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Pattern Recognition and Machine Intelligence

8th International Conference, PReMI 2019
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Proceedings, Part I

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Foreword

Welcome to PReMI 2019, the 8th International Conference on Pattern Recognition and Machine Intelligence. We were glad to have you among us at this prestigious event to share exciting results of your pattern recognition and machine intelligence research. This year we were fortunate to have the conference located in a historic city of Northeastern India—Tezpur. We hope that you enjoyed this idyllic place on the bank of the mighty Brahmaputra and that you took the opportunity to enjoy the beauty and uniqueness of this cultural hub of Assam. The Technical Program Committee worked very hard to put together an outstanding program of 90 full-length oral papers and 41 short oral-cum-poster presentations that aptly reflect the recent accomplishments in machine intelligence and pattern recognition research from across the globe. This represents a significant growth in the number of presentations compared to previous years. Although, we had planned to adopt the single-session format so that everyone could attend all oral presentations and learn from them, due to the large number of high-quality papers from multiple sub-themes, we decided to have parallel sessions.

The conference began with two parallel tutorial sessions followed by another, led by three eminent academic experts. The first session was on ‘Compressed Sensing’ by Dr. Ajit Rajwade from IIT Bombay. The second session was led by Prof. Chiranjib Bhattacharyya from IISc Bangalore on ‘Machine Learning and its Application in Industrial Problem Solving.’ The third session was delivered by Dr. M. Tanveer from IIT Indore on ‘Machine Algorithms for the Diagnosis of Alzheimer’s Disease.’ The main conference began the next day led by two plenary talks, five invited talks, and two industry talks, followed by the oral presentations.

The first plenary talk was delivered by Prof. Witold Pedrycz of University of Alberta, Canada on ‘Granular Artificial Intelligence’ to highlight its applications in modeling environments and pattern recognition. Prof. Jayaram Udupa of University of Pennsylvania, Philadelphia, USA delivered the next plenary talk on ‘Biomedical Imaging.’ The technical sessions were organized in parallel oral presentations under ten major themes: Bioinformatics, Biomedical Signal Processing, Deep Learning, Soft Computing, Image and Video processing, Information Retrieval, Machine Learning and Pattern Recognition, Remote Sensing and Signal Processing, and Smart and Intelligent Sensors. Each of these sessions began with an invited academic or industry talk. There were five invited academic talks and two industry talks. Prof. Pushpak Bhattacharyya of IIT Patna delivered an invited talk on ‘Imparting Sentiment and Politeness on Computers.’ Prof. C. V. Jawahar of IIIT Hyderabad delivered his invited talk on ‘Beyond Text Detection and Recognition: Emerging Opportunities in Scene Understanding.’ Another invited talk on ‘Cognitive Analysis using Physiological Sensing’ was delivered by Prof. S. K. Saha of Jadavpur University. The fourth invited talk focused on ‘The Rise of Hate Content in Social Media,’ and was presented by Dr. Animesh Mukherjee of IIT Kharagpur. Another invited talk on wireless networks was delivered by Prof. Sudip Misra of IIT Kharagpur.

PReMI 2019 was also be an excellent platform for facilitating industry-academic collaboration. As in previous years, this year's event included industry talks to better expose academic researchers to real-life problems and recent application-oriented developments. The first industry talk was delivered by Dr. Praneeth Netrapalli from Microsoft Research India. His talk focused on 'How to Escape Saddle Point Efficiently.' The second industry talk was on 'Machine Learning and its Applications in Remote Sensing Data Classification,' was delivered by Dr. Anil Kumar from the Department of Photogrammetry and Remote Sensing, Indian Institute of Remote Sensing, Indian Space Research Organization (ISRO), Dehradun, India.

Another attractive and distinguishing feature of PReMI 2019 was the inclusion of a Doctoral Symposium in the name of late Prof. C. A. Murthy, which was held on the first day of the conference. This forum was useful for PhD students to showcase their research outcomes and seek advice and mentorship from prominent scientists and engineers. Although we received a good number of submissions for this symposium, we were only able to select 12 presentations.

Finally, we feel privileged to acknowledge and appreciate the expertise and hard work of the various committees, sub-committees, and individuals of PReMI 2019, who were deeply involved in making this prestigious event an outstanding success. It was truly a memorable experience for us to work with such a professional group. Our sincere and heartfelt thanks to all.

Please enjoy the proceedings!

