

Kushagra Pandey

Kanpur, Uttar Pradesh, 208017, India

✉ kushagrap20@iitk.ac.in | 🏠 kpandey008.github.io/ | 📧 kpandey008 | 📺 kushagra-pandey-008

Education

Indian Institute of Technology (IIT), Kanpur

M.TECH IN COMPUTER SCIENCE AND ENGINEERING

CPI: 10.0 / 10.0

Kanpur, India

Sept. 2020 - May. 2022 (Expected)

Indian Institute of Technology (IIT), Bhubaneswar

B.TECH IN ELECTRICAL ENGINEERING

CGPA: 8.87 / 10.0

Bhubaneswar, India

July. 2012 - May. 2016

Broad Research Interests

Scalable Bayesian Inference and Bayesian Deep learning, Unsupervised representation learning, Deep Generative Models and their applications in Computer vision and Computational genomics

Research Publications

VAEs meet Diffusion Models: Efficient and High-Fidelity Generation

Kushagra Pandey, Avideep Mukherjee, Abhishek Kumar, Piyush Rai

NEURIPS 2021 WORKSHOP ON DEEP GENERATIVE MODELS AND DOWNSTREAM APPLICATIONS

Oral Presentation (8 out of 40 accepted papers)

Inference of cell state transitions and cell fate plasticity from single-cell with MARGARET

Kushagra Pandey, Hamim Zafar

PREPRINT (SUBMITTED TO NATURE METHODS)

DOI: <https://doi.org/10.1101/2021.10.22.465455>

Research Experience

Improved sample fidelity and synthesis using VAE's

GRADUATE THESIS | SUPERVISOR: DR. PIYUSH RAI

IIT Kanpur

July 2021 - Present

- Working on improving the sample quality of VAE's by utilizing multi-stage approaches for image synthesis.
- Understanding the fundamental problems underlying the poor reconstruction quality of non-hierarchical VAE's and the need for large latent code size in VAE's in general.

Elucidating cellular dynamics using Metric learning and Deep generative models in single-cell RNA-seq data

RESEARCH ASSISTANT | SUPERVISOR: DR. HAMIM ZAFAR

IIT Kanpur

December 2020 - Present

- Working on developing a deep generative model for joint analysis of transcriptomes and epitopes generated from CITE-seq
- Developed MARGARET: a deep unsupervised metric learning-based algorithm for trajectory inference in fundamental biological processes like cell differentiation using single-cell RNA-seq data.

Visual Surveillance using Unmanned Aerial Vehicles

UNDERGRADUATE THESIS | SUPERVISOR: DR. DEBI PROSAD DOGRA

IIT Bhubaneswar

Sep 2015 - May 2016

- Developed an algorithm for real-time detection and tracking of road segments from aerial imagery captured using Unmanned Aerial Vehicles.
- Developed a sparse coding based model for detecting abnormal events in crowd-surveillance videos.

- Designed a vibrotactile module based on the Arduino platform for assisting people with sensory impairments.
- The module converts speech or text signals to a vibration pattern that emulates Braille which the users can interpret.

Academic achievements

- Currently ranked 1st in a cohort of 100 students in the CSE department at IITK. Received the Academic Excellence Award, 2020-2021 for the same (Awarded to top 10% students).
- Secured 36th All India Rank (AIR) in the Nationwide Education Scholarship Test (NEST-2013)
- Cleared IIT-JEE 2012 entrance with an overall standing within the top 0.7% of total participating students.

Academic / Research Projects

Conditional text to image generation using Hierarchical VAEs

*Course: Statistical NLP*FRAMEWORK: PYTORCH | CODE: [HTTPS://GITHUB.COM/KPANDEY008/HVAE-G2V](https://github.com/KPANDEY008/HVAE-G2V)

- Proposed a model for conditional image generation from text sequences using hierarchical VQ-VAE
 - Performed an extensive literature survey of language grounding to vision.
 - Implemented a hierarchical conditional VQVAE and proposed a novel attention mechanism for grounding textual and image representations in the conditional VAE and benchmarked on the CUB200 dataset.

Hindi to English Neural machine translation

*Course: Statistical NLP*FRAMEWORK: PYTORCH | CODE: [HTTPS://GITHUB.COM/KPANDEY008/HIN2ENG-NMT](https://github.com/KPANDEY008/HIN2ENG-NMT)

- Designed and developed an end to end Hindi to English neural machine translation system.
 - Developed a data-preprocessing / cleaning pipeline for hindi and english text datasets.
 - Proposed a novel dual attention mechanism in the standard transformer architecture.
 - On an in-house competition, the proposed model achieved a BLEU score of 0.1428 and was ranked 3rd out of around 100 submissions.

