National Institute of Technology Tiruchirappalli
Electronics and Communication Engineering
Patten recognition and Computational Intelligence group

COMPSIG NITT

Second International Conference on Machine Learning, Deep Learning and Computational Intelligence for Wireless Communication

MDCWC 2023

22nd to 24th June 2023

Hybrid event

ONE EARTH – ONE FAMILY – ONE FUTURE

PATRON

Prof. Dr. (Mrs.) G. Ahila,

Beloved Director,

National Institute of Technology Tiruchirappalli

Previously, Dr. Aghila served as Registrar-in-charge of NIT Puducherry where she was a Professor of Computer Science and Engineering. She preserved PhD from Anna University, Chennai, Dr. Aghila has contributed significantly to the fields of Block Chain, Big Data Analytics, Ontology Engineering, Cheminformatics and AI. NIT Tiruchirappalli, which is the 9th best NIRF-ranked Engineering Institute, is poised to reach greater heights under the new Director. While taking charge, she said that her priority is to make NIT Trichy more visible at the national and global levels. Dr. Aghila brings with her the wealth of a 32-year career in which she has carved a niche as both an academic and an administrator.

GUEST OF HONOUR

EDUCATION REFORMER

Prof. Dr. M. Chidambaram,
Former Beloved Director,
National Institute of Technology Tiruchirappalli,
Retired professor from IIT Madras.

Dr. M. Chidambaram has completed his B.E. from Annamalai University with First Class and Distinction in 1975. He completed his M.E. from the Indian Institute of Science, Bangalore, in 1977 with distinction. Later on, he completed his Ph.D. on “Studies on Slurry Reactors” in 1984. From 1984 to 1991, he was the faculty member at the Indian Institute of Technology, Bombay. Later, he joined the Indian Institute of Technology Madras, where he served as the faculty from 1991 to 2017. He also served as the head of the department from 2000 to 2003. He worked as the director from 2005 to 2010 at National Institute of Technology Tiruchirappalli. He was working as an emeritus professor at NIT Warangal from September 2018 to June 2021. He was one of the top 2% of scientists (based on the report given by Stanford University Studies). He has authored 190+ national and international journal papers. He has authored or coauthored 10 books. He had academic visits to the USA, Germany, Singapore, Malaysia, the U.A.E., Japan, South Korea, and Ireland

ORGANIZERS AND EDITORS

Dr. E.S. Gopi, Convener and Conference Chair, MDCWC 2023

Co-ordinator and Head, Pattern recognition and Computational intelligence group

Associate professor, Department of ECE, National Institute of Technology Tiruchirappalli

Dr. P. Maheswaran, Co-ordinator, MDCWC 2023

Assistant professor, Department of ECE, National Institute of Technology Tiruchirappalli

KEYNOTE

Prof. Arumugam Nallanathan
Professor of Wireless Communications, FIEEE, FIET, CEng,
Web of Science Highly Cited Researcher
Founding Head of Communication Systems Research (CSR) Group
School of Electronic Engineering and Computer Science
Queen Mary University of London

Dr. Jithin Jagannath

Chief Scientist of Technology, ANDRO Computational Solutions, LLC
Founding Director of Marconi-Rosenblatt AI/ML Innovation Lab
Adjunct Assistant Professor,
Department of Electrical Engineering at the University at Buffalo
IEEE Senior Member | IEEE Region 1 Technological Innovation Awardee
AFCEA International Meritorious Rising Star Awardee | AFCEA 40 Under 40

INVITED TALKS AND SESSION CHAIRS

Dr. Anamika Singh, VNIT, Nagpur (Session chair)

Dr. Narayanan C Krishnan, Head, Department of Data science, IIT Palakkad (Invited Talk)

Dr. Prabhat Kumar Sharma, Department of ECE, VNIT Nagpur (Invited Talk and Session chair)

Dr. Rahul Meshram, Department of Electrical Engineering, IIT Madras (Invited Talk and Session chair)

