ARCHAN RAY

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RESEARCH INTEREST

Randomized Methods for Matrix Approximation, Sublinear Algorithms, Machine Learning, Numerical Linear Algebra, Model Compression for NLP.

I develop computationally efficient algorithms using numerical linear algebra, with applications in machine learning. The body of my work can be thought of as a toolbox that can be used to perform various tasks within neural networks, such as compressing weight matrices, designing fast learning functions, and reducing memorization of training data by neural networks. The central focus of my work revolves around pushing the boundaries of sublinear time or sublinear query algorithms in the context of matrices and their practical applications.

EDUCATION

University of Massachusetts, Amherst May 2024
Ph.D. in Computer Science, *advised by* Cameron Musco
Thesis: Sublinear Algorithms for Matrices: Theory and Applications
Defense Date: September, 2023
Committee: Cameron Musco, Andrew McCallum, Andrew McGregor, David P Woodruff

Indian Statistical Institute, Kolkata July 2015
M.Tech. in Computer Science, *advised by* Dipti Prasad Mukherjee
Thesis: Estimation of Facial Emotions for Emotion Synthesis

Jalpaiguri Government Engineering College, West Bengal June 2013
B.Tech. in Computer Science and Engineering

PUBLICATIONS

(author listing is alphabetical for papers marked with *)

Musco, C., **Ray, A.**. (2024, February) "Eigenvalue Approximation using Matrix-Vector Query Algorithms". *In preparation**.

Bhattacharjee, R., Dexter, G., Musco, C., **Ray, A.**, Sachdeva, S., & Woodruff, D.P. (2023, February) "Universal Matrix Sparsifiers and Fast Deterministic Algorithms for Linear Algebra". *In Innovations in Theoretical Computer Science (ITCS) 2024* [arxiv]*.

Bhattacharjee, R., Dexter, G., Drineas, P., Musco, C., & **Ray, A.** (2022, May) "Sublinear Time Eigenvalue Approximation via Random Sampling". Extended abstract in *In International Colloquium on Automata, Languages, and Programming (ICALP) 2023* and full paper in *Algorithmica 2024* [arxiv]*.

Ray, A., Monath, N., McCallum, A., & Musco, C. (2021, December) "Sublinear Time Approximation of Text Similarity Matrices". *In AAAI Conference on Artificial Intelligence (AAAI) 2022* [arxiv].

Ray, A., Chowdhury, A. R., Fung, Y., Weinman, J., & Learned-Miller, E. (2019, December). "Tight Coupling of Character, Word, and Place Recognition for End-to-End Text Recognition in Maps". *Technical Report, College of Information and Computer Sciences, University of Massachusetts, Amherst, MA* [PDF].

Ray, A., Chen, Z., Gafford, B., Gifford, N., Jai Kumar, J., Lamsal, A., Niehus-Staab, L., Weinman, J., & Learned-Miller, E. (2018, October). "Historical Map Annotations for Text Detection and Recognition". *Technical Report, Grinnell College, Grinnell, IA 50112* [PDF].

Ray, A., Kumar, N., Shaw, A., & Mukherjee, D. P. (2018, September). "U-PC: Unsupervised Planogram Compliance". *In European Conference on Computer Vision (ECCV) 2018.* [PDF].

WORKING PAPERS

Ray, A., Monath, N., Zaheer, M., "Generalizability with Localization: Algorithms for Learning Problems".

RESEARCH EXPERIENCE

Graduate Research Assistant, University of Massachusetts, Amherst, MA   August 2019 - June 2024
- Designed algorithms for approximate matrix properties, with applications to real world datasets.
- *Area of Study*: Sublinear Algorithms.

Graduate Research Assistant, University of Massachusetts, Amherst, MA   May 2017 - May 2019
- Created a database of annotated historical maps, and designed algorithms to detect and recognize texts in them.
- *Area of Study*: Convolutional Neural Networks, Computer Vision.

Visiting Research Scholar, Indian Statistical Institute, Kolkata, India   August 2015 - August 2016
- Developed an algorithm for detection and recognition of objects in images of shelves in superstores.
- *Area of Study*: Computer Vision, Graph Theory.