December 2019

Sushmita Mitra
Dhruba Kumar Bhattacharyya
Prabin Kumar Bora

Preface

Recent technological advancements have played a prominent role in directing Information Technology research towards making ‘intelligent’ machines. Traditionally, intelligence has been commonly associated with humans as an intellectual characteristic, by virtue of which they demonstrate the ability to transcend trivial computations or decisions. Intelligent computations or decisions act as a driving force to deal with problems from a wide range of domains. Intelligent machines have the ability to acquire crucial knowledge from the environment, which enables them to learn and draw significant inferences based on evidences. Since these machines are knowledge-oriented, they possess the ability to generalize which makes them quite reliable. This volume covers all these aspects of machine intelligence, as an outcome of PReMI 2019, an international conference on Pattern Recognition and Machine Intelligence, held at Tezpur University, India, during December 17–20, 2019. It includes 90 full-length and 41 short papers from across the globe. It aims to provide a comprehensive and in-depth discussion of the contemporary research trends in the domain of pattern recognition and machine intelligence. The conference began with two plenary talks followed by five invited talks and oral presentations. The first plenary talk on ‘Granular Artificial Intelligence’ highlighted its applications in modelling environments and pattern recognition and was delivered by Prof. Witold Pedrycz of University of Alberta, Canada. The second plenary talk by Prof. Jayaram Udupa of University of Pennsylvania, Philadelphia, USA focused on ‘Biomedical Imaging.’

The technical sessions included parallel oral presentations under six major themes: Machine Learning and Deep Learning, Bioinformatics and Medical Imaging, Pattern Recognition and Remote Sensing, Intelligent Sensor and Information Retrieval, Signal, Image, and Video Processing, and Evolutionary and Soft Computing. The sessions included five academic talks and two industry talks. Prof. P. Bhattacharyya of IIT Patna delivered the first invited talk on ‘Imparting Sentiment and Politeness on Computers.’ Another invited talk on ‘Beyond Text Detection and Recognition: Emerging Opportunities in Scene Understanding’ was by Prof. C. V. Jawahar of IIIT Hyderabad. Prof. S. K. Saha of Jadavpur University focused his talk on ‘Cognitive Analysis using Physiological Sensing.’ The fourth invited talk, presented by Dr. Animesh Mukherjee of IIT Kharagpur, was on ‘The Rise of Hate Content in Social Media.’ Another invited talk on wireless networks was delivered by Prof. Sudip Misra of IIT Kharagpur. As in previous editions, PReMI 2019 intended to bridge the gap between academia and industry by adopting a collaborative approach in the relevant fields. As in previous years, PReMI 2019 included two industry talks to provide better exposure to academic researchers in real-life problems and recent application-oriented developments. Dr. Praneeth Netrapalli from Microsoft Research India deliberated on ‘How to Escape Saddle Point Efficiently.’ Another industry talk by Dr. Anil Kumar from the Department of Photogrammetry and Remote Sensing, Indian Institute of Remote Sensing,

Indian Space Research Organization (ISRO), Dehradun, India, focused on ‘Machine Learning and its Applications in Remote Sensing Data Classification.’

