Shubhang Bhatnagar

shubhangb97@gmail.com | https://shubhangb97.github.io ↗ | LinkedIn

EDUCATION

University of Illinois Urbana-Champaign *(Aug '21- Present)*
Ph.D. student in Electrical and computer engineering,   Advisor: Prof. Narendra Ahuja
Research Area: Computer Vision and Machine Learning

Indian Institute of Technology, Bombay *(Jul '16- Jul '21)*
Dual Degree (B.Tech + M.Tech) Electrical Engineering, Specializing in Signal Processing, Minor in CS
Thesis: Label Efficiency in Deep Learning   Advisor: Prof. Amit Sethi
GPA 9.81/10,   Institute Silver medal, Department Rank 1/72,

Nanyang Technological University, Singapore *(Jul '19- Dec '19)*
GPA 4.82/5, TFLearn Funded Semester Exchange Program in Electrical Engineering

PROFESSIONAL EXPERIENCE

HP Inc, CA | ML Research Intern | Adv: Dr. Kar-Han Tan *(May '24 - Current)*

- Worked on an edge-device inference engine for Multimodal LLMs. Reduced model size by 50% (vs 4-bit) using a novel hybrid 2 bit quantization without severe loss of performance. Deployed prototype system to run in real-time on a edge device using llama, bitnet cpp frameworks, with upto 10x speedups on limited RAM devices.

Bosch Research, CA | Comp. Vision & Mixed Reality intern | Adv: Dr. Sharath Gopal *(May '22 - Aug '22)*

- Designed, implemented, and demonstrated a long distance **gesture recognition** system to interact with and control mobile robots, achieving state-of-the-art recognition accuracy on the LD-ConGR dataset while **reducing model** size by 40% using a novel **spatially dynamic** 3D neural network (presented at **IROS'23**). **US Patents** under review (18/068,091 & 18/068,118) .

Qualcomm | Modem Firmware Intern *(May '19 -Jul '19)*

- Developed a tool to help optimize modem firmware for chipsets by **analyzing data** and automating multiple tasks, with the tool being eventually deployed on 50+ workstations for the team

Decimal Point Analytics | Computer Vision intern *(Jun '18- Aug '18)*

- Worked on designing a **CNN** based product to estimate household income from photos by recognizing objects of interest.

KEY RESEARCH PROJECTS

Potential Field based Metric Learning, [project page] , *Under Review*   *Prof. Narendra Ahuja, UIUC*

- Proposed a continuous potential-field representation to model the influence of embeddings as opposed to discrete n-tuplet/ contrastive models used in embedding learning. Proved that such a potential field forms a better model of the data distribution than previous methods, helping learn better **representations for visual search** while being more robust to **label noise**. Significantly reduced error on zero-shot image retrieval benchmarks **by more than 10**% compared to **SOTA**.

Improving Multi-label Recognition using Co-Occurrence , [project page] , *CVPRw '24, ICPR'24 (Oral)*   UIUC

- Developed an approach to extend vision-language models (VLMs) for multi-label recognition by modeling class co-occurrences; designed a Graph Convolutional Network (GCN) to enforce conditional probabilities between object pairs on VLM output logits, achieving state-of-the-art performance on four MLR datasets

Piecewise-Linear manifolds for Deep Metric Learning [project page], *PMLR, CPAL '24 (Oral)*   UIUC

- Proposed an **unsupervised framework** to learn a semantically meaningful embedding space for a given dataset by finetuning pretrained models. By using a piecewise linear model to model the neural data manifold, we identify images with similar content with **50% better accuracy** than current SOTA methods. Representations learned established a new **SOTA** on unsupervised zero-shot retrieval benchmarks.

Long-Distance Gesture Recognition using Dynamic Neural Networks [project page], *IROS '23*   UIUC, Bosch

- Proposed a **novel dynamic neural network** to enable gesture recognition from long distances by identifying and processing only gesturing subject features. Outperformed **SOTA** in terms of recognition accuracy while using **40% lesser compute**.

PAL - Pretext Based Active Learning [paper][slides], *BMVC '21*   *Masters Thesis, IITB*

- Proposed a **technique** to estimate the novelty of a sample for a given model by using self-supervision to augment task-specific uncertainty leading to a better and more diverse selection of samples for active learning. Required 15% less labeled data than **state-of-the-art** techniques to achieve the same performance on classification and semantic segmentation.

