

# ARCHAN RAY

github: archanray ♦ website: people.cs.umass.edu/~ray  
(413) · 992 · 9222 ♦ ray@cs.umass.edu, talk2archan@gmail.com  
New York, NY 11372

## RESEARCH INTEREST

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Randomized Algorithms, Kernel Methods, Statistical Analysis, Machine Learning.

## EDUCATION

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**University of Massachusetts, Amherst** *September 2016 - present*  
Ph.D. in Computer Science, *advised by* Professor Cameron Musco  
GPA: 3.717/4.0

**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  
*Percentage:* 74.25%

**Jalpaiguri Government Engineering College, West Bengal** *June 2013*  
B.Tech. in Computer Science and Engineering  
GPA: 8.5/10.0

## RESEARCH EXPERIENCE

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**University of Massachusetts** *August 2019 - present*  
*Graduate Research Assistant* *Amherst, MA*

- Approximate matrix properties and applications to real world datasets.
- *Area of Study:* Randomized Algorithms, Kernel Methods.

**Amazon Web Services** *May 2020 - August 2020*  
*Applied Research Intern* *New York, NY*

- Develop an algorithm to perform pseudo semi-supervised learning for short texts.
- The challenges involve: a) leveraging the giant body of supervised architectures with unlabelled data, b) identifying confident pseudo labelled samples.
- *Area of Study:* Unsupervised Learning, Natural Language Processing.

**University of Massachusetts** *May 2017 - May 2019*  
*Graduate Research Assistant* *Amherst, MA*

- Develop an algorithm to detect and recognize texts in historical maps. Compare with relevant baselines.
- Create a database of annotated historical maps (technical publication listed).
- *Area of Study:* Convolutional Neural Networks, Computer Vision and Word Spotting.

**Amazon Web Services** *June 2019 - August 2019*  
*Applied Research Intern* *New York, NY*

- We develop an algorithm for visual question answering using transformer architecture.
- The challenges involve: a) object detection, and b) multimodal attention.
- *Area of Study:* Computer Vision, Natural Language Processing.

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

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

**TCS Innovation Labs** *May 2014 - July 2014*  
*Research Intern* *Gurgaon, India*

- A new computation framework was developed and the interpretations are done on the basis of statistical differences between populations of normal and abnormal classes of face images.
- *Area of Study:* Computer Vision, Support Vector Machines, Markov Models, Topology and Modern Analysis, Active Shape Modeling.

#### **RRSC-E (Indian Space Research Organization)**

*Research Intern*

June 2012 - August 2012

*Kolkata, India*

- 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.

### **PROFESSIONAL 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.

### **PUBLICATIONS**

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

Bhattacharjee R., Musco, C., & **Ray, A.** (2021, August) "Sublinear Time Eigenvalue Approximation via Random Sampling". *arXiv preprint arXiv:2109.07647*.

**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*

**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*.

**Ray, A.**, Kumar, N., Shaw, A., & Mukherjee, D. P. (2018, September). "U-PC: Unsupervised Planogram Compliance". In *European Conference on Computer Vision (pp. 598-613)*. Springer, Cham.

### **PATENTS**

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

### **HONORS AND ACHIEVEMENTS**

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**AAAI-22 Student Scholarship**, 36<sup>th</sup> AAAI Conference on Artificial Intelligence

*January 2015*

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

*July 2015*

### **RELEVANT COURSEWORKS**

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**University of Massachusetts, Amherst:** Deep Learning (A), Computer Vision (A), Machine Learning (A), Research Methods in Empirical CS (A), Automated Knowledge Based Construction (A), Advanced Algorithms (B+), Software Analysis and Evaluation (A-), Advanced Database Systems (B+).

**Indian Statistical Institute, Kolkata:** Artificial Neural Networks, Computer Vision, Computer Graphics, Advanced Pattern Recognition, Advanced Digital Signal Processing, Abstract Algebra.