Section I of this volume primarily deals with Machine Learning and Deep Learning and their applications in diverse domains. Kannadasan et al. propose an approach to predict performance indices in Computer Numerical Control (CNC) milling using regression trees. Subramanyam et al. introduce a machine learning based method to detect dyscalculia. Dammu and Surampudi explore the temporal dynamics of the brain using Variational Bayes Hidden Markov model with applications in autism. Dutta et al. present a robust dense or sparse crowd identification technique based on classifier fusion. Buckchash and Raman present a novel sampling algorithm for sustained Self-supervised pre-training for Temporal Order Verification. John et al. analyze the retraining conditions of a network after pruning layer-wise. Jain and Phophalia introduce M-ary Random Forest algorithm, where multiple features are used for splitting at a time instead of just one in the traditional Random Forest algorithm. Jain et al. propose a dynamic weighing scheme for Random Forest algorithm. Alam and Sobha present a method for instance ranking using data complexity measures for training set selection. Karthik and Katika introduce an identity independent face anti-spoofing technique based on Random scan patterns. Das et al. propose a method for automatic attribute profile construction for spectral-spatial classification of hyperspectral images. Rathi et al. propose an enhanced depression detection method from facial cues using univariate feature selection techniques. Shanmugam and Tamilselvan propose a game theoretic approach to design an efficient mechanism for identifying a trustworthy cloud service provider by classifying the providers based on how they cooperate to form a coalition. Prasad et al. propose an incremental k-means clustering method to improve the quality of clusters. This session also includes several significant contributions on Deep Learning. Challa et al. propose a multi-class deep all CNN architecture for detection of diabetic retinopathy using retinal fundus images. Maiti et al. aim to provide a solution to the problem faced in real-time vehicle detection in aerial images using skip-connected convolutional network. Repala and Dubey use Convolutional Neural Networks for unsupervised depth estimation. Basavaraju et al. introduce a Deep CNN based technique with minimum number of skip connections to derive a High Resolution image from a Low Resolution image. Mazumdar et al. propose a technique to detect image manipulations using Siamese Convolution Neural Networks. Mishra et al. present a deep learning based model comprising of causal convolutional layers for load forecasting. Trivedi et al. present a technique for facial expression recognition using multichannel CNN. Gupta et al. propose a data driven sensing approach for action recognition. Sharma et al. propose a method for gradually growing residual and self-attention based dense deep back propagation network for large scale super-resolution image. M J et al. propose a method to solve 3D object classification on point cloud data using 3D Grid Convolutional Neural Networks (GCNN). Singh et al. introduce a new steganalysis approach to learn prominent features and avoid loss of stego signals using densely connected convolutional network. Rastogi and Gangnani outline a generalized semi-supervised learning framework for multi-category classification with generative adversarial networks.

Section II covers topics from the field of Bioinformatics and Medical Imaging. Mahapatra and Mukherjee introduce GRAPHical Footprint for classifying species in

large scale genomics. While Pant and Paul present an effective clustering method to produce enriched gene clusters using biological knowledge, Paul et al. report the impact of continuous evolution of Gene Ontology on similarity measures. Kakati et al. introduce DEGNet, a deep neural network to predict the up-regulating and down-regulating genes from Parkinson's and breast cancer RNA-seq datasets. Saha et al. perform a survival analysis study with the integration of RNA-seq and clinical data to identify breast cancer subtype specific genes. Barnwal et al. present a deep learning based Optical Coherence Tomography (OCT) image classifier for Intra Vitreal Anti-VEGF therapy. In another effort, Patowary and Bhattacharyya present an effective method for biomarker identification of Esophageal Squamous Cell Carcinoma using integrative analysis of Differentially Expressed genes. Jana et al. present a gene selection technique using a modified Particle Swarm Optimization approach. This session also includes several noteworthy contributions in the field of Biomedical Applications. Baruah et al. propose a model to simulate the effects of signal interference by mathematically modeling a pair of dendritic fibers using cable equation. While Dasgupta et al. cluster EEG signals of epileptic patients and normal individuals using feed forward neural networks, Dammu et al. report a new approach that uses brain dynamics in the classification of autistic and neurotypical subjects using rs-fMRI data. While Singh et al. use Stockwell transform to detect Dysrhythmia in ECG, Kumar et al. propose an energy efficient MEG reconstruction method. Chowdhury et al. investigate the changes in the brain network dynamics between alcoholic and non-alcoholic groups using electro-encephalographic signals. Das and Mahanta analyze segmentation techniques for cell identification from biopsy tissue samples of childhood medulloblastoma microscopic images based on conventional machine learning methods. Mahanta et al. introduce a method for automatic counting of platelets and white blood cells from blood smear images. Kumar and Maji present an effective method for automatic recognition of virus particles in Transmission Electron Microscopy (TEM) images. Roy et al. use Deep Convolutional Neural Network to detect Necrosis in mice liver tissue by classifying microscopic images after dividing them into small patches in the preprocessing phase. Deshpande and Bhatt employ Bayesian deep learning to register the medical images that are rendered corrupt by nonlinear geometric distortions. Das and Mahanta develop a novel method where the features of Adenocarcinoma and Squamous Cell Carcinoma of a histological image are taken from various statistical and mathematical models implemented on the coefficients of wavelet transform of an image. Banerjee et al. propose a new iterative method to remove the effects of motion artifacts from multiple non-simultaneous angiographic projection. Datta and Deka propose a Compressed Sensing based parallel MRI reconstruction method. Deka et al. introduce Single-image Super Resolution technique for diffusion-weighted and spectroscopic MR images. Konar et al. propose a Quantum-Inspired Bidirectional Self-Organizing Neural Network architecture for fully automatic segmentation of T1-weighted contrast enhanced MR images. Sasmal et al. present a two-class classification of colonoscopic polyps using multi directions and multi frequency texture analysis. Section III is focused on Pattern Recognition and Remote Sensing. Ahmed and Nath introduce a modified Conditional FP-tree, an efficient frequent pattern mining approach that uses both bottom-up and top-down approach to generate frequent patterns. Malla and Bhavani present a method to predict link weights

