Chaitanya Ahuja

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Education

Carnegie Mellon University — **Pittsburgh**
PhD in Language Technologies, 3.69/4 — *Aug 2015 – Present*
Advisor: Dr. Louis-Philippe Morency

Indian Institute of Technology, Kanpur — **Kanpur**
B.Tech in Electrical Engineering, 9.5/10 — *Aug 2011 – May 2015*
Minor in Artificial Intelligence

Research Areas

Multimodal Representation Learning, Speech Processing and Synthesis, Structured Prediction, Spatial Audio

Research Experience

Carnegie Mellon University, Prof. Louis-Philippe Morency — *August 2015 – Present*

Lattice Recurrent Unit: Improving Convergence and Statistical Efficiency for Sequence Modeling

- Designed a recurrent unit (a.k.a. Lattice Recurrent Unit) which creates a distinct flow of information along time and depth dimensions allowing for **training of deeper models**
- Compared it and demonstrated **improvements on language modeling** as compared to SOTA recurrent units on metrics: accuracy, computational convergence, and statistical efficiency
- Decoupling information along depth and time shows significant improvement in all the aforementioned metrics

Speech Synthesis conditioned on Emotions

- Designing a model to *change texture of a speech signal* conditioned on a particular set of emotions
- Generate features for human speech that capture the texture and content independent of each other
- Synthesise speech based on the changed texture and the original content

IIT Kanpur, Prof. Rajesh Hegde — *Aug 2014 – May 2015*

Final Year Project: *Source Separation using a Complex Matrix Factorization approach for Joint Modeling of Magnitude and Phase* [arXiv]

- Proposed a new algorithm to jointly model magnitude and phase while matrix factorization
- Reduced the Complex Matrix Factorization (CMF) problem to a simple Non-Negative Matrix Factorization (NMF) problem by simple transformations
- Algorithm's effectiveness was justified by comparison against state of the art source-separation methods
- Accurate phase reconstruction resolves unwanted artifacts in the reconstructed speech signal

IIT Kanpur, Prof. Vinay Namboodiri — *Aug 2014 – May 2015*

Final Year Project: *Visual Summarization of foreground object motion using boundary initialization of object tracking* [tech. report]

- Proposed an online system for creating **human-centric image summaries** of **surveillance videos** which is based on Kernel-based tracking for automated live synthesis of video synopsis of surveillance videos
- Initialization of foreground objects based on locally varying blob-detection algorithm
- Clustering tracks based on time and space to prevent occlusion in the summary
- Video Summary was synthesized by placing objects, equally spaced in time, on the background

Selected Honors and Awards

- Awarded **Summer Undergraduate Research Grant for Excellence** (SURGE) 2013, IIT Kanpur
- Judged as one of the top 7 projects (out of 70) **in SURGE 2013**
- Received **Academic Excellence Award** for distinctive performance in terms 2011-12, 2012-13.
- Secured **All India Rank 231 - Top 0.05%** (amongst 4,75,000 students) in IIT-JEE 2011.
- Secured **All India Rank 124 - Top 0.05%** (amongst 10,00,000 students) in AIEEE 2011.

Publications

Preprints

[1] T. Baltrusaitis, C. Ahuja, and L.-P. Morency, "Multimodal machine learning: A survey and taxonomy," *ArXiv preprint arXiv:1705.09406*, 2017. [Online]. Available: https://arxiv.org/abs/1705.09406.

Published

[1] C. Ahuja and L.-P. Morency, "Lattice recurrent unit: Improving convergence and statistical efficiency for sequence modeling," *AAAI*, 2018. [Online]. Available: https://arxiv.org/abs/1710.02254.

[2] C. Ahuja and R. M. Hegde, "Fast modelling of pinna spectral notches from hrtfs using linear prediction residual cepstrum," in *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, IEEE, 2014, pp. 4458–4462. [Online]. Available: http://chahuja.com/files/icassp_chahuja_paper.pdf.

[3] A. Sohni, C. Ahuja, and R. M. Hegde, "Extraction of pinna spectral notches in the median plane of a virtual spherical microphone array," in *4th Joint Workshop on Hands-free Speech Communication and Microphone Arrays (HSCMA)*, IEEE, 2014, pp. 142–146. [Online]. Available: http://chahuja.com/files/hscma_chahuja_paper.pdf.

Tech. Reports

[1] C. Ahuja, K. Nathwani, and R. M. Hegde, "A complex matrix factorization approach to joint modeling of magnitude and phase for source separation," *ArXiv preprint arXiv:1411.6741*, 2014. [Online]. Available: https://arxiv.org/abs/1411.6741.

Teaching and Professional Activities

- **TA** Advance Multimodal Machine Learning (CMU 11-777) *Spring 2017*
- **Reviewer** International Conference on Learning Representations (ICLR) *2017*
- **Reviewer** NIPS Workshop on Multimodal Machine Learning *2016*

Professional Experience

Internships

Cornell University, Prof. Tsuhan Chen *Summer 2014*

Prediction of Adjectives for given Nouns using Probability distribution of adjective-noun pairs and adjective-adjective similarity [tech. report]

- Designed a system to **predict adjectives** for a given noun based on an existing set of tags, which increased the vocabulary of the tags while maintaining the sanctity of the noun-adjective pair
- Incorporated a Sentence Corpus (British-National-Corpus) to improve the compatibility of adjective with respect to nouns based on a probability measure
- **Removed redundant data** from the sentence corpus using a hash table which increased accuracy as compared to the baseline

IIT Kanpur, Prof. Rajesh Hegde *Summer 2013*

On-Line modeling of the Pinna for Computation of HRTF's in Rendering 3D Audio

- Finding relations between the structure of the ear and Head Related Transfer Functions (HRTFs)
- Preliminary **testing of spatial audio** to recognize issues that needed improvement
- Understanding the structure of the ear and working towards mimicking its functioning through digital filters
- Relating the **anthropometry of the ear to HRTFs** in general and developing methods to verify contours generated by spectral notches (significant feature in HRTFs)

Selected Projects

Deep RL and control *Jan 2017 – May 2017*

- *Segmentation Models for NLP tasks with RL* [tech. report]
  Segmenting sentences into useful phrases for tasks like Machine Translation and Summarization

Statistical Machine Learning *Jan 2017 – May 2017*

- *Topological Data Analysis* [tech. report] [presentation]
  Analysing confidence intervals in cluster trees to facilitate pruning of low-confidence branches (or leaves)

Multimodal Machine Learning *Aug 2015 – May 2016*

- *Video Captioning* [tech. report]
  Generating descriptive captions for movie video segments.

Skills

- Languages: Bash, C, CSS, HTML, LaTeX, Make, Python
- Frameworks: Numpy, Pandas, Pytorch, Scipy, Scikitlearn, Tensorflow, Theano
- OS: Linus, OSX

Graduate Course-work

- Deep Reinforcement Learning (CMU 10-703): R. Salakhutdinov, K. Fragkiadaki *Spring 2017*
- Statistical Machine Learning (CMU 10-702): L. Wasserman, R. Tibshirani *Spring 2017*
- Deep Learning (CMU 10-707): R. Salakhutdinov *Fall 2016*
- Intermediate Statistics (CMU 10-705): L. Wasserman *Fall 2016*
- Advance Multimodal Machine Learning (CMU 11-777): L.-P. Morency *Spring 2016*
- Machine Learning (CMU 10-701): T. Mitchell *Spring 2016*
- Human Communication and Multimodal ML (CMU 11-776): L.-P. Morency *Fall 2015*
- Algorithms for NLP (CMU 10-702): C. Dyer *Fall 2015*