

# 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

## Interests

**Areas:** Deep Learning, Machine Learning, Computer Vision, Self/Weakly-Supervised Learning, Reinforcement Learning

## 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

### Exploring Inter-Image Relationships for Object-centric Self-supervised Learning

Vector Institute, Canada

RESEARCH FELLOW, **PROF. SANJA FIDLER**

Jan 2021 - Present

- Ongoing research on extracting object-centric features by learning prototypes that is leveraged for constructing a contrastive loss.
- Proposed an image-context aware method to mine positive/negative prototypes from a set of images. Early results indicate about 1% mIoU improvements over existing benchmarks. Aiming to publish our results in ICCV.

### Joint Learning of Dense Representations And Object-Part Relationships

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

IIT Kanpur, India

([Slides](#))

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 - Dec 2020

- 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

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### Machine Learning Engineer

SAMSUNG RESEARCH

- 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.

Seoul, South Korea

Oct 2021 - Present

### Research Fellow

VECTOR INSTITUTE OF ARTIFICIAL INTELLIGENCE

Toronto, Canada

Aug 2020 - Aug 2021

### Intern

SAMSUNG RESEARCH

Seoul, South Korea

May 2020 - Jul 2020

## Other Projects

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### A Bayesian Approach to Semi-Supervised Learning ([Report](#))

COURSE PROJECT, PROF. PIYUSH RAI

- Extended a standard latent variable model to jointly train discriminative ( $\theta_d$ ) and generative ( $\theta_g$ ) 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.

IIT Kanpur, India

Jan 2021 - May 2021

### Height Invariant Object Detection Using Unsupervised Domain Adaptation ([Report](#))

SUMNER INTERN, PROF. VINAY NAMBOODIRI

- Created a dataset for the study by stimulating height variations on aerial images using traditional and GAN based approach.
- Established the need for height invariance 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.

IIT Kanpur, India

May 2019 - July 2019

### Atari Playing Agent Using Reinforcement Learning

SUMMER PROJECT, PROGRAMMING CLUB

- 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.

IIT Kanpur, India

May 2018 - July 2018

## Honors & Awards

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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 (KVPPY)**, Fellowship by Indian Institute of Science and Government of India

Bangalore, India

## Relevant Courses

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### 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 & Algorithms, Signals, Systems and Networks, Digital Signal Processing, Control System Analysis, Microelectronics, Digital Electronics, Analog & Digital Communication Systems, Antenna Theory and Transmission Lines

### Mathematics

Probability and Statistics, Partial Differential Equations, Complex Analysis Basics, Linear Algebra, Differential Equations

## Skills

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### Programming Languages

Python, MATLAB, C/C++

### Software/Tools

PyTorch, Keras, TensorFlow, NumPy, OpenCV, Git