for directed Weighted Signed Networks using features from network and its dual. Dhar et al. present a content resemblance based Author Identification System using ensemble learning techniques. Baruah and Bharali present a comparative study of the airline networks on India with ANI based on some network parameters. Chittaragi and Koolagudi present a spectral feature-based dialect classification method from stop consonants. Saini et al. introduce neighborhood concepts to enhance the traditional Self-organizing maps based multi-label classification. This session also includes several interesting contributions in the field of Remote Sensing. Gadhiya et al. propose a multi frequency PolSAR image classification algorithm with stacked autoencoder based feature extraction and superpixel generation. Parikh et al. introduce an ensemble technique for land cover classification problems. Sarmah and Kalita present a supervised band selection method for hyperspectral images using information gain ratio and clustering. Baruah et al. present a non-sub-sampled shearlet transform based remote sensing image retrieval technique. Hire et al. propose a perception based navigation approach for autonomous ground vehicles using Convolutional Neural Networks (CNN). Shah et al. introduce a deep learning architecture using Capsule Network for automatic target recognition from Synthetic Aperture Radar images. Rohit and Mishra present an end-to-end trainable model of Generative Adversarial Networks used to hide audio data in images. Mankad et al. investigate feature reduction techniques for replay anti-spoofing in voice biometrics.

Session IV includes several interesting research outcomes in the field of Intelligent Sensor and Information Retrieval. Devi et al. propose a method where two layers of CNT-BioFET are fabricated for Creatinine detection. While Hazarika et al. present the modeling and analyzing of long-term drift observed in ISFET, Jena et al. present Significance-based Gate Level Pruning (SGLP) technique to design an approximate adder circuit for image processing application. Senapati and Sahu model mathematically a MOS-based patch electrode multilayered capacitive sensor. Nath et al. propose the design, implementation and working of a syringe based automated fluid infusion system integrated with micro-channel platforms for lab-on-a-chip application. Several significant works on Information Retrieval will also be discussed in this session. Chakrabarty et al. report a Joke Recommendation system, based primarily on Collaborative Filtering and Joke-Reader segmentation influenced by the similarity of the user's preference patterns. Vijai Kumar et al. propose TagEmbedSVD, a tag-based Cross-Domain Collaborative model aimed to enhance personalized recommendations in the cross-domain setting. Two of the many important aspects of recommendation systems are diversity and long tail item recommendation, which can be improved by an efficient method as presented by Agarwal et al. Pahal et al. introduce a context-aware reasoning framework that caters to the need and preferences of a group of users in a smart home environment by providing contextually relevant recommendations. Anil et al. The authors introduce a method to apply meta-path for network embedding in mining heterogeneous DBLP network. Kumar et al. introduce two techniques, one to automatically detect and filter null tweets in the Twitter data and another to identify sarcastic tweets using context within a tweet. Yumnam and Sharma propose a grammar-driven approach to parse Manipuri language using Earley's parsing algorithm. Gomathinayagam et al. introduce an information fusion-based approach for query expansion for news articles retrieval. Kumar and Singh propose a prioritized

named entity driven LDA, a variant of topic modeling method LDA, to address the issue of overlapping topics by prioritizing named entities related to the topics. Yadav et al. perform sentiment analysis to extract sentiments from a piece of text using supervised and unsupervised approach. Kundu et al. propose a method for finding active experts for a new question in order to improve the effectiveness of a question routing process in community question answering services.

