Archan Ray

Contact Information

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Objective

To contribute towards the development of the scientific and technological aspects of the institution wherein I get the opportunity to involve myself academically, scientifically and technologically, with dedication, sincerity and perseverence.

Research Interests

Machine Learning, Computer Vision, Pattern Recognition, Statistical Analysis

Education

University of Massachusetts, Amherst (Sep 2016 - *present*)
Ph.D in Computer Science
Thesis Topic: Text recognition on cartographic images
Advisor: Prof. Erik Learned-Miller
Area of Study: Machine Learning, Convolutional Neural Networks.
GPA : 3.75/4.0

Indian Statistical Institute, Kolkata (Jul 2013 - Jul 2015)
M.Tech in Computer Science
Thesis Topic: Estimation of image features representing facial emotions for emotion synthesis *(awarded best dissertation)*
Advisor: Prof. Dipti Prasad Mukherjee
Area of Study: Computer Vision, Machine Learning, Differential Geometry, Functional Analysis
Percentage : 74.25%

Jalpaiguri Government Engineering College, West Bengal (Aug 2009 - Jun 2013)
B.Tech in Computer Science and Engineering
Thesis Topic: Facial Recognition using Fiducial Points and Graph Matching
Advisor: Animesh Hazra
Area of Study: Image Processing, Machine Learning, Algorithms, Optimization Theory
CPI : 8.5/10.0

Awards & Achievements

Graduate
Awarded Best Dissertation in M.Tech Computer Science for the thesis on *Estimation of image features representing facial emotions for emotion synthesis*

Professional experience

Teaching Assistant (Sep 2016 - *now*)
Graduate Machine Learning (CS589), *Spring '17*, Prof. Benjamin Marlin
Introduction to Algorithms (CS311), *Fall '16*, Prof. Andrew McGregor and Prof. Akshay Krishnamurthy

Indian Statistical Institute, Kolkata (Aug 2015 - Aug 2016)
As a visiting research scholar, worked on Object detection and recognition from images
Advisor: Prof. Dipti Prasad Mukherjee, Indian Statistical Institute, Kolkata

TCS Innovation Labs - Gurgaon, India (May 2014 - Jul 2014)
As a research intern, worked on Statistical analysis of human expressions
Advisors: Dr. Hiranmay Ghosh, Principle Scientist, TCS Innovation Labs, Gurgaon, New Delhi
Dr. Ehtesham Hassan, TCS Innovation Labs, Gurgaon, New Delhi

RRSC-E (Indian Space Research Organization) (Jun 2012 - Aug 2012)
As a research intern, worked on Spectral unmixing of hyperspectral data
Advisor: Arati Paul, Scientist, RRSC-E(ISRO), Kolkata

Relevant Courseworks

University of Massachusetts, Amherst
Deep Learning (A), Machine Learning (A),
Advanced Database Systems (B+), Software Analysis and Evaluation (A-)

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

Key Research Projects

Text detection and recognition in cartographic maps (May 2017 - *present*)
Guide: Prof. Erik Learned-Miller (UMass Amherst)

In this project we are building a system to detect texts in cartographic maps. The baseline is constructed using a modified Faster-RCNN which is capable of detecting rotated texts in the images. We also built a dataset for the same.

Area of Study: *Convolutional Neural Networks*, *Computer Vision* and *Text Recongnition*

Invariant methods and graph equivalence (IMAGE) (Feb 2017 - May 2017)
Guide: Prof. Yuriy Brun (UMass Amherst)

In this project we inspect invariant methods with a view to identify code similarity using graph equivalence. we represent each method from the codebase as a program dependency graph, and use graph kernels as a similarity measurement to quantify the similarity between code pieces. We test various kernels including random walk kernel, shortest path kernel, graphlet kernel and Weisfeiler-Lehman kernel family. Weisfeiler-Lehman kernels achieve promising result, and node label information are proved to be highly useful. We also explored slicing large graphs into smaller ones, concluding that a semantic clustering method is demanded to make slicing helpful.

Area of Study: *Kernel Methods*, *Software Analysis* and *Graph Kernels*

Recommendation from citation databases (Apr 2017 - May 2017)
Guide: Prof. Alexandra Meliou (UMass Amherst)

Citation databases offer a natural ability to model the community of research papers as a graph. Most existing studies use topic modeling and citation field analysis for recommendations on these databases. In this study, we investigate the problem of recommendation in the context of bibliographic networks and propose a recommendation framework that uses only the graph topology to estimate valid recommendations given a query node in the graph. Given a query node in a bibliographic network, our algorithm computes the ranking of the nodes in the neighborhood of the query node and return the top k results. Unlike traditional methods, our algorithm computes a measure based on the local and global importance of a node. While our experiments on Stanford citation networks and CiteULike datasets reveal poor performance with respect to state-of-the-art algorithms, it promises that the combination of our method and topic modeling would result in competent recommender models.

Area of Study: *Statistical Learning*, *Graph Database* and *Recommender Framework*

Generating Harder CAPTCHAs using GAN (Sep 2016 - Dec 2016)
Guide: Prof. Sridhar Mahadevan (UMass Amherst)

Recent findings suggest that the newer challenging text distortion based CAPTCHAs can be solved using deep CNNs. We propose the use of Generative Adversarial Nets to generate harder CAPTCHAs taking into account the intrinsic properties of the breaker CNNS. We modify the loss function of the Generator component of GAN to produce adversarial test samples. Our experiments showed a significant decreasein the recognition accuracy of the CNNs.

