SHIVAM UTREJA

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AREAS OF INTEREST

Artificial Intelligence | Machine Learning | Computer Vision | Natural Language Processing | Data Mining | Algorithms

SELECTIVE PROJECTS

Computer Vision

Identifying Tennis Actions from Video — *Tools: Python, Tensorflow, OpenCV*

- Implemented variations of recurrent and convolutional neural architectures for fine-tuned action classification in tennis, just using the player's video. Achieved **best average accuracy of 60%** across 12 tennis strokes.

Real Time Sentiment Analysis — *Tools: Python, OpenCV, Tensorflow*

- Designed a machine learning algorithm that uses a **convolutional neural network to detect the emotion** of a facial image input. The output is one emotion out of a set of 7 possible emotions. Best performance achieved was a **top 2 precision of 71%**.

Image Stitching — *Tools: Python, Scipy/Numpy, OpenCV*

- Implemented an image stitching method which first, detects keypoints in the two images using a blob detector and SIFT features. It then uses these keypoints to perform the RANSAC algorithm, which estimates the best affine transform between the pairs of images.

Optical Character Recognition — *Tools: Python, Pytorch*

- Compared the performance of several handcrafted features (Pixel, Histogram of Gradients, Local Binary Patterns) against CNN on MNIST dataset classification. Achieved best accuracy of 92% with CNN, using only 1000 training images.

Photometric Stereo — *Tools: Python, Scipy/Numpy*

- Implemented an algorithm that generates the 3D surface of a face, using its 2D images as input.

Image Denoising with Neural Nets — *Tools: Python, Pytorch*

- Implemented an encoder-decoder like neural architecture to remove noise from an input image. The mean squared error reduced to one-third(or better) of its original value in all cases.

Deep Learning & Neural Networks

One Shot Learning — *Tools: Python, Pytorch*

- Implemented variations of **Siamese networks** and **Matching networks** for one-shot learning on the Omniglot and MNIST datasets. Achieved **best accuracy of 85.63%** on 20-way one-shot learning task, using the matching network architecture.

3D Surface Reconstruction — *Tools: Python*

- Implemented a neural network that reconstructs the object surface with **high visual fidelity** given a set of input points from the surface; by learning to predict the signed distance function.

Network Visualization & Fooling Neural Nets — *Tools: Python, Scipy, Pytorch*

- Implemented neural network visualization techniques such as saliency maps and class visualization, in Pytorch.
- Also implemented algorithms that generate images which can fool a state-of-the-art neural network classification model.

Style Transfer — *Tools: Python, Scipy/Numpy, Pytorch*

- Implemented an algorithm that regenerates an input image in the style of an input painting. This method can potentially be used to create a wide variety of image filters.

Generative Adversarial Networks (GANs) — *Tools: Python, Scipy/Numpy, Pytorch*

- Implemented vanilla GAN, and its more nuanced variations. Used these networks to generate realistic handwritten digit images. This method can be extended further to create realistic facial images.

EDUCATION

M.S. in Computer Science

University of Massachusetts, Amherst

Sept'19 – May'21

GPA: 3.66/4.0

Coursework: Reinforcement Learning | Computer Vision | Neural Networks | Machine Learning | Mobile Computing | Artificial Intelligence | Algorithms for Data Science | Applied Information Retrieval | Advanced Natural Language Processing | Intelligent Visual Computing

B.Tech. in Electrical Engineering

Indian Institute of Technology, Kanpur

June'15 – May'19

GPA: 8.8/10.0
Graduated with Distinction.
Minor in **Machine Learning** & Applications.

Coursework: Data Mining | Image Processing | Convex Optimization | Probabilistic Machine Learning | Datastructures & Algorithms | Game Theory & Mechanism Design

TECHNICAL SKILLS

Languages: Python | C | LaTeX | Java | MATLAB

Libraries: Scipy | Pytorch | Tensorflow | OpenCV | Transformers | Scikit-learn

Tools: Android Studio | Unity | Anaconda

ACHIEVEMENTS

- **Academic Excellence Awardee** for 2015-16 and 2016-17, at IIT Kanpur.
- **All India Rank 535** in Joint Entrance Examination (IITJEE-Advanced) amongst 875,000 participants. 2015
- Participant at the **National Science Camp** [VIJYOSHI] at **IISc Bangalore**. 2014
- Received the **Young Scientist Award** (KVPY Scholar, Stream SA) for ranking amongst **top 0.01%** all over India. 2013
- Received the **National Talent Scholarship** (NTSE) for ranking in the **top 1000 amongst 900,000** participants. 2013

SELECTIVE PROJECTS

Natural Language Processing

Multimodal Sentiment Classification *Tools: Python, Pytorch, Transformers*
- Experimented with several state of the art unimodal and multimodal neural nets to identify sentiment using both, visual and textual modalities. Achieved 70.42% accuracy on hateful meme detection and 88.25% on sarcastic tweet detection (using ViLBERT and MMBT respectively).