Section V covers topics from the fields of Signal, Image, and Video Processing. Saikia et al. describe a case study involving a framework to classify facies categories in a reservoir using seismic data by employing machine learning models. Sahoo and Dandapat introduce a technique to analyze the changes in speech source signals under physical exercise induced out-of-breadth condition. Mukherjee et al. present a long short-term memory-recurrent neural network for segregating musical chords from clips of short durations which can aid in automatic transcription. Kamble et al. propose a novel Teager energy based sub-band features for audio acoustic scene detection and classification. Pj et al. propose an audio replay attack detection technique using non-voiced audio segments and deep learning models like CNN to classify the audio as genuine or replay. Jyotishi and Dandapat use inverse filtering-based technique to present a novel feature to represent the amount of nasalization present in a vowel. Bhat and Shekar propose an approach for iris recognition by learning fragile bits on multi-patches using monogenic riesz signals. Baghel et al. present a shouted and normal speech classification detection mechanism using 1D CNN architecture. Qadir et al. aim to provide a quantitative analysis of electroencephalographic-based cognitive load while driving in Virtual Reality (VR) environment compared to a fixed non-VR environment. A good number of contributions on Image and Video Processing are also part of this session. Mukherjee et al. propose an unsupervised detection technique for mine regions with reclamation activity from satellite images. Meetei et al. introduces a text detection technique in natural scene and document images in Manipuri and Mizo. Mukherjee et al. propose a method to generate segmented surface of a mapping environment in modeling 3D objects from Lidar data. Koringa and Mitra propose a class similarity based orthogonal neighborhood preserving projection technique for recognition of images with face and hand-written numerals. Mondal et al. introduce a novel combinatorial algorithm for segmentation of articulated components of 3D digital objects using Curve Skeleton. Rajpal et al. propose EAI-Net, an effective and accurate iris segmentation network based on U-Net architecture. Memon et al. use ANN and XGBoost algorithms to classify data for land cover categorization in Mumbai region. Selvam and Mishra introduce a multi-scale attention aided multi-resolution feature extractor baseline network for human pose estimation. Tiwari et al. present a CNN-based method to detect splicing forgery in images using camera-specific features. Vishwakarma et al. propose a multi-focus image fusion technique using sparse representation and modified difference. Biswas and Barma focus on the quality assessment of agricultural product based on microscopic image, generated by Foldscope. Kagalkar et al. propose a learning-based pipeline with image clustering and image selection methods for 3D reconstruction of heritage sites. Sharma and Dey describe a method to analyze the texture quality of fingerprint images using Local Contrast Phase Descriptor. Adarsh et al. present a novel framework for detecting and filling missing regions in point cloud data using clustering techniques. Mullah et al. present a sparsity

regularization based spatial-spectral super-resolution method for multispectral remote sensing image. Chetia et al. introduce a quantum image edge detection technique based on four directional sobel operator. Hatibaruah et al. propose a method for texture image retrieval using multiple low and high pass filters and decoded sparse local binary pattern. Devi and Borah propose a new feature extraction approach where both multi-layer and multi-model features are extracted from pre-trained CNNs for aerial scene classification. Bhowmik et al. present a novel high-order Vector of Locally Aggregated Descriptors (VLAD) with increased discriminative power for scalable image retrieval. Pal et al. perform Image-based analysis of patterns formed in drying drops of a colloidal solution. Choudhury and Sarma propose a two-stage framework for detection and segmentation of writing events in air-written Assamese characters. Purwar et al. present an innovative method to offer a promising deterrent against alcohol abuse using Augmented Reality (AR) as a tool. Roy and Bag introduce a detection mechanism for handwritten document forgery by analyzing writer's handwriting. Prabhu et al. use it as a feature extractor for face recognition techniques. Naosekpan et al. propose a novel scalable non-parametric scene parsing system based on super-pixels correspondence. Saurav et al. introduce an approach towards automatic autonomous vision-based powerline segmentation in aerial images using convolutional neural networks. Bhunia et al. present a new correlation filter based visual object tracking method to improve accuracy and robustness of trackers. Kumar et al. introduce an efficient way to detect objects in 360° videos for robust tracking. Singh and Sharma introduce an effective hybrid change detection algorithm in real-time applications using centre-symmetric local binary patterns. Jana et al. present a novel multi-tier fusion strategy for event classification in unconstrained videos using deep neural networks.