Efficient Music Conditioned Dance Motion generation   *Prof. Liangyan Gui*, UIUC *('22)*

- Proposed a multi-modal spatiotemporally **separable GCN** to generate human dance poses conditioned on music using the AIST ++ dataset. The proposed model used **10x fewer parameters** than SOTA while still being competitive in generation quality.

Robust CV in Compressed Sensing [paper] [slides] [arxiv], *EUSIPCO '21*   *Prof. Ajit Rajwade, IITB*

- **Proposed a novel technique** for selecting parameters using the L1 **cross-validation (CV)** error and **theoretically proved** it yields optimal reconstruction in presence of noise demonstrating **order of magnitude gain** over other techniques empirically

Noise Tolerant QR Code Recognizer using Hopfield Network [pre-print]   *(IITB, '18)*

- Proposed a **novel technique** to use Hopfield networks in **parallel** using the **energy gradient difference** around trained and false energy minima, providing a method to deal with applications requiring large storage capacity, like QR code denoising.

PUBLICATIONS

- **Potential Field Based Deep Metric Learning** [preprint][project page],
  S. Bhatnagar, Narendra Ahuja, *Under Review*

- **Rethinking Prompting Strategies for Multi-Label Recognition with Partial Annotations** [paper][project page],
  S.Rawlekar, **S. Bhatnagar**, Narendra Ahuja, **WACV 2024**

- **Improving Multi-label Recognition using Class Co-Occurrence Probabilities** [paper][project page],
  S. Bhatnagar*, S.Rawlekar*, Narendra Ahuja, in **CVPRw 2024, ICPR 2024 (Oral Top-5%)**

- **Piecewise-Linear Manifolds for Deep Metric Learning** [paper][project page],
  S. Bhatnagar, Narendra Ahuja, in **PMLR Vol 234, CPAL 2024 (Oral)**

- **Long-Distance Gesture Recognition using Dynamic Neural Networks** [paper][project page],
  S. Bhatnagar, S. Gopal, N. Ahuja, L. Ren, in **IROS 2023**

- **Insights on coding gain and its properties for principal component filter banks** [paper],
  P. Chaphekar, A. Bhatia, **S. Bhatnagar**, et al., Sādhanā , Journal of the Indian Academy of Sciences, 2023

- **PAL - Pretext Based Active Learning** [paper],
  S. Bhatnagar, S. Goyal*, D. Tank*, A. Sethi, in **BMVC 2021**

- **Analyzing Cross Validation in Compressed Sensing with Gaussian and Impulse Measurement Noise with L1 Errors** [paper], **S. Bhatnagar***, C. Gurjarpadhye*, A. Rajwade, in **EUSIPCO 2021**

- **Memory Efficient Attention For Multi Domain Learning** [preprint],
  H.Aswani, A.Kanse, **S.Bhatnagar**, A.Sethi, Arxiv Preprint, 2021

- **QR Code Denoising Using Parallel Hopfield Networks** [preprint],
  S. Bhatnagar *, I. Bhatnagar *, Arxiv Preprint, 2018

denotes that these authors contributed equally

HONORS AND AWARDS

- **Institute Silver Medal**, IIT B for graduating at the top of my batch ('21)
- **Institute Award** for **academic excellence**, IIT B (twice) ('18,'20)
- **INSPIRE** scholarship, Govt of India for being in top 1% of class 12 ('15)

- **Bhavesh Gandhi memorial award** given to most outstanding student in EE IITB ('21)
- **Temasek Foundation TFLearn** fellowship ('19)
- **KVPY fellowship** awarded by Govt of India with All India Rank 93 ('13)

TECH SKILLS

Python, Pytorch, Llama cpp, HF Transformers, Diffusers, Pytorch Lightning, Java, MATLAB, C, C++, ROS

KEY COURSES

Computer Vision	Computer Vision • Efficient and Predictive Vision • Digital Image Processing • Advanced Image Processing
ML & Optimization	Intro to Machine Learning • Stochastic Optimization • Deep Learning Theory • Advanced Signal Processing • Pattern Recognition
Math & Statistics	Markov Chains • Calculus • Probability and Random Processes • Linear Algebra • Vector Space Signal Processing
Electrical Engineering	Microprocessors • Audio Signal Processing • Information Security • Digital Signal Processing • Digital Communication
Computer Science	Computer Networks • Operating Systems • Data Structures and Algorithms

SERVICE

- **Reviewer** for ICPR '20 ; CVPR '22, '23, '24; NAACL '24; NeurIPS '24; ICLR '24
- Graduate Teaching Assistant @ Math, EE IIT Bombay   *('18,'20,'21)*