Aditya Kusupati

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Contact Information

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Research Interests

Resource Constrained Machine Learning
Applied Machine Learning: Search and Vision

Current Position

Microsoft Research India *June 2017 - Present*
Research Fellow, MLO Group Advisor: Dr. Manik Varma

Under Submission

Kusupati, A., Singh, M., Bhatia, K., Kumar, A., Jain, P., and Varma, M. "FastGRNN: A Fast, Accurate, Stable and Tiny Kilobyte Sized Gated Recurrent Neural Network." Under submission, NIPS 2018

Acknowledgements

Subramanian, S., and Chakrabarti, S "New Embedded Representations and Evaluation Protocols for Inferring Transitive Relations." Short paper, ACM SIGIR 2018.

Education

Indian Institute of Technology Bombay *2013 - 2017*

Bachelor of Technology (Honours)

- Cumulative GPA: 8.63/10.0
- Major: Computer Science and Engineering
- Minor: Electrical Engineering

Research Experience

Resource Constrained Machine Learning *June 2017 - Present*
Advisor: Dr. Manik Varma [Open Source Repo]
Working on development and analysis of fundamental Machine Learning algorithms.

FastGRNN: A Fast, Accurate, Stable and Tiny Kilobyte Sized Gated Recurrent Neural Network *Dec 2017 - May 2018*
Advisors: Dr. Manik Varma and Dr. Prateek Jain, *Microsoft Research, India*
Developed FastRNN and FastGRNN algorithms to address the twin RNN limitations of inaccurate training and inefficient prediction. FastRNN, inspired from peephole connections, is thoroughly analysed with bounded & well-behaved gradients, provable convergence and generalization bounds which are polynomial in timesteps when compared to a simple RNN which has exponential bounds. FastGRNN is developed over FastRNN to achieve state-of-the-art accuracies on various benchmark datasets with 35x lesser memory and compute footprint when compared to leading Gated RNN techniques along with lesser training cost and higher accuracies compared to unitary RNNs. Paper under submission to NIPS, 2018

Wakeword Detection on IoT devices *Oct 2017 - Nov 2017*
Advisors: Dr. Harsha Simhadri, Dr. Prateek Jain and Dr. Manik Varma, *MSR, India*
Investigated the deployment of end-end pipeline based on tiny LSTM models with EdgeML classifiers at the end to solve the wakeword detection, "*Hey Cortana*" , on Azure Sphere.

Searching for Stronger Activation Functions *Aug 2017 - Oct 2017*
Advisor: Dr. Manik Varma, *Microsoft Research, India*
Explored the domain of activation functions systematically in the context of CNNs and proposed multiple fundamentally strong activations to solve the existing issues. Discovered Swish in the same time-line as the paper and experimented with residual activation functions coupled with 2 kernels which helped in getting over 1% gain on CIFAR-100 using DenseNet.

EdgeML: An ML library for machine learning on the Edge *July 2017 - Sep 2017*
Advisor: Dr. Harsha Vardhan Simhadri, *Microsoft Research, India* [Open Source Repo]
Developed EdgeML library for Resource Constrained Machine learning. Implemented an efficient and scalable version of Bonsai, a non-linear tree based classifier with very less memory and compute foot-print to work in resource constrained scenarios, in C++ and Tensorflow. Proposed and inducted use of EdgeML classifiers as end-classifiers in deep learning through stable joint training thereby reducing the cost of fully-connected layers.

Efficient Spatial representation for Entity-Typing *July 2016 - May 2017*
Undergraduate Thesis, IIT Bombay [Informal Report]
Advisor: Prof. Soumen Chakrabarti
Entity-Typing is a problem to be addressed in order to make keyword search effective. The project aimed at learning spatially bounded embeddings using type hierarchy from Knowledge Graph and context from the Corpus for better representation and understanding of entity-types in a multi-dimensional hyperspace. The proposed intuitive embedding of Entity-Types can help in visualization as well as tasks like Knowledge Base Completion and query answering. A project branched out of this was published in SIGIR 2018.

Poisson Denoising with Dictionary Learning *June-Nov 2016*
R&D Project, IIT Bombay [Report]
Advisor: Prof. Suyash Awate
Denoising of images with low SNR is vital for the Medical Vision. The project was a dictionary learning based denoising technique. Apart from the dictionary learning, the incorporated methods include sparse and non-negative encoding along with regularization constraints to obtain desirable dictionaries for image reconstruction. The results showed significant improvement over Gaussian prior model which was used earlier in the setting.