In Session VI, several significant contributions in the field of Evolutionary and Soft Computing are reported. Dhanalakshmy et al. analyze and empirically validate the impact of mutation scale factor parameter of the Differential Evolution algorithm. Pournami et al. discuss a scheme to modify the conventional PSO algorithm and use it to present an image registration algorithm. Lipare and Edla propose an approach where a shuffling strategy is applied to PSO algorithm for improving energy efficiency in WSN. Srivatsa et al. propose a GA based solution to solve the classic Sudoku problem. Indu et al. present a critical analysis of an existing prominent graph model of evolutionary algorithms. Singh and Bhukya present an evolutionary approach based on a steady-state GA for selection of multi-point relays in Mobile Ad-Hoc networks. Shaji et al. propose a new Aggregated Rank Removal Heuristic applied to adaptive large neighborhood search to solve Work-over Rig Scheduling Problem. Saharia and Sarmah report a method for optimal design of a DC-DC converter with the goal of minimizing overall losses. Bandagar et al. propose a MapReduce based distributed/parallel approach for standalone fuzzy-rough attribute reduction algorithm. Bar et al. attempt to find an optimal rough set reduct having least number of induced equivalence classes or granules with the help of A* Search algorithm.

We are very grateful to all the esteemed reviewers who were deeply involved in the review process and helped improve the quality of the research contributions. We are privileged and delighted to acknowledge the continuous support received from various committees, sub-committees, and Springer LNCS in preparing this volume of the prestigious PReMI 2019. Thanks are also due to Sushant Kumar, Muddashir, and

Kabita for taking on the major load of secretarial jobs. Finally, we also extend our heartfelt thanks to all those who helped host the PReMI 2019 reviewing process on the EasyChair.org site. We hope that PReMI 2019 was an academically productive conference and you will find the proceedings to be a valuable source of reference for your ongoing and future research.

We hope you will enjoy the proceedings!

December 2019

Pradipta Maji
Bhabesh Deka
Sushmita Mitra
Dhruba Kumar Bhattacharyya
Prabin Kumar Bora
Sankar Kumar Pal

Message from the Honorary General Chair

I am delighted to see that the eighth edition of the biennial International Conference on Pattern Recognition and Machine Intelligence, PReMI 2019, was held, for the first time, in the north-east region of our country at Tezpur University, Assam, India, during December 17–20, 2019. Assam is the most vibrant among the eight states in the north-east, rich in natural resources, and has a great touristic charm. PReMI 2017 was held in the year that marked the 125th birthday of late Prof. Prasanta Chandra Mahalanobis, the founder of our Indian Statistical Institute (ISI). PReMI 2019, on the other hand, was organized when our ISI was preparing to celebrate the birth centenary of another doyen in statistics, namely, Prof. C. R. Rao, a living legendary. Prof. Rao has always been an inspiration to us, and was associated in different capacities with PReMI.

Since its inception in 2005, PReMI has always drawn big responses globally in terms of paper submission. This year, PReMI 2019 was no exception. It has a nice blend of plenary and invited talks, and high-quality research papers, covering different facets of pattern recognition and machine intelligence with real-life applications. Both classical and modern computing paradigms are explored. Special emphasis has been given to contemporary research areas such as big data analytics, deep learning, AI, Internet of Things, and Smart and Intelligent Sensors through both regular and special sessions. Some pre-conference tutorials were also arranged for the beginners. All this made PReMI 2019 an ideal state-of-the-art platform for researchers and practitioners to exchange ideas and enrich their knowledge.

I thank all the participants, speakers, reviewers, different chairs, and members of various committees for making this event a grand success. My thanks are due to the sponsors for their support, and Springer for publishing the PReMI proceedings under the prestigious LNCS series. Last, but not the least, I sincerely acknowledge the support of Tezpur University in hosting the event. I believe, the participants had an academically fruitful and enjoyable stay in Tezpur.

December 2019

Sankar Kumar Pal

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Abstracts of Invited Talks

Granular Artificial Intelligence: A New Avenue of Artificial Intelligence for Modeling Environment and Pattern Recognition

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Recent advancements in Artificial Intelligence fall under the umbrella of industrial facets of AI (Industrial AI, for short) and explainable AI (XAI). We advocate that in the realization of these two pursuits, information granules and Granular Computing play a significant role. First, it is shown that information granularity is of paramount relevance in building meaningful linkages between real-world data and symbols commonly encountered in AI processing. Second, we stress that a suitable level of abstraction (information granularity) becomes essential to support user-oriented framework of design and functioning AI artifacts. In both cases, central to all pursuits is a process of formation of information granules and their prudent characterization. We discuss a comprehensive approach to the development of information granules by means of the principle of justifiable granularity; here various construction scenarios are discussed. In the sequel, we look at the generative and discriminative aspects of information granules supporting their further usage in the formation of granular artifacts, especially pattern classifiers. A symbolic manifestation of information granules is put forward and analyzed from the perspective of semantically sound descriptors of data and relationships among data.