WORK EXPERIENCE

Postdoctoral Research Scholar, Sloan Kettering Institute, New York, NY   June 2024 - *present*
- Developed an algorithms for matrix approximation with applications in clinical data.
- *Area of Study*: Randomized Algorithms, Optimization, Numerical Linear Algebra.

Applied Research Intern, Amazon Web Services, New York, NY   Summers 2019, 2020
- Developed an algorithm for visual question answering using transformer architecture.
- Developed an algorithm to perform pseudo semi-supervised learning for short texts.
- *Area of Study*: Computer Vision, Unsupervised Learning, Natural Language Processing.

Research Intern, TCS Innovation Labs, Gurgaon, India   Summer 2014
- Developed a computational framework for classification of emotion classes of facial images.
- *Area of Study*: Computer Vision, Support Vector Machines, Topology, Active Shape Modeling.

Research Intern, Indian Space Research Organization (RRSC-E), Kolkata, India   Summer 2012
- Developed an algorithm to identify distinct signals (spectral unmixing of endmembers) in a hyperspectral image.
- *Area of Study*: Game Theory, Digital Signal Processing, PCA & KPCA, Image Processing.

TEACHING EXPERIENCE

University of Massachusetts
Graduate Teaching Assistant   *Amherst, MA*
- Representing, Storing, and Retrieving Information (CS145), *Spring '21*, with William T. Verts
- Algorithms for Data Science (CS514), *Spring '20*, with Cameron Musco.
- Graduate Computer Vision (CS670), *Fall '19*, with Subhransu Maji.
- Graduate Machine Learning (CS589), *Spring '19*, with Justin Domke.
- Graduate Machine Learning (CS589), *Spring '17*, with Benjamin Marlin.
- Introduction to Algorithms (CS311), *Fall '16*, with Andrew McGregor and Akshay Krishnamurthy.

PATENTS

Pranoy, H., Rao, S.Y., Ramakrishnan, R., Shaw, A.K., **Ray, A.**, Kumar, N. and Mukherjee, D.P., "System and method for object recognition based estimation of planogram compliance." U.S. Patent 10,748,030, issued August 18, 2020.

HONORS AND ACHIEVEMENTS

Dissertation Writing Fellowship Award, Manning College of Information and Computer Sciences, University of Massachusetts Amherst   Spring 2023

AAAI-22 Student Scholarship, 36th AAAI Conference on Artificial Intelligence   January 2022

Best Dissertation in M.Tech. Computer Science, Indian Statistical Institute, Kolkata   July 2015

TALKS AND POSTERS

Approximating Eigenvalues of Symmetric Matrices using Matrix-vector Query Algorithms. *In DIMACS Workshop on Modeling Randomness in Neural Network Training.* Poster June 2024

Sublinear Time Eigenvalue Approximation via Random Sampling. *In ICALP.* Talk August 2023

Sublinear Time Eigenvalue Approximation via Random Sampling. *In FODSI Sublinear Algorithms Workshop.* Poster August 2022

Estimating Eigenvalues of Symmetric Matrices using Random Submatrices. *In Workshop for Algorithm for Large Data (Online) (WALDO).* Poster August 2021

Efficient Kernel Learning in the Online and Sliding Window Models. *In Workshop on Local Algorithms (WOLA).* Poster June 2021

Detection and Recognition of Texts in Cartographic Images. *In New England Computer Vision Workshop (NECV).* Poster November 2018

RELEVANT COURSEWORKS

Deep Learning, Computer Vision, Machine Learning, Research Methods in Empirical CS, Automated Knowledge Based Construction, Advanced Algorithms, Software Analysis and Evaluation, Advanced Database Systems.

ACADEMIC ACTIVITIES

Reviewing. AISTATS 2024, IEEE Transactions on Image Processing (TIP), NeurIPS 2019 Workshop Sets & Partitions, Indian Conference on Computer Vision, Graphics and Image Processing (ICVGIP).

MENTORSHIP AND OUTREACH

CARE PhD Application Support Program at UMass. Mentor. 2020 - *present*

Undergraduate Research Volunteers at UMass. Mentor. Winter 2021

Machine Learning and Friends Lunch at UMass. Co-organizer. Fall 2018 - Fall 2019

Computer Vision Lab at UMass. Mentor Masters students. Fall 2018

Graduate Employee Organisation at UMass. Steward. Fall 2017 - Fall 2018