

ARCHAN RAY

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RESEARCH INTEREST

Matrix Approximations, Kernel Methods, Statistical Analysis, Machine Learning.

EDUCATION

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

University of Massachusetts

August 2019 - present

Graduate Research Assistant

Amherst, MA

- Approximate kernel methods.
- *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

- Develop an algorithm for visual question answering.
- The challenges involve: a) object detection, and b) multimodal attention. We developed an algorithm based on transformers to achieve state-of-the-art level performance without pre-training.
- *Area of Study*: Computer Vision, Natural Language Processing.

Indian Statistical Institute

August 2015 - August 2016

Visiting Research Scholar

Kolkata, India

- Develop an algorithm for detection and recognition of objects from planogram images.
- The challenges involve: a) difference in resolution between images in database and images of objects, and b) varying illumination.
- *Area of Study*: Computer Vision, Graph Theory.

TCS Innovation Labs*Research Intern*

May 2014 - July 2014

Gurgaon, India

- Study variations on the manifold of facial images and identify distinct features on the surface.
- A new computation framework was developed and the interpretations are done on the basis of statistical differences between populations of normal and abnormal classes.
- *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 maximize the success of identifying distinct signals (endmembers) from a mixed image for every pixel.
- Spectral unmixing of hyperspectral data was done on the Hyperion cube.
- *Area of Study:* Game Theory, Digital Signal Processing, PCA & KPCA, Image Processing.

PROFESSIONAL EXPERIENCE

University of Massachusetts*Graduate Teaching Assistant**Amherst, MA*

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

WORKING PAPERS

Ray, A., Monath, N., McCallum, A., & Musco, C. (2021, April) "Embedding Arbitrary Similarity Matrices Using Nyström Approximation".

Ray, A., Musco, C., (2021, May) "Efficient Kernel Learning in Online and Sliding Window Models: Accuracy Guarantees and Regret Bounds".

PUBLICATIONS

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

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

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

July 2015

RELEVANT COURSEWORKS

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

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

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*Advisor: Prof. Erik Learned Miller*

September 2016 - December 2016

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*Advisor: Dr. Swagatam Das*

September 2014 - August 2015

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*)*Advisor: Prof. Dipti Prasad Mukherjee*

February 2014 - July 2015

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*Advisor: Dr. Sarbani Palit*

August 2014 - October 2014

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*Course advisor: Prof. Mandar Mitra*

April 2014 - May 2014

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*Advisor: Dr. Sandip Das*

November 2013 - February 2014

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*Advisor: Prof. Animesh Hazra*

Aug 2012 - May 2013

Jalpaiguri Govt. Engg. College

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