Imparting Sentiment and Politeness on Computers

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In this talk we will describe the attempts made at making machines “more human” by giving them sentiment and politeness abilities. We will give a perspective on automatic sentiment and emotion analysis, with a description of our work in this area, touching upon the challenging problems of sarcasm arising from numbers, and multitask and multimodal sentiment and emotion analysis. Subsequently we touch upon the interesting problem of “making computers polite” and our recent work on this. We will end with noting the places of rule based, classical ML based and deep learning-based approaches in NLP.

Beyond Text Detection and Recognition: Emerging Opportunities in Scene Understanding

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Recent years have seen major advances in the performance of reading text in natural outdoor. Methods for text detection and recognition, are reporting very high quantitative performances on popular benchmarks. In this talk, we discuss a set of opportunities in scene understanding where text plays a critical role. Many associated challenges, ongoing research and emerging opportunities for research are discussed.

Cognitive Analysis Using Physiological Sensing

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Cognitive load is a measure of the processing done using working memory of the brain. The effectiveness of an activity is dependent on the amount of cognitive load experienced by an individual. Subjected to a task, assessing the cognitive load of an individual may be useful in evaluating the individual and/or task. Physiological sensing can help in cognitive analysis. EEG, GSR, PPG sensors, Eyegaze tracker can sense different aspects. Talk will mostly focus on EEG signal and eye gaze data and their processing. Their applicability in assessing the readability of text materials will also be highlighted.

The Rise of Hate Content in Social Media

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The recent online world has seen an upheaval in the fake news, misinformation, misbehavior and hate speech targeted toward communities, race and gender. This has resulted in severe consequences. Reports say, that the last US election was heavily influenced by the social media (<https://www.bbc.com/news/technology-46590890>). The EU referendum similarly was under social media influence (<https://www.referendumanalysis.eu/eu-referendum-analysis-2016/section-7-socialmedia/impact-of-social-media-on-the-outcome-of-the-eu-referendum/>). Facebook has been considered responsible for the spread of unprecedented volume of hate content resulting into Rohingya genocide. The Pittsburg Synagogue shooter was an active member of the extremist social media website GAB where he continuously posted anti-Semitic comments finally resulting into the shooting. Similar cases have been reported for the Tamil Muslim community in Sri Lanka, attacks on refugees in Germany and the Charleston church shooting incident. A concise report of the events and the damages caused thereby is present in this article from the Council on Foreign Relations (<https://www.cfr.org/backgrounder/hatespeech-social-media-global-comparisons>).

Since 2017, we have started to put in focused efforts to tackle this problem using computational techniques. Note that this is not a computer science problem per se; this is a much larger socio-political problem. As a first work we show how simple opinion conflicts among social media users can lead to abusive behavior (CSCW 2018, <https://techxplore.com/news/2018-10-convolutional-neural-networkabuse-incivility.html>). As a next step we investigate the GAB social network and show how hateful users are much more densely connected among each other compared to others; how the messages posted by hateful users spread far, wide and deep into the social network compared to the normal users (ACM WebSci 2019). Consequently, we propose a solution to this problem; as such suspending hateful accounts or deleting hate messages is not a very elegant solution since this curbs the freedom of speech. More speech to counter hate speech has been thought to be the best solution to fight this problem. In a recent work we characterize the properties of such counter speech and show how they vary across target communities (ICWSM 2019). Presently, we are also investigating how the hate patterns change if they are allowed to evolve in an unmoderated environment. To our surprise we observe that hatespeech is steadily increasing and new users joining are exposed to hate content at an increased and faster rate. Further the language of the whole community is driven to the language of the hate speakers. We believe that this is just the beginning. There are many challenges that need to be yet addressed. For instance, we plan to investigate how misinformation and hate content

are related - do they influence each other? Can containing one of them automatically contain the other to some extent at least? In similar lines, how does hate content affect gender and cause gender/sex related discrimination/crime.

In this talk, we will try to present a summary of some of the above experiences that we have had in the last few years relating to our ventures into hate content analysis in social media.

How to Escape Saddle Points Efficiently?

