

ARCHAN RAY

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RESEARCH INTEREST

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

I design computationally efficient algorithms using numerical linear algebra, with applications in machine learning. Broadly, my work can be seen as a set of tools that can be utilized to accomplish various tasks within neural networks, including model compression, designing fast learning functions, and the study of memorization. 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

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| University of Massachusetts, Amherst Ph.D. in Computer Science, <i>advised by</i> Cameron Musco <i>Thesis</i> : Sublinear Algorithms for Matrices: Theory and Applications Committee: Cameron Musco , Andrew McCallum , Andrew McGregor , David P Woodruff | September 2023 |
| Indian Statistical Institute, Kolkata M.Tech. in Computer Science, <i>advised by</i> Dipti Prasad Mukherjee <i>Thesis</i> : Estimation of Facial Emotions for Emotion Synthesis | July 2015 |
| Jalpaiguri Government Engineering College, West Bengal B.Tech. in Computer Science and Engineering | June 2013 |

PUBLICATIONS

(author listing is alphabetical for papers marked with *)

- Musco, C., **Ray, A.**, “Approximating Eigenvalues of Symmetric Matrices using Matrix-Vector Query Algorithms”. *In preparation* *.
- Bhattacharjee, R., Dexter, G., Musco, C., **Ray, A.**, & 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”. *In International Colloquium on Automata, Languages, and Programming (ICALP) 2023* [[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 - *present*

- 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

- Create a database of annotated historical maps. Detect and recognize texts in historical maps.
- *Area of Study*: Convolutional Neural Networks, Computer Vision.

Visiting Research Scholar, Indian Statistical Institute, Kolkata, India August 2015 - August 2016

- Develop an algorithm for detection and recognition of objects from planogram images.
- *Area of Study*: Computer Vision, Graph Theory.

WORK EXPERIENCE

Applied Research Intern, Amazon Web Services, New York, NY Summers 2019, 2020

- Develop an algorithm for visual question answering using transformer architecture.
- Develop 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

- Develop a computation framework to identify between populations of normal and abnormal classes of face images.
- *Area of Study*: Computer Vision, Support Vector Machines, Topology, Active Shape Modeling.

Research Intern, Indian Space Research Organization (ISRO), Kolkata, India Summer 2012

- Develop 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

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| Sublinear Time Eigenvalue Approximation via Random Sampling. <i>In ICALP</i> . Talk | August 2023 |
| Sublinear Time Eigenvalue Approximation via Random Sampling. <i>In FODSI Sublinear Algorithms Workshop</i> . Poster | August 2022 |
| Estimating Eigenvalues of Symmetric Matrices using Random Submatrices. <i>In Workshop for Algorithm for Large Data (Online) (WALDO)</i> . Poster | August 2021 |
| Efficient Kernel Learning in the Online and Sliding Window Models. <i>In Workshop on Local Algorithms (WOLA)</i> . Poster | June 2021 |

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

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| CARE PhD Application Support Program at UMass. Mentor. | 2020 - <i>present</i> |
| 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 |