan 2021 - May 2021*
- Extended a standard latent variable model to jointly train discriminative (θ_d) and generative (θ_g) model in a Bayesian framework.
- Introduced a shared prior of form $p(\theta_d, \theta_g) = p(\theta_g)p(\theta_d|\theta_g)$ to couple discriminator and generator, training done using ELBO loss.

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