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Non-convex optimization is ubiquitous in modern machine learning applications. Gradient descent based algorithms (such as gradient descent or Nesterov’s accelerated gradient descent) are widely used in practice since they have been observed to perform well on these problems. From a theoretical standpoint however, this is quite surprising since these nonconvex problems are teeming with highly suboptimal saddle points, and it is well known that gradient descent (and variants) can get stuck in such saddle points. A key question that arises in resolving this apparent paradox is whether gradient descent based algorithms escape saddle points where the Hessian has negative eigenvalues and converge to points where Hessian is positive semidefinite (such points are called second-order stationary points) efficiently. We answer this question in the affirmative by showing the following: (1) Perturbed gradient descent converges to second-order stationary points in a number of iterations which depends only poly-logarithmically on dimension (i.e., it is almost “dimension-free”). The convergence rate of this procedure matches the wellknown convergence rate of gradient descent to first-order stationary points, up to log factors, and (2) A variant of Nesterov’s accelerated gradient descent converges to second-order stationary points at a faster rate than perturbed gradient descent. The key technical components behind these results are (1) understanding geometry around saddle points and (2) designing a potential function for Nesterov’s accelerated gradient descent for non-convex problems.

Machine Learning and Its Application in Remote Sensing Data Classification Applications

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From 2000 onwards sub-pixel or later called soft classification has been explored very extensively. Later learning based algorithm taken over when modified forms of learning algorithms were proposed. Artificial Neural networks (ANN) is a generic name for a large class of machine learning algorithms, most of them are trained with an algorithm called back propagation. In the late eighties, early to mid-nineties, dominating algorithm in neural nets was fully connected neural networks. These types of networks have a large number of parameters, and so do not scale well. But convolutional neural networks (CNN) are not considered to be fully connected neural nets. CNNs have convolution and pooling layers, whereas ANN have only fully connected layers, which is a key difference. Moreover, there are many other parameters which can make difference like number of layers, kernel size, learning rate etc. While applying Possibilistic c-Means (PCM) fuzzy based classifier homogeneity within class was less while observing learning based classifiers homogeneity was found more. Best class identification with respect to homogeneity within class was found in CNN soft output as shown in the figure. With this it gives a path to explore various deep learning algorithms in various applications of earth observation data like; multi-sensor temporal data in crop/forest species identification, remote sensing time series data analysis. As learning based algorithms require large size of training data, but in remote sensing domain it's difficult to generate large training data sets. This issue also has been resolved in this research work.

Brief History of Topic Models

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The success of Machine Learning is often attributed to Supervised Learning models. Comparatively, progress on learning models without supervision is limited. However, Unsupervised Learning has the potential of unlocking a whole new class of applications. In this tutorial we will discuss Topic models, an important class of Unsupervised Learning Models which have proven to be extremely successful in practice. The tutorial will discuss a self-contained introduction to learning Latent variable models (LVMs) and will discuss Topic models as a special case of LVMs. Time permitting, recent results on deriving sample complexity of Topic models will be also covered.

Introduction to Compressed Sensing

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Compressed sensing is a relatively new sensing paradigm that proposes acquisition of images directly in compressed format. This is different from the more conventional sensing methods where the entire 2D image array is first measured followed by JPEG/MPEG compression after acquisition. Compressed sensing basically aims to reduce *acquisition time*. It has shown great results in speeding up MRI (magnetic resonance imaging) acquisition where time is critical, in improving frame rates of videos, and in general in improving acquisition rates in a variety of imaging modalities.

Central to compressed sensing is the solution to a seemingly under-determined system of linear equations, i.e. a system of equations where the number of unknowns (n) is greater than the number of knowns (m). Hence at first glance, there will be infinitely many solutions. However the theory of compressed sensing states that if the vector of unknowns is sparse, and the system's sensing matrix obeys certain properties, then the system is provably well-posed and unique solutions can be guaranteed. Moreover, the theory also states that the solution can be computed efficiently, and is robust to measurement noise or slight deviations from sparsity.

In this talk, I will give an introduction to the above concepts. I will also introduce a few applications, and enumerate a few research challenges/directions.

Novel Support Vector Machine Algorithms for the Diagnosis of Alzheimer's Disease

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Support vector machine (SVM) has provided excellent performance and has been widely used in real world classification problems due to many attractive features and promising empirical performance. Different from constructing two parallel hyperplanes in SVM, recently several non-parallel hyperplane classifiers have been proposed for classification and regression problems. In this talk, we will discuss novel non-parallel SVM algorithms and their applications to Alzheimer's disease. Numerical experiments clearly show that non-parallel SVM algorithms outperform traditional SVM algorithms. This talk concludes that non-parallel SVM variants could be the viable alternative for classification problems.

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