Area of Study: *Deep Learning*, *Generative Models* and *Adversarial Networks*

Canonicalizing Neural Networks (Sep 2016 - Dec 2016)
Guide: Prof. Erik Learned Miller (UMass Amherst)

In the age of deep learning there has been a growth in interest to understand the relationship among the local optima of a fixed network. This is due to the fact that such understand would leavarge in faster training for neural networks. In this work we studied the convergence of a fixed network to its many optima. We then 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*

Object Detection and Recognition from Images (Jul 2015 - Aug 2016)
Guide: Prof. Dipti Prasad Mukherjee (ISI Kolkata)

We develop a method to identify objects in an image and recognition. The challenges involved are: a) difference in resolution between images in database and images of objects, and b) varying illumination. This project is under a non-disclosure agreement and as a result we are not allowed to elaborate on it.

Area of Study: *Image Processing*, *Support Vector Machine*, and *Random Forest*

Sammon's Mapping Using a Revised Distance Strategy (Sep 2014 - Aug 2015)
Guide: Dr. Swagatam Das (ISI Kolkata)

Over the years Sammon's mapping has been extensively studied using different distance measures to attain a better pre-image mapping for non-linear methods. Recently Bregman's divergence was used to obtain very good pre-images. We experiment using a different distance strategy to attain the reduction from non-linear dimension.

Estimation of Image Features Representing Facial Emotions for Emotion Synthesis *(awarded best dissertation)* (Feb 2014 - Jul 2015)
Guide: Prof. Dipti Prasad Mukherjee (ISI Kolkata)

We developed a method to estimate emotion-specific features on human face. Application of such a method include characterizing an emotion class and synthesis of emotions. The emotion-specific features can also be used to study the statistical differences between two clusters, one facial expression images with no expressions and two facial expression images with some or maximum emotional content. Once the feature vectors are extracted from the input data, we classify the data and use the normal to the classifier to trace the changes that a facial expression image may undergo in different stages of an emotion. We use Support Vector Machines learning algorithm to construct an optimal classifier. Our method reduced the number of features by 66.36% as compared to the number of pixels in an image and the SNR of the synthesized image was improved by 13.20% as compared to state-of-the-art methods.

Area of Study: *Support Vector Machines*, *Statistical Inference*, *Computer Vision*, *Differential Geometry*

Statistical Analysis of Human Expressions (May 2014 - Jul 2014)
Guide: Dr. Hiranmay Ghosh (TCS Innovation Labs)
Dr. Ehtesham Hassan (TCS Innovation Labs)

Human Expression Analysis requires knowledge of change in contours of the human face. Here we study variations on the manifold of facial images and identify distinct features on the surface. The inputs were modified using into binary images using STASM library. These images were distance transformed for further analysis. We then analyze the skeleton points on the surface and thereby the reason for any changes in these points in a face with expressions as compared to normal faces. 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*

Frame Based Audio Signal Processing using DSK6713 (Aug 2014 -Oct 2014)
Guide: Dr. Sarbani Palit (ISI Kolkata)

This project was done with a view to help people with poor hearing abilities. The basic signal was convoluted with six filters, and the result was amplification of this signal with noise removal. A frame based approach was taken to flatten jitters between two frames. Each frame was convolved with each of the filter's impulse response and the results were added. The first n bits were forwarded to the output buffer and the rest m bits were added to the next frame's convolved result. This resulted in smoothing of the input noise and also amplification of the signal components.

Area of Study: *Convolution Theorem*, *Microcontrollers and Microprocessor*, *DSK Toolkit*

Thread Library Implementation in Pintos (Apr 2014 - May 2014)
Guide: Dr. Mandar Mitra (ISI Kolkata)

Pintos is a simple operating system framework for the 80x86 architecture. Our principal goal was to strengthen the thread library that supports the operating system. 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. We also implemented the advanced scheduler at a basic level.

Area of Study: *Multithreaded Programming*, *Multilevel Feedback Queue Scheduling*, *Optimization Barriers*, *Priority Scheduling*

Minimum Enclosing Circle of a Set of Points and two Mobile Points (Nov 2013 - Feb 2014)
Guide: Dr. Sandip Das (ISI Kolkata)

In this project we 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. We are primarily trying to fix the nature of the two attributes on the basis of the change in 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)
Guide: Prof. Animesh Hazra (Jalpaiguri Govt. Engg. College)

B.Tech Thesis: An algorithm was developed 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*, *Co-Ordinate Geometry*, *Algorithms & Optimization*

Spectral Unmixing of Hyperspectral Data (Jun 2012 - Aug 2012)
Guide: Arati Paul (RRSC-E, ISRO)

An algorithm was developed to maximize the success of identifying distinct signals (endmembers) from a mixed image for every pixel. The project was carried out on a Hyperion cube.

Area of Study: *Game Theory*, *Digital Signal Processing*, *PCA & KPCA*, *Image Processing*

Academic Activities

IEEE Transactions on Image Processing
Reviewer

Indian Conference on Computer Vision, Graphics and Image Processing
Reviewer

Programming Skills

Programming & Scripting Language
- (*Proficient*): C, Python, C++, Java, SQL
- (*Proficient*): Matlab®, (*Acquaintance*): Prolog

References available on request.