**Jalpaiguri Government Engineering College:** Digital Image Processing, Artificial Intelligence, Mathematics, Advanced Algorithms

## ACADEMIC ACTIVITIES

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**IEEE Transactions on Image Processing.** Reviewer

**NeurIPS 2019 Workshop Sets & Partitions.** Reviewer

**Indian Conference on Computer Vision, Graphics and Image Processing.** Reviewer

## OTHER RESEARCH AND CLASS PROJECTS

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### **Efficient distributed routing in quantum networks**

October 2019 - December 2019

*Advisor: Dr. Kaushik Chakraborty*

*QuTech, TU Delft*

- 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.

### **Online nearest neighbor clustering using leverage score sampling**

October 2019 - December 2019

*Course advisor: Prof. Cameron Musco and Prof. Andrew McCallum*

*UMass Amherst*

- We present an efficient and online nearest neighbor search.
- A kernel function is used as a distance measure for two points in the cluster. The use of leverage scores allows for a faster implementation.
- *Area of Study:* Kernel Methods and Natural Language Processing.

### **Invariant methods and graph equivalence (IMAGE)**

February 2017 - May 2017

*Course advisor: Prof. Yuriy Brun*

*UMass Amherst*

- 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.

### **Recommendation from citation databases**

April 2017 - May 2017

*Course advisor: Prof. Alexandra Meliou*

*UMass Amherst*

- Investigate recommendations in the context of bibliographic networks. Design a recommendation framework that uses only the graph topology to estimate valid recommendations given a query node in the graph.
- Our experiments on Stanford citation networks and CiteULike datasets promises that the combination of our method and topic modeling result in competent recommender models.
- *Area of Study:* Statistical Learning, Graph Database and Recommender Framework.

### **Generating Harder CAPTCHAs using GAN**

September 2016 - December 2016

*Course advisor: Prof. Sridhar Mahadevan*

*UMass Amherst*

- We propose the use of GANs to generate harder CAPTCHAs taking into account the intrinsic properties of the breaker CNNs.
- Our experiments showed a significant decrease in the recognition accuracy of the CNNs.
- *Area of Study:* Deep Learning, Generative Models and Adversarial Networks.

### **Canonicalizing Neural Networks**

September 2016 - December 2016

*Advisor: Prof. Erik Learned Miller*

*UMass Amherst*

- 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

### **Sammon’s Mapping Using a Revised Distance Strategy**

September 2014 - August 2015

*Advisor: Dr. Swagatam Das*

*ISI Kolkata*

- Investigate Sammon’s mapping using Bregman’s divergence. Propose a different distance strategy to attain the reduction from non-linear dimension.
- *Area of Study:* Functional Analysis, and Measure Theory.

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

- 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.

**Frame Based Audio Signal Processing using DSK6713** August 2014 - October 2014  
*Advisor: Dr. Sarbani Palit* *ISI Kolkata*

- Investigate and develop an algorithm to remove noise and jitters while amplifying signals.
- *Area of Study:* Convolution Theorem, Micro-controllers and Microprocessor, DSK Toolkit.

**Thread Library Implementation in Pintos** April 2014 - May 2014  
*Course advisor: Prof. Mandar Mitra* *ISI Kolkata*

- 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.

**Minimum Enclosing Circle of a Set of Points and Two Mobile Points** November 2013 - February 2014  
*Advisor: Dr. Sandip Das* *ISI Kolkata*

- Study variations in the center and radius of the minimum enclosing circle (MEC) of a given set of points and two mobile points moving along straight lines.
- The basis of the changes is the farthest point Voronoi of the given set of points.
- *Area of Study:* Voronoi Diagram, Kinetic Data Structure, Co-Ordinate Geometry.

**Facial Recognition using Fiducial Points and Graph Matching** Aug 2012 - May 2013  
*Advisor: Prof. Animesh Hazra* *Jalpaiguri Govt. Engg. College*

- Develop an algorithm to extract the facial features of the given image to help identify people's faces from an already available database with increased efficiency and optimal time complexity.
- *Area of Study:* Image Processing, Graph Theory.