

# Akshar Varma

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## Research interests

- **Theoretical Computer Science**  
Theoretical Aspects of Machine Learning and Deep Learning in particular; Algorithms
- **Computational Science**  
High Performance Computing; Complex Networks

## Education

- **PhD. in Computer Science** GPA: 3.97/4  
Northeastern University, Boston, USA. (2017—)  
*Advisor: Dr. Ravi Sundaram*
- **B.Tech. (Hons.) in Information and Communication Technology** GPA: 8.9/10  
**Minor: Computational Science**  
DA-IICT, Gandhinagar, India. (2013–2017)  
*Bachelor's Thesis: Reachability Problems and Space Bounds*  
*Advisor: Dr. Nutan Limaye, IIT Bombay*

## Papers and posters

- **Realization Problems on Reachability Sequences**  
Matthew Dippel, Ravi Sundaram, Akshar Varma.  
*The 26th International Computing and Combinatorics Conference (2020)*,  
<https://aksharvarma.org/reachability-realization-cocoon-2020.pdf>
- **Let's HPC: A web-based platform to aid parallel, distributed and high performance computing education**  
Bhaskar Chaudhury, Akshar Varma, Yashwant Keswani, Yashodhan Bhatnagar, Samarth Parikh.  
*Journal of Parallel and Distributed Computing (2018)*, <https://doi.org/10.1016/j.jpdc.2018.03.001>.
- **Parallelizing Union-Find for shared-memory architectures**  
Joint work with Yashwant Keswani, under the guidance of Prof. Bhaskar Chaudhury.  
*Poster presented @ IEEE International Conference on High Performance Computing, Data, & Analytics, 2016*

## Workshops

- Short talk at the Theoretical Basis of Machine Learning discussion meeting at ICTS Bangalore, December 2018.
- *Attended:* Statistical Physics and Machine Learning at ICTS, Bangalore, January 2020; Theory of Deep Learning: Where next? at IAS, Princeton, October 2019; Non-convex optimization and deep learning at MIT, Boston, 2019; The NMI workshop on Complexity Theory at IIT Gandhinagar, November 2016; Forum for Information Retrieval Evaluation at DA-IICT, Gandhinagar, December 2015.

## Internships

- **Automated Time Series Forecasting and Anomaly Detection** *(Oracle, Summer 2020)*  
Mentor: Rajagopalan Govindarajan and Vikas Agrawal, Oracle  
Worked on a fully automated time series forecasting and anomaly detection proof-of-concept project in the Oracle Cloud Analytics team. Developed and implemented algorithms to detect seasonality and trend in time series data as well as to automatically determine SARIMAX model parameters. Combined with causality detection on exogenous variables, this resulted in an end-to-end method for solving forecasting and anomaly detection problems on stationary time series data.
- **Latent Space Embeddings for Query Reformulation** *(Amazon, May-December 2018)*  
Mentor: Raju Matta, Amazon and Ravi Sundaram, NEU  
Worked on the problem of generating latent space embeddings of product search queries for the task of reformulating infrequent queries using popular queries. Implemented novel Attention based Deep Neural Networks trained on query-query similarity graph. Also developed a novel quantitative metric for evaluation of the models. We further did analysis of theoretical aspects of the models and a paper is under submission.

- **Cryptanalysis of Classical Ciphers using Markov Chain Monte Carlo methods**  
Mentor: Prof. Anish Mathuria (Summer 2016)  
Studied the effectiveness of using Markov Chain Monte Carlo (MCMC) methods for the purpose of cryptanalysis of classical ciphers. Focused on the cryptanalysis of the Vigenere cipher and showed that MCMC methods are a poor cryptanalysis choice, by comparing against classical cryptanalysis methods, using Python implementations.
- **Existence of k-ary Trees: Subtree Sizes, Heights and Depths**  
Mentors: Prof. Rahul Muthu, Prof. Srikrishnan Divakaran (Summer 2015)  
Obtained several results on the complexity of determining the existence of k-ary trees when a sequence of attributes like subtree sizes, heights or depths (or a combination of these) are given as input.  
arXiv preprint: <https://arxiv.org/abs/1510.00958v2>.

## Graduate Coursework

Theoretical Topics in Machine Learning, Advanced Algorithms, Topics in Streaming Algorithms, Theory of Computation, Cryptography, Probabilistic Methods, Machine Learning, Computer Systems, Compilers.

## Selected course projects

- **Estimating the Last Vertex of Random Walks on Graphs in the Streaming Model**  
Mentor: Prof. Huy L. Nguyen. Spring 2019  
Looked at the problem of outputting the last vertex in a  $t$ -step random walk on graphs in the one-pass streaming model. Showed a lower bound of  $\Omega(n \log n)$  for this problem in the case of both directed and undirected graphs where  $n$  is the number of vertices in the graph.
- **Who let the tweets out: Author identification of very short texts**  
Mentor: Prof. Rose Yu. Team Size - 2. Fall 2018  
Studied the problem of author attribution for very short texts, focusing on the feature extraction aspect. Implemented latent space embeddings methods and evaluated their performance against bag of words based approaches on Twitter data. Github: <https://github.com/aksharvarma/who-let-the-tweets-out>.
- **GPUs for HPC: Future directions and challenges**  
Mentor: Prof. Gene Cooperman. Fall 2017  
Surveyed the use of GPUs for High Performance Computing applications, focusing on the challenges in using GPUs for HPC in the cloud, in embedded systems and incorporating them using heterogenous computing techniques.
- **On using community detection algorithms for data clustering.**  
Mentor: Prof. Mukesh Tiwari. Team Size - 2. November 2016  
Studied feasibility of using community detection algorithm from complex networks analysis for the problem of data set clustering. Ran simulations in Python for comparison with standard clustering algorithms.
- **Parallelizing  $k$ -means algorithm on a shared-memory architecture.**  
Mentor: Prof. Bhaskar Chaudhury. Team Size - 2. November 2016  
A parallel implementation of the  $k$ -means algorithm using OpenMP library in C to implement thread-based parallelism for shared-memory architectures, which achieved super-linear speedups.

## Programming skills

- Python 3 (Numpy, Scipy, Matplotlib, Pandas libraries for scientific computing, PyTorch)
- C/C++ (Linux/GCC development environment; OpenMP, MPI parallelization libraries; CUDA)

## Teaching

- Head Teaching Assistant for the Algorithms course offered to Master's students (Sep – Dec 2019).
- Teaching Assistant for the High Performance Computing course offered to junior year students (Jul – Nov 2016).
- Teaching Assistant for the Algorithms and Data course offered to undergraduates (Sep – Dec 2017).

## Positions of responsibility

- One of the founding members and head of the student Research Club at DA-IICT (Jan 2017 – Apr 2017).
- Chief Editor of the College e-magazine in DA-IICT (Jan 2017 – Apr 2017) and Member of Editorial Board (Apr 2015 – Apr 2017).