Nikhil Shah

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Education

Bachelor of Technology (Hons.) in Computer Science — **Graduating 2021**
Indian Institute of Technology Kharagpur, West Bengal, India — *GPA 9.02/10 (after 7 semesters)*

Publications

- Hassani, A., Walton, S., **Shah, N.**, Abuduweili, A., Li, J., Shi, H. (2021). "Escaping the Big Data Paradigm with Compact Transformers." arXiv e-prints, arXiv:2104.05704. (*Submitted to NeurIPS 2021*)
- **Shah. N**, Singhal A., Singh. C, Khandelwal. Y, "Model-agnostic information biasing for Visual Question Answering.", *ACM CODS-COMAD 2021*

Experience

Amazon, Bangalore — **Research Internship**
Advisor: ***Dr. Vineet Chaoji*** — *May 2021 - August 2021*

University of Oregon, USA — **Research Internship**
Advisor: ***Prof. Humphrey Shi*** — *April 2020 - April 2021*

Worked on supervised representation learning in visual and linguistic domains. Learned how to identify a research problem and approach it's solution in a systematic manner. Grew from a beginner to expert in using PyTorch. Submitted a research paper to the NeurIPS conference. The projects that I worked on during this internship are listed as follows.

Compact Convolutional Transformers — ***Github*** | ***Experiments***

- Developed a compact vision transformer model to dispel the myth that transformers are data hungry
- Extended the ViT using a conv block to inculcate the inductive biases and to eliminate the positional embeddings
- Replaced the [CLS] token in ViT with a sequence pooling method to further increase the accuracy by 1+% on CIFAR10

Internal Knowledge Distillation — ***Github*** | ***Experiments***

- Devised a multiple branch strategy to enforce implicit knowledge distillation in CNNS via selective backpropagation
- Improved the performance of ResNet50 on the CIFAR100 dataset by 1+% using internal knowledge distillation from ResNet101. Single training procedure makes our method much more efficient than the existing methods

Adaptive Transfer Learning — ***Github*** | ***Experiments***

- Implemented several existing adaptive transfer learning techniques for V&L transformers – VLBERT and LXMERT
- Developed a novel method for adaptively choosing pre-trained attention heads for finetuning via a policy network
- Reduced the generalization errors by 5% for VLBERT and by 7% for LXMERT, measured on the VQAv2 benchmark
- Proposed a global decision variant of the above, reducing the parameters by upto 50% with minimal drop in accuracy

CERN, Hong Kong — **Research Internship**
Advisor: ***Dr. Hok-Chuen Cheng*** — *Feb. 2020 - June 2020*

Developed efficient learning algorithms for identification of Tau-Leptons from Hadronic decay in the ATLAS experiment

- Setup the ATLAS environment in a Singularity container over a GPU cluster, after dealing with several data handling and machine learning frameworks natively developed at CERN such as Scientific Linux for CERN, ROOT, LWTNN etc.
- Reduced the training time of existing algorithms – recurrent neural networks based ensembles – five folds by efficient data handling through caching, effective parallelization and multi-GPU distributed training
- Developed an attention based pipeline to model correlations between particle energy-momentum measures from different time-stamps. Created a two-stream transformer architecture to separately model Track and Cluster measures

Department of CSE, IIT Kharagpur — **Bachelor's Thesis**
Advisor: ***Prof. Abir Das*** — ***Report*** | ***Presentation*** | *May 2020 - April 2021*

Task: Improve visual grounding in VQA methods via a teacher-student attention transfer method leveraging answers

- Utilised an augmented form of answer to ground relevant regions in an image which make for the teacher attentions
- Proposed a teacher-student attention transfer framework – pre-training the teacher network and transferring attentions using an auxiliary loss over the student and teacher attention maps. The teacher branch is removed at the test time
- Experimented with several choices of the loss term – L1, L2, BCE loss over a discriminator, contrastive loss etc.
- Achieved improvement of +0.95% and +0.57% on the VQAv2 dataset for the base models MFB and BAN respectively