Advanced Emergency Braking System in CARLA

*Course: Embedded and Cyber physical Systems*FRAMEWORK: PYTORCH, KERAS, CARLA | CODE: [HTTPS://GITHUB.COM/KPANDEY008/CARLA-AEBS](https://github.com/KPANDEY008/CARLA-AEBS)

- Developed an Advanced Emergency Braking system (AEBS) in CARLA to study the impact of Out of distribution samples in a learning-enabled controller (LEC). The core contributions included:
 - Extracting data from the CARLA simulator and training a CNN for estimating distance between two cars.
 - Training an RL agent using the DDPG algorithm to estimate the appropriate braking signal given an estimated distance and car velocity.
 - Implementing a Martingale based statistical test by training a VAE on in-distribution samples so as to detect out of distribution samples.

Predicting Drug Resistance in Mycobacterium Tuberculosis (MTB)

Course: Computational Genomics

FRAMEWORK: PYTORCH | CODE: PRIVATE

- Developed a novel multi-task model to predict the resistance of Mycobacterium tuberculosis (MTB) towards several first and second line drugs commonly used for treating tuberculosis.
- The proposed model achieved the best prediction rates in 7 out of 10 drugs among all the submissions in an in-house competition.

Implementation and Ablation analysis of GAN architectures

*Research Project*FRAMEWORK: PYTORCH | CODE: [HTTPS://GITHUB.COM/KPANDEY008/COMPARING-GANS](https://github.com/KPANDEY008/COMPARING-GANS)

- Implemented GAN models including DCGAN, WGAN, WGAN-GP, and LSGAN and performed an experimental study on several aspects of GAN training.
- Benchmarking the implemented models on MNIST, Fashion-MNIST and KMNIST.
- FID was used as a quantitative measure to compare different GAN architectures. The different criterion analyzed were:
 - Sample Quality
 - Analysis of fine-tuning in GAN architectures
 - Role of different architectural considerations like activation functions.

Abnormal Event detection with Real time performance

Undergraduate thesis

FRAMEWORK: OPENCV (C++) | CODE: [HTTPS://GITHUB.COM/KPANDEY008/ABNORMAL-EVENT-DETECTION](https://github.com/KPANDEY008/ABNORMAL-EVENT-DETECTION)

- Implemented a Sparse coding model in C++ to detect abnormal events in surveillance videos.
- The implementation is based on the paper “Abnormal Event Detection at 150 FPS in MATLAB” by C. Lu et al.
- Benchmarked the model on the Avenue Dataset and reproduced the paper results.

Road Detection and Tracking using Aerial Road Imagery

Undergraduate thesis

FRAMEWORK: OPENCV (C++) | CODE:

[HTTPS://GITHUB.COM/KPANDEY008/ROAD-DETECTION-AND-TRACKING](https://github.com/KPANDEY008/ROAD-DETECTION-AND-TRACKING)

- Used GrabCut segmentation to detect road segments in the starting frame of a video depicting aerial road imagery.
- Developed a methodology to track this initial road segment in subsequent frames using a KLT Tracker. This obviates the need for applying segmentation to each frame thus making the method real-time.
- We improved upon the detection results in the paper “Efficient Road Detection and Tracking for Unmanned Aerial Vehicle” by Zhou et al. with a tracking rate of 30 FPS.

Relevant Coursework

- | | | |
|--|-------------------------------|---|
| • Computational Genomics A* | • Statistical NLP | • Computational Intelligence |
| • Introduction to Machine Learning A* | • Special Topics in Comp. Sc. | • Image and Video Processing Ex |
| • Cyber Physical Systems | • Pattern Recognition | • Programming and Data Structures Ex |
| • Prob. Modelling and Inference | | |

Ex, A* - TOP 1%

Engineering Experience

Lexent Bio Inc. (Now acquired by Foundation Medicine)

Hyderabad, India

MACHINE LEARNING ENGINEER

Jun. 2018 - May. 2020

- Co-developed a scalable platform to run data science pipelines for analysis of DNA sequencing data and extracting relevant features like Copy Number Aberration(CNA) and Methylation levels in cfDNA.
- Developed and maintained a data warehouse-like framework for integrating and storing clinical data from multiple data sources like Airtable and OpenClinica.

Technical Skills

Programming	Python, LaTeX, C
DevOps	Docker, Kubernetes, Terraform, Git, Luigi, Postgres
Cloud Platforms	Google Cloud Platform (GCP)
Frameworks	Tensorflow, PyTorch, Keras, OpenCV, Django

Teaching Experience

Embedded and Cyber Physical systems (CS237)

IIT Kanpur

TEACHING ASSISTANT

July 2021 - Present

- Core responsibilities include designing and grading course assignments.

Fundamentals of Computing (ESC101)

IIT Kanpur

TEACHING ASSISTANT

Nov 2020 - May 2021

- Core responsibilities included conducting first-year undergrad labs, quizzes and grading lab solutions.

Programming and Data Structures

IIT Bhubaneswar

TEACHING ASSISTANT

Jul 2015 - Dec 2015

- Served as a Teaching Assistant (TA) for the course Programming and Data Structures where I mentored first-year undergrads during weekly 3-hour lab sessions.