Dr. Shyam Lal, NIT, Karnataka (Session chair)

Dr. Swaminathan, Department of ECE, IIT Indore (Invited Talk and Session chair)

Dr. S. Deivalakshmi, Department of ECE, NIT Tiruchirappalli (Session chair)

Dr. E.S. Gopi, Department of ECE,NIT Tiruchirappalli (Session chair)

Dr. P. Maheswaran, Department of ECE, NIT Tiruchirappalli (Session chair)

Dr. Oswald, Department of CSE,NIT Tiruchirappalli (Session chair)

Dr. Shameedha Begam, Department of CSE, NIT Tiruchirappalli (Session chair)

Dr. P.Sudharshan, Department of ECE, NIT Tiruchirappalli (Session chair)

Dr. G. Thavasi Raja, Department of ECE,NIT Tiruchirappalli (Session chair)

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Dr Naresh Kumar Reddy B

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Dr Murali Krishna

KEY NOTE 1:

FEDERATED LEARNING FOR ENERGY LIMITED WIRELESS NETWORKS

Prof. Arumugam Nallanathan

Professor of Wireless Communications, FIEEE, FIET, CEng,

Web of Science Highly Cited Researcher

Founding Head of Communication Systems Research (CSR) Group

School of Electronic Engineering and Computer Science

Queen Mary University of London

Abstract: Federated learning (FL) is a promising distributed learning approach for protecting data privacy. In FL, edge devices collaboratively train a model under the orchestration of a parameter server (PS), which only requires local learning models/gradients instead of local private data. FL operations can be divided into two parts, namely the communication part and the computation part. For the communication part, the learning performance is constrained by the limited communication resources, e.g., bandwidth and energy. For the computation part, the model accuracy is degraded by non-independent and identically distributed (non-IID) data samples. More specifically, the inadequate wireless resources hinder more devices devoted to the FL training process, and thus negatively affect the convergence speed and learning accuracy. Moreover, since the PS aggregates models learned from the different devices, the data heterogeneity presented on different devices may lead to weak generalization ability of the trained global model, even resulting in an unstable training process of FL. Therefore, FL needs well-designed solutions to address these two challenges. In this talk, two approaches, namely a partial model aggregation-based approach and a knowledge-aided FL approach will be presented. Promising research directions and possible FL solutions will also be discussed, e.g., bandwidth and energy. For the computation part, the model accuracy is degraded by non-independent and identically distributed (non-IID) data samples. More specifically, the inadequate wireless resources hinder more devices devoted to the FL training process, and thus negatively affect the convergence speed and learning accuracy. Moreover, since the PS aggregates models learned from the different devices, the data heterogeneity presented on different devices may lead to weak generalization ability of the trained global model, even resulting in an unstable training process of FL. Therefore, FL needs well-designed solutions to address these two challenges. In this talk, two approaches, namely a partial model aggregation-based approach and a knowledge-aided FL approach will be presented. Promising research directions and possible FL solutions will also be discussed.

Bio: Arumugam Nallanathan is a Professor of Wireless Communications and the founding head of the Communication Systems Research (CSR) group in the School of Electronic Engineering and Computer Science at Queen Mary University of London since September 2017. He was with the Department of Informatics at King's College London from December 2007 to August 2017, where he