Entrepreneurial Experience

FrostLabs **Research Based Startup**
Co-Founder, Head of Reasearch *October 2019 - April 2020*
Early-stage startup that develops solutions to commonplace problems by bridging the gap between state of art Machine Learning Research and consumer products along with fundamental research for novel, robust and deployable models

Model-Agnostic Information Biasing for VQA ***Paper*** | ***Github*** | ***Experiments***
Research Project, FrostLabs *December 2019 - May 2020*
Task: Create homogeneous latent space for the image-question and the answer representations to improve VQA systems
- Proposed a model-agnostic fusion loss based method to fuse the latent space representations from Image-Question obtained by any VQA method and the auto-encoded representations from an augmented form of the answer
- Devised a novel angle-based gradient update method for simultaneous optimization of multiple objective functions
- Achieved statistically significant improvement of 0.1% and 0.3% over BUTD and MFB on the VQAv2 benchmark

NaiTRA: Invisible Presence ***Presentation***
Product Developed at FrostLabs *October 2019 - December 2019*
NaiTRA is a low-compute facial-recognition based system that can be used to for various applications. Two of the applications that we have explored include – seamless attendance marking and zero-touch sanitation monitoring
- Created a face recognition model based on MTCNN and adjusted it for robustness on Indian faces through fine-tuning
- Sped up the pipeline by 60% by using k-nearest neighbour search in feature space instead of classification layers
- Deployed a web app to view real-time analytics about target purpose and to add/remove/modify users remotely

Exploratory Research Projects

Visual Object Tracking **VIP lab, IIT Kharagpur**
Advisor: ***Prof. Jayanta Mukhopadhyay*** ***Github*** | *May 2019 - September 2019*
Task: Design and implementation of learning algorithms for visual object tracking with a focus on tackling occlusion
- Carried out an intensive literature survey and implemented the state-of-the-art methods like SiamFC and DaSiamRPN
- Devised a multi-path look-ahead approach which improves the estimated average overlap by ~5% when tested on KCF
- Formulated the tracking problem as one shot arbitrary object detection to improve results in long term tracking

Context-Based Question Answering **Centre for AI, IIT Kharagpur**
Advisor: ***Prof. Sudeshna Sarkar*** *July 2019 - September 2019*
Task: Design and implementation of deep neural networks for context based question answering
- Conducted an intensive literature survey on existing datasets and methods and on commonsense inclusion in NLP
- Extracted the edge relations from the knowledge graph, ConceptNet, to create commonsense inclusive word vectors
- Improved the accuracy of Bi-LSTM based baseline model by 3% by incorporating the edge based relations

Open Source Projects

Learning Turtle ***Blog*** | ***Github***
Blog posts and lucid visualizations intended to intuitively and Mathematically explain machine learning concepts

Visual Relationship Classifier ***Experiments*** | ***Github***
Implementation of a visual relationship classifier that can be used to create visual relationships for the VQAv2 dataset

Paper Implementation ***Github***
PyTorch implementation of the experiments mentioned in the paper 'All for One: Multi-modal, Multi-Tasking'

Kinship Relationship ***Github***
Keras implementation of Siamese convolutional neural networks for determining kinship relationship using face pairs

GRE Preparation Tool ***Github***
A command-line tool with features like interactive learning, vocab-search and timed tests to prepare for GRE vocabulary

Awards and Achievements

- Ranked 732 (99.93 percentile) from over a million candidates in the Joint Entrance Examination (Main) 2017
- Ranked 259 (99.90 percentile) from 250,000 candidates in the Joint Entrance Examination (Advanced) 2017
- Received the Young Achievers' award at FIITJEE for being the youngest – 15yo – to pass the JEE Advanced
- Selected to attend the first ever Google Research AI Summer School in India for the AI for Social Good track
- Part of the team that was awarded the Gold medal for the Intra-College Software development competetion