Image Captioning *Tools: Python, Scipy/Numpy*
- Implemented Vanilla RNN and LSTM networks in python, that artificially generate captions for input images.

Coherent Story Generation *Tools: Python, NLTK library*
- Implemented **statistical machine translation** and **plot graphs method** for generating a coherent story from given independent plot points. The method using plot graphs performed much better, but the context of stories was very limited.

Visual Question Answering *Tools: Python, Pytorch, NLTK*
- Implemented a method which builds separate graphs over image objects and question words; and then **trains a neural network over these graphs** for visual question answering.

System Design & Mobile Computing

Information Retreival System *Tools: Python*
- Implemented all major components (Inverted Index, Retrieval Model, Inference Network) of an Information Retrieval System from scratch.

Social Distancing App *Tools: Android Studio*
- Designed an Android app that combines GPS and Bluetooth information to help the user identify surrounding regions of high human density.

Indoor User Localization *Tools: Python, Scipy/Numpy*
- Predicted user-path in an indoor environment using UWB Radar data from 3 stationary sensors.

Breathing Rate Estimation *Tools: Python, Scipy/Numpy*
- Predicted a stationary subject's breathing rate in an indoor environment in several different postures, using UWB radar data.

Human Activity Recognition *Tools: MATLAB, Python*
- Developed a real-time activity recognition system, that classifies different physical activities like walking, using the elevators, running etc. using various smartphone sensors.

High Confidence Policy Improvement (HCPI) *Tools: Python, Pycma library*
- Implemented the HCPI algorithm in python from scratch. The algorithm produces a new set of policy parameters just using data generated from an older policy. The **new policy is better** with 95% probability.

Miscellaneous

Scaling Mixed Membership Stochastic Blockmodels to Large Datasets
- Explored both, the generative story and inference methods for this probabilistic model for relational data. Also attempted scaling this method to large data-sets by exploring graph sub-sampling techniques and nested variational inference.

Majorization-Minimization in Large Scale ML *Tools: Python, Scipy/Numpy*
- Performed **theoretical convergence analysis** of Incremental Majorization-Minimization for machine learning problems. **Implemented** the same for both, **convex and non-convex** objective functions.

Localization in Wireless Sensor Networks
- Performed a literature survey of the various state-of-the-art techniques for wireless sensor netowrk localization. Compared and contrasted methods that used physical network coding, with those that utilized deep learning for sensor localization.

Sarsa and Q-learning *Tools: C++*
- Implemented the above two policy improvement algorithms for an unsupervised intelligent agent interacting with its environment.

INTERNSHIPS

Summer Research Intern

Dept. of Computer Science & Automation, Indian Institute of Science.

May'17 – July'17 Bangalore, India

- **Designed an efficient data structure** for 3-dimensional range counting queries. Both, worst case query time complexity and amortized update time complexity, **improved by a factor of** $(lglgn)^2$.
- The **space requirement improved** to $O(nlgn)$ space.

EXTRA CURRICULARS

Student Guide

Counselling Service, IIT Kanpur

July'16-May'19 Kanpur, India

- Was in charge of helping six students from a junior batch to adjust with the college lifestyle, especially in their freshmen year. This included everything from academics to social life at college.

Video Jockey & Core Team Member

Vox Populi, IIT Kanpur

Aug'15-April'17 Kanpur,India

- Held the pivotal role of video jockey as part of the video division of IIT Kanpur's campus news body, Vox Populi. Major events covered include the Inter-IIT Sports Meet 2016 and Orientation Program 2016.
- As core team member, I was involved in the major decision making regarding the plans for the video division.

Videographer

Media & Publicity Team, Antaragni'15

Aug'15-Oct'15 Kanpur, India

- Part of the videography team, covering various events during the college's annual cultural festival.
- Performed video coverage of seven different events over the course of four days.