

# 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

<b>University of Massachusetts, Amherst</b> Ph.D. in Computer Science, <i>advised by</i> <a href="#">Cameron Musco</a> <i>Thesis</i> : Sublinear Algorithms for Matrices: Theory and Applications Committee: <a href="#">Cameron Musco</a> , <a href="#">Andrew McCallum</a> , <a href="#">Andrew McGregor</a> , <a href="#">David P Woodruff</a>	May 2024
<b>Indian Statistical Institute, Kolkata</b> M.Tech. in Computer Science, <i>advised by</i> <a href="#">Dipti Prasad Mukherjee</a> <i>Thesis</i> : Estimation of Facial Emotions for Emotion Synthesis	July 2015
<b>Jalpaiguri Government Engineering College, West Bengal</b> B.Tech. in Computer Science and Engineering	June 2013

## 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](#)].

## 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

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**Applied Research Scientist, JP Morgan Chase, New York, NY** September 2024 - *present*

- I design randomized methods with applications in quantum-inspired and machine learning algorithms.
- *Area of Study*: Randomized Algorithms, Numerical Linear Algebra, Quantum Algorithms.

**Postdoctoral Research Scholar, Sloan Kettering Institute, New York, NY** Summer 2024

- Developed 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 (ISRO), 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

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**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

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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

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

**AAAI-22 Student Scholarship**, 36<sup>th</sup> 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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- 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

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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

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**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 - *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