was Professor of Wireless Communications from April 2013 to August 2017. He was an Assistant Professor in the Department of Electrical and Computer Engineering, National University of Singapore from August 2000 to December 2007. His research interests include 6G Wireless Networks and Internet of Things (IoT). He published nearly 600 technical papers in scientific journals and international conferences. He is a co-recipient of the Best Paper Awards presented at the IEEE International Conference on Communications 2016 (ICC'2016), IEEE Global Communications Conference 2017 (GLOBECOM'2017) and IEEE Vehicular Technology Conference 2017 (VTC'2017). He is a co-receipient of the IEEE Communications Society Leonard G. Abraham Prize, 2022. He is an Editor-at-Large for IEEE Transactions on Communications and a senior editor for IEEE Wireless Communications Letters. He was an Editor for IEEE Transactions on Wireless Communications (2006-2011), IEEE Transactions on Vehicular Technology (2006-2017), IEEE Signal Processing Letters and a Guest Editor for IEEE Journal on Selected Areas in Communications (JSAC). He served as the Chair for the Signal Processing and Computing for Communications (SPCC-TC) of IEEE Communications Society and Technical Program Chair and member of Technical Program Committees in numerous IEEE conferences. He received the IEEE Communications Society SPCE outstanding service award 2012 and IEEE Communications Society RCC outstanding service award 2014. He has been selected as a Web of Science (ISI) Highly Cited Researcher in 2016 and 2022. He is an IEEE Fellow and IEEE Distinguished Lecturer.

KEYNOTE 2

RADIO FREQUENCY MACHINE LEARNING FOR EDGE DEPLOYMENT: HOW TO DESIGN AI/ML MODELS FOR NEXTG WIRELESS APPLICATIONS

Dr. Jithin Jagganathan

Chief Scientist of Technology, ANDRO Computational Solutions, LLC
Founding Director of Marconi-Rosenblatt AI/ML Innovation Lab
Adjunct Assistant Professor,
Department of Electrical Engineering at the University at Buffalo
IEEE Senior Member | IEEE Region 1 Technological Innovation Awardee
AFCEA International Meritorious Rising Star Awardee | AFCEA 40 Under 40

Abstract: Radio Frequency Machine learning for Edge Deployment: How to Design AI/ML models for NextG Wireless Applications. The recent emergence of machine learning approaches for enhancing wireless communications and empowering them with much-desired intelligence holds immense potential for redefining wireless communication including 6G, radio frequency (RF) signal intelligence, distributed networking, among others. In this talk, we will take a closer look at some of the applications of Radio Frequency Machine learning (RFML) at the edge for both spectrum sensing and autonomous transceiver control. First, we will look at a novel cross-domain attentional multi-task architecture - xDom - for robust real-world wireless RF fingerprinting. To the best of our knowledge, this was the first time such a comprehensive attention mechanism has been applied to solve RF fingerprinting problem. In this work, we resort to real-world IoT WiFi and Bluetooth (BT) emissions (instead of synthetic waveform generation) in a rich multipath and unavoidable interference environment in an indoor experimental testbed. Next, to improve the performance for frequency hopping nature of Bluetooth, we designed an embedding-assisted attentional framework (Mbed- ATN) suitable for fingerprinting actual Bluetooth devices. We closely evaluate the complexity of the model and test its fingerprinting capability with real-world Bluetooth dataset collected under a different time frame and experimental setting while being trained on another. Finally, we will look at how Deep reinforcement learning model is deployed on the next generation of GPU-embedded software defined radio to autonomously select frequency and power level in the presence of jamming attacks. Therefore, in the talk, we will look at some real-world over-the-air advances made in the field of RFML.

Bio: Dr. Jithin Jagganathan received his Ph.D. degree from Northeastern University. He is the Chief Scientist of Technology and the Founding Director of the Marconi-Rosenblatt AI/ML Innovation Lab at ANDRO Computational Solutions. He is also the Adjunct Assistant Professor in the Department of Electrical Engineering at the University of Buffalo, State University of New York. He is an IEEE Senior member and serves as an IEEE SPS Applied Signal Processing Systems Technical Committee member.

Dr. Jagannath was the recipient of the 2021 IEEE Region 1 Technological Innovation Award with the citation, "For innovative contributions in machine learning techniques for the wireless domain". He is also the recipient of AFCEA International Meritorious Rising Star Award for achievement in Engineering and AFCEA under 40. Dr. Jagannath's recent research has led to over 40 peer-reviewed journal and conference publications and 12 patents (granted and pending).

