THARUN KUMAR REDDY MEDINI
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Academics

- **PhD** in Electrical and Computer Engineering at **Rice University** *Aug 2016 - ongoing*
- **BTech** with major in Electrical Engineering and minor in Math from **IIT Bombay** *2011 - 2015*
- **All India Rank 21** in IIT JEE-2011

Work Experience

Applied Scientist Intern at Amazon Search, Berkeley, CA *June 2020 - Aug 2020*
Manager: Inderjit Dhillon, Lab: MIDAS

- Implemented a new Iterative Sparsification technique in the general purpose Extreme Classification package PECOS to reduce the model memory by **2x** at no or minimal loss in precision.
- On a category with **26 MM** products, brought down model memory from **180 GB** to **93 GB** and increased real-time inference throughput by **33%**.

Applied Scientist Intern at Amazon Search, Palo Alto, CA *May 2018 - Aug 2019*
Manager: Vijai Mohan, Lab: Search Labs

- Implemented a new hashing based extreme classification algorithm MACH for improving **Matching** and **Ranking** performance of Amazon Search.
- Achieved **9%** better offline recall than production model on a category with **85 million** products.
- Developed a MinHash based low latency fall-back package FLASH to replace queries with most relevant ones in the event of search failure.

Graduate Research Assistant at Rice University, Houston, TX *Aug 2016 - present*
Advisor: Prof.Anshumali Shrivastava, Lab: RUSHLAB

- Working on Large Scale Machine Learning using smart Hashing and Randomization methods. Working on memory and time efficient **Extreme Classification**, **Sparse Embedding Models**, **Structured Prediction** and **Imitation Learning** using minimal expert information.

Data Analyst at Target Corporation, Bengaluru *July 2015 - July 2016*
Manager: Sourav Dutta, Mentor: Venkataramana Kini, Lab: Enterprise Data Analytics & Business Intelligence

- Worked on estimating customer **subscription propensity** using Mixture Models.
- Worked with **Personalization** team on improving the purchase rate of **complimentary product** recommendations using **word2vec** and **Bayesian Personalized Ranking(BPR)**.

Research

IRLI:Iterative Re-paritioning for Learning to Index *Under review at ICML 2021*
Tharun Medini, Gaurav Gupta, Anshumali Shrivastava, Alex Smola

- Proposed a novel Learning to Index algorithm **IRLI** which iteratively partitions the items by learning the relevant buckets directly from the query-item relevance data.
- IRLI employs power-of-k-choices based load balancing strategy.
- We achieve **5x** faster inference on extreme classification and requires $\frac{1}{6}^{th}$ candidates for same recall for Approximate Near Neighbor (ANN) Search than respective baselines.
- We index 100 million dense vectors and surpass FAISS library by ¿10% on recall.

SOLAR: Sparse Orthogonal Learned and Random Embeddings *Published at ICLR 2021*
Tharun Medini, Beidi Chen, Anshumali Shrivastava

- Proposed a novel one-sided method SOLAR to learn sparse and orthogonal high dimensional vectors for efficient Information Retrieval and Extreme Classification.
- Achieved **10x** faster inference with much improved precision on a multitude of Book Recommendation and Extreme Classification Datasets.
- Proved theoretical equivalence between 'fixing label vectors' (one-sided learning) and imposing orthogonality in two-sided learning.

Extreme Classification in Log Memory using Count-Min Sketch *Published at NeurIPS 2019*
Tharun Medini, Qixuan Huang, Yiqiu Wang, Vijai Mohan, Anshumali Shrivastava

- Proposed a novel method to group K classes (millions) into a few hundreds of meta-classes using 2-universal hashing. Using just $O(log(K))$ such groupings, we can train small classifiers in just logarithmic memory

- We bypass the prediction of K-vector and directly predict its count-min sketch values and recover the original predictions when needed.
- We show improved precision and recall with significantly less memory on an **Amazon Search Dataset** with **50 million** classes and several other multi-class and multi-label datasets.

SLIDE: Sub-Linear Deep Learning Engine *Published at MLSys 2020*

Beidi Chen, Tharun Medini, James Farwell, Sameh Gobriel, Charlie Tai, Anshumali Shrivastava

- Developed a new DL framework from scratch in C++ that sparsifies the computations in neural networks to $\approx 1\%$ of typical matrix multiplications. Our package uses simple **CPU** parallel instructions and trains and evaluates **5x faster** than **NVIDIA Tesla V-100** on large extreme classification datasets.

RAMBO: Repeated And Merged BloOm Filter for Multiple Set Membership Testing (MSMT) in Sub-linear time *SIGMOD 2021*

Gaurav Gupta, Minghao Yan, Benjamin Coleman, Leo Elworth, Tharun Medini, Todd Treangen, Anshumali Shrivastava

- Proposed a novel streaming algorithm RAMBO that achieves $O(\sqrt{K}logK)$ query time for K sets as opposed to $O(K)$ for the popular Array-of-Bloom-Filters.
- Indexed **170 TB** Genome sequence dataset in just **14 hrs**.

A Deep Dive into Sketching Algorithms for Extreme Classification *ML with Guarantees Workshop, NeurIPS 2019*

Tharun Medini, Anshumali Shrivastava

- Provided memory-precision-identifiability tradeoffs for using Count Sketch and Count-Min Sketch for Extreme Classification.
- Proposed a novel quadratic estimator using Inclusion-Exclusion Principle for recovering original class probabilities from Sketched Measurements. Our estimator has significantly lower reconstruction error than the typical Count-Min estimator.

Academic Services

PC Member/Reviewer

- NeurIPS 2020, 2019 (top-50% reviewers); ICLR 2021; ICML 2021, 2019; AAAI 2021, 2020, 2018

Teaching Assistant *Aug 2013 - May 2014*

- Worked as **Teaching Assistant** for **Calculus** and **Differential Equations** courses at IIT Bombay.

Mentor, Department Academic Mentorship Program *April 2014-April 2015*

- Worked as a **mentor** for under performing students with academic and personal problems.

Skills

- Programming Languages : **Python**, MATLAB, C++
- Tools and Packages: **TensorFlow**, **PySpark**, Keras, Hadoop MapReduce.

Awards & Scholarships

- Ken Kennedy Institute-BP Graduate Fellowship *Aug 2020 - May 2021*
- American Society of Indian Engineers Scholarship *Nov 2019*
- IIT Bombay MCM scholarship *Aug 2011 - May 2015*
- Academic Excellence Award from EE Department, IIT Bombay *Apr 2015*
- Best Mentor award from Institute Student Mentorship Program (ISMP), IIT Bombay *2014, 2015*

Invited Talks

- Jane Street Symposium *Jan 2020, NY*
- Houston ML Meetup (Intro to Actor-Critic Methods and Imitation in Deep Reinforcement Learning) *Dec 2019, Univ. of Houston*
- Schlumberger (Imitation Learning) *Nov 2019, Katy*
- Rice Data Science Conference (Imitate like a Baby: The Key to Efficient Exploration in Deep Reinforcement Learning) *Oct 2019, BRC, Rice Univ.*

In the News

- An algorithm could make CPUs a cheap way to train AI *Endgadget*
- Deep Learning breakthrough made by Rice University scientists *ARS Technica*
- Sub-linear deep learning algorithm that does not need a GPU? *KD Nuggets*
- SLIDE algorithm for training deep neural nets faster on CPUs than GPUs *Inside HPC*
- Hash Your Way To a Better Neural Network *IEEE Spectrum*
- Researchers report breakthrough in 'distributed deep learning' *TechXplore*
- Deep learning rethink overcomes major obstacle in AI industry *TechXplore*