Enhancement of Gradient Boosting Machines for Big Data *May-July 2016*
Research Internship, American Express Big Data Labs, Bangalore [Slides]
Advisors: Madhan RA and Dr. Vishwa Vinay
Gradient Boosting Machines are a popular choice for classification problems.The project was to speed up the algorithm without significant decrease in accuracy. Various Binning strategies and Stochastic Sub-Sampling proved out to be outstanding methods for achieving the same along with an raise in accuracy. Finally, had a speed-up of 2x along with significant improvement in the performance metrics like Gini index, default-capture rate etc.,

Polymorphic anisotropic metric for surfaces *May-July 2015*
Research Internship, TITANE team, Inria Sophia Antipolis [Report]
Advisor: Prof. Pierre Alliez
Mobile computing devices being the future(IoT) we needed faster and approximate metrics to reconstruct the surface using meshing with a lower cost. The project proposed a stochastic optimisation based technique for shape approximation. Final implementation resulted in anisotropic metrics for surface meshes based on largest inscribed canonical primitives. This resulted in speed up of about 10x for the mesh generation using quadrilateral primitives.

Development Experience

AutoPerf - Scalability and Stability Improvement *Jan-May 2016*
R&D Project, IIT Bombay [Slides]
Advisor: Prof. Varsha Apte
AutoPerf is a load-generator that requires minimal input and configuration from user to produce a comprehensive capacity analysis as well as server-side resource usage profile of a web-based distributed system in an automated fashion. Worked on the single and multi node scalability along with the stability and robustness of the server side profiler by implementing accurate measuring methods for various system resources usage in a distributed system.

Scholastic Achievements

- All India Rank 44 in JEE Advanced 2013 among 150,000 candidates *2013*
- Scored 99.99 percentile in JEE Main 2013 Paper I among 1.3 million candidates *2013*
- Scored 100.0 percentile in JEE Main 2013 Paper II among half a million candidates *2013*
- Among top 40 students who attended the OCSC for International Chemistry Olympiad and was awarded with Gold medal and Certificate of Merit *2013*
- Prestigious KVPY Fellowship from Government of India - All India Rank 22 *2011*
- Prestigious NTSE Scholarship from Government of India *2008*
- Represented India in the SAARC level of the IGNOU-UNESCO Science Olympiad *2011*
- Among top 1% (300) students in India in Chemistry, Astronomy and Junior Science National Olympiads *2009, 2011, 2012*

Positions of Responsibility

- Undergraduate Teaching Assistantship
  - One of the only 2 students to be awarded **TA of the month** award twice during the

period of 2015-2017

  - Digital Logic Design Lab - *Prof. Supratik Chakraborty* *Spring 2017*
    * Lab supervision and evaluation for a batch of 120 students
    * TA of the month award (14 out of 480 TAships for academic year 2016-17) by CSE, IIT Bombay for the efforts *Feb 2017*
  - Software Systems Lab - *Prof. Sharat Chandran* *Autumn 2016*
    * Design of labs and guidance for a batch of 120 students including project evaluations
  - Digital Logic Design Lab - *Prof. Supratik Chakraborty* *Spring 2016*
    * Lab supervision and evaluation for a batch of 100 students
    * TA of the month award (14 out of 480 TAships for academic year 2015-16) by CSE, IIT Bombay for the efforts *Feb 2016*
  - Computer Programming and Utilisation - *Prof. Varsha Apte* *Autumn 2015*
    * Lab supervision and logistics handling for 90 students
  - Computer Programming and Utilisation - *Prof. Kavi Arya* *Spring 2015*
    * Design of questions papers & handouts for a batch of 500 students

- Department General Secretary, CSE, IIT Bombay *2016-17*
  - Elected academic representative responsible for various activities and initiatives conducted for the students over the year
  - **Institute Organizational Special Mention** award for the efforts during the tenure
- Exchange Buddy, International Relations, IIT Bombay *Autumn 2016*
  - Responsible for facilitating hassle-free stay of the assigned foreign exchange student
- Internship Coordinator, Placement Cell, IIT Bombay *2015-16*
  - Played a key role in career development of students though internships and handled the requests from companies along with logistics

Relevant Electives

- Computer Graphics
- Algorithms for Medical Image Processing
- Fundamentals of Digital Image Processing
- Special topics in Network Algorithms
- Information Retrieval and Web Mining
- Organization of Web Information
- Computer Vision
- Digital Geometry Processing
- Information Theory & Coding

Selected Academic Projects

Gloss: A Continuous Contextual Shape Descriptor *Spring 2017*
Digital Geometry Processing, Prof. Siddhartha Chaudhuri [Report]
The project uses 3D visual context inspired from the 2D language context of word embeddings to represent each 3D object in a scene, there by learns a representation, contextual shape descriptor, which is unique for each object in a real world scene. This can be used for various real world tasks like auto-completion of scenes and decorative suggestions for a given setting.

