

# ARCHAN RAY

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## RESEARCH INTEREST

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Sublinear Algorithms, Machine Learning.

## EDUCATION

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**University of Massachusetts, Amherst** September 2016 - *present*  
Ph.D. in Computer Science, *advised by* [Professor Cameron Musco](#)  
*Thesis*: Sublinear Algorithms for Matrices: Theory and Applications

**Indian Statistical Institute, Kolkata** July 2015  
M.Tech. in Computer Science, *advised by* [Professor Dipti Prasad Mukherjee](#)  
*Thesis*: Estimation of image features representing facial emotions for emotion synthesis

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

## RESEARCH EXPERIENCE

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**Graduate Research Assistant, University of Massachusetts, Amherst, MA** August 2019 - *present*  
· Approximate matrix properties and applications to real world datasets.  
· *Area of Study*: Sublinear Algorithms.

**Applied Research Intern, Amazon Web Services, New York, NY** Summer 2020  
· Develop an algorithm to perform pseudo semi-supervised learning for short texts.  
· *Area of Study*: Unsupervised Learning, Natural Language Processing.

**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.

**Applied Research Intern, Amazon Web Services, New York, NY** Summer 2019  
· We develop an algorithm for visual question answering using transformer architecture.  
· *Area of Study*: Computer Vision, Natural Language Processing.

**Visiting Research Scholar, Indian Statistical Institute, Kolkata, India** August 2015 - August 2016  
· We developed an algorithm for detection and recognition of objects from planogram images.  
· *Area of Study*: Computer Vision, Graph Theory.

**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

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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 Subhansu 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.

## WORKING PAPERS

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(author listing is alphabetical for papers marked with \*)

Musco, C., **Ray, A.**, “Sublinear Time Matrix-Vector Algorithms for Eigenvalue Approximations: A Comparative Study”\*.

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

## PUBLICATIONS

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Bhattacharjee, R., Dexter, G., Musco, C., **Ray, A.**, & Woodruff, D.P. (2023, February) “Universal Matrix Sparsifiers and Fast Deterministic Algorithms for Linear Algebra”. *In submission* [[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](#)].

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

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

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

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

## 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.** 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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<b>CARE PhD Application Support Program at UMass.</b> Mentor.	2020 - <i>present</i>
<b>Undergraduate Research Volunteers at UMass.</b> Mentor.	Winter 2021
<b>Machine Learning and Friends Lunch at UMass.</b> Co-organizer.	Fall 2018 - Fall 2019
<b>Computer Vision Lab at UMass.</b> Mentor Masters students.	Fall 2018
<b>Graduate Employee Organisation at UMass.</b> Steward.	Fall 2017 - Fall 2018

## OTHER RESEARCH AND CLASS PROJECTS

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<b>Efficient distributed routing in quantum networks</b>	October 2019 - December 2019
<i>Advisor: Dr. Kaushik Chakraborty</i>	<i>QuTech, TU Delft</i>

- We present an efficient algorithm for routing in quantum networks.
- We improve upon the state of the art by using link prediction for dynamic routing of incoming datastreams.
- *Area of Study:* Quantum Networks and Link Prediction.

<b>Invariant methods and graph equivalence (IMAGE)</b>	February 2017 - May 2017
<i>Course advisor: Prof. Yuriy Brun</i>	<i>UMass Amherst</i>

- Inspect invariant methods with a view to identify code similarity using graph equivalence.
- Use graph kernels as a similarity measurement to quantify the similarities between code pieces.
- *Area of Study:* Kernel Methods, Software Analysis and Graph Kernels.

<b>Canonicalizing Neural Networks</b>	September 2016 - December 2016
<i>Advisor: Prof. Erik Learned Miller</i>	<i>UMass Amherst</i>

- Study the convergence of a fixed neural network to its many optima.
- Transform the trained network keeping its functional behaviour consistent and studied the existence of “equivalence classes” for a neural network.
- *Area of Study:* Neural Networks, and Functional Analysis

<b>Estimation of Image Features for Emotion Synthesis (<i>best dissertation</i>)</b>	February 2014 - July 2015
<i>Advisor: Prof. Dipti Prasad Mukherjee</i>	<i>ISI Kolkata</i>

- Develop a method to estimate emotion-specific features on human face which characterizes an emotion class.
- Develop an algorithm to estimate the change a person’s image from no emotion to a given emotion using these features.
- SNR of the synthesized images showed improvements as compared to state-of-the-art methods.
- *Area of Study:* Support Vector Machines, Statistical Inference, Computer Vision, Differential Geometry.

<b>Thread Library Implementation in Pintos</b>	April 2014 - May 2014
<i>Course advisor: Prof. Mandar Mitra</i>	<i>ISI Kolkata</i>

- Strengthen the thread library that supports the operating system. Implement an advanced scheduler.
- We removed busy waiting of the timer function. We further improved the timer interrupt service and added priority scheduling support for threads, including priority inversion and priority donation.
- *Area of Study:* Multilevel Feedback Queue Scheduling, Optimization Barriers, Priority Scheduling.