Classification in Social Networks based on Activity in Politics *Spring 2017*
Organization of Web Information, Prof. Soumen Chakrabarti [Report]
The project tried to predict the political alignment of each person in the social network based on their activity and social circle along with the influences the circle had on them. Quantitative scores for political alignment were generated to help targeted campaigning and advertising along with the insights pertaining to peer vs page influence in a social network.

Camera Calibration using Vanishing Points *Spring 2017*
Computer Vision, Prof. Ajit Rajwade [Report]
The project was an implementation of the camera calibration algorithm specified by :"Camera calibration from vanishing points in images of architectural scenes - R. Cipolla, T. Drummond, D. Robertson". This is a unique method to calibrate a camera given two images taken by it at two different viewpoints and angles using the salient points produced using SIFT.

Performance Comparison of Open Virtual Switch with 4x4 switch *Autumn 2016*
Special Topics in Network Algorithms, Prof. Ashwin Gumaste [Report]
Deployed and compared OVS based performance against a 4x4 switch implemented on DPDK. Benchmarked it for various traffic patterns and other parameters like look-ups, MTU. Studied various limitations and reported the latency for both over various settings.

Language Assistant using predictive POS tags *Autumn 2016*
Web Search and Mining, Prof. Soumen Chakrabarti [Report]
A predictive POS tagging based technique implemented using the ideas of Language models using RNN(LSTM). POS prediction signal tones down the obscure recommendations which might pop up in a typical language model as the corpus is not expansive enough. Extended language modeling to corpus of POS tags were able to make futuristic prediction.

Restricted C compiler *Spring 2016*
Implementation of Programming Languages, Prof. Amitabha Sanyal
Developed a compiler using Lex and Bison. The input language included most of the ANSI C features. The output machine language was a limited form of MIPS assembly, with a minimal instruction set and fewer registers. Final implementation included optimizations like short-circuit evaluation, and efficient register allocation using Sethi-Ullman algorithm.

Animation of Star Wars Droids *Autumn 2015*
Computer Graphics, Prof. Parag Chaudhuri [Video]
Employed all the principles of Modeling-Viewing pipeline along with hierarchical modeling, created an entire scene based on a story between 3D models of two star war droids(R2D2 and Enemy droid). Implemented camera motion along user specified Bezier curves and used keyboard control to generate key-framed animation used to stitch together the video.

Mortality Prediction using Neural Networks *Autumn 2015*
Artificial Intelligence, Prof. Siva Kumar [Slides]
The project made online prediction of mortality when admitted to ICUs based the patient's vitals. The model was a 2-layer neural-net trained using Stochastic Gradient Descent(SGD) to make a 95% accurate prediction using scikit-learn, NumPy and theanets in Python.

Internal Algorithms in Database Systems *Autumn 2015*
Database Systems, Prof. N.L.Sarda [Report]
Implemented external merge-sort on ToyDB platform. Made statistical comparison of various metrics between B+ tree based algorithms and external merge-sort. Built a command-line interface to help the user make an informed choice based on various constraints involved.

UART Design on FPGA *Spring 2015*
Digital Logic Design, Prof. Ashutosh Trivedi [Slides]
Designed, simulated and deployed UART circuit onto a FPGA using using VHDL based on Finite State Machines for transmission and retrieval of binary data with sampling.

Relation Prediction in a Corpus *Autumn 2014*
Data Analysis and Interpretation, Prof. Ganesh Ramakrishnan
Made use of an existing knowledge base and special indicators to identify the relation between any country and number present in a given sentence from a corpus using regression analysis. Processed the given sentence to assign a confidence score for the country-number pair using statistical methods like confidence intervals, hypothesis testing and distributions.

Extra-curricular

- Secured 1^{st} position in Survive the Rubble competition by Capital One in IIT Bombay *2016*
- Stood 17^{th} in National Finals of Build the Shield competition conducted by Microsoft *2016*
- Ranked 5^{th} in Logic General Championship, IIT Bombay *2015*
- Won 1^{st} prize in Math quiz conducted by Maths & Physics Club, IIT Bombay *2013*
- Won Andhra Pradesh Under-12 Singles and Doubles Lawn Tennis Championship *2008*

References

Available On Request