Dr. Jagannath heads several of the ANDRO's research and development projects in the field of 5G and beyond, signal processing, signal intelligence, applied machine learning, protocol design for ad hoc networks, Internet-of-Things, and UAV automation. He has been the Principal Investigator of several Rapid Innovation Fund (RIF)s and Small Business Innovation Research (SBIR)s with the objectives of designing and developing novel solutions in the domain of intelligent wireless networking, machine learning, MIMO wireless communication, and signal detection and classification among others. These projects serve several customers including the U.S. Army, U.S. Navy, USSOCOM, and the Department of Homeland Security (DHS). He is currently leading several teams developing commercial products such as SPEARLink™, DEEPSpec™, among others. Dr. Jagannath has been invited to give various talks including Keynotes on the topic of machine learning and Beyond 5G wireless communication. He has been invited to serve on the Technical Program Committee (TPC), editor, and reviewer of several leading journals and conferences.

INVITED SPEAKER

BIOLOGICAL AND MOLECULAR COMMUNICATIONS: FUNDAMENTALS, EVOLUTION, AND ROLE IN 6G AND BEYOND COMMUNICATION

Dr. Prabhat Kumar sharma

Department of Electronics and Communication Engineering,
Visvesvaraya National Institute of Technology, Nagpur, India

Abstract: The engineered molecular communication has got notable attention from the communication researchers due to its possible application in a wide range of areas such as disease detection, disease treatment, lab-on-chip and toxic agent detection in the environment. In molecular communication the nanomachines which are used as transmitter and receiver are equipped with actuating and sensing mechanisms i.e., transmitter nanomachines (TN) have the ability to actuate the transmission of information through molecules by sensing the surrounding conditions, and receiver nanomachines are capable of sensing the information carrying molecules. This talk will focus on the fundamentals and current advancements in the area of molecular and biological communications. We will also discuss the role of molecular and biological communications in the future generation communication systems such as 6G and beyond.

Bio: Prabhat Kumar Sharma (Senior Member, IEEE) received the B.Tech. and M.Tech. degrees in Electronics and Communication Engineering and VLSI design from Uttar Pradesh Technical University, Lucknow, and Malaviya National Institute of Technology, Jaipur, respectively. and the Ph.D. degree in wireless communications from the University of Delhi in 2015. He is an Assistant Professor at the Department of Electronics and Communication Engineering, Visvesvaraya National Institute of Technology, Nagpur, India. He has authored over 80 journal and conference papers. His current research interests include Molecular and Biological Communications, and 6G and Beyond Wireless Communications Systems. He is the recipient of the Visvesvaraya Young Faculty Research Fellowship from the Ministry of Electronics and Information Technology, Government of India, and URSI/InRaSS Young Indian Radio Scientist Award 2019. Dr. Sharma is currently serving on the editorial boards of IEEE Transactions of Molecular Biological and Multiscale communications and IEEE Wireless Communication letters.

INVITED SPEAKER

AUTOMATIC CODE AND INTERLEAVER CLASSIFICATION USING CONVENTIONAL AND ML TECHNIQUES

Dr. Swaminathan

Department of Electronics and Communication Engineering,

Indian Institute of Technology Indore

Abstract: Non-cooperative scenarios exist particularly in electronic warfare, military, spectrum surveillance, signals intelligence (SIGINT), and communications intelligence (COMINT) systems, where the noisy data sequence is obtained from an unknown communication system. Thus, automatic classification of error correcting codes and interleavers plays a vital role in non-cooperative communication. Moreover, it is always a costly and tedious process to design separate receivers for every communication standard in use around the world. Recent advancements in modern wireless digital communication techniques motive us to design intelligent receivers that can adapt to any communication applications. Thus, automatic channel code and interleaver classification plays a significant role in the design of intelligent receiver for future generation communication systems. In this talk, various state-of-the-art conventional and machine learning (ML) techniques for code and interleaver classification from incoming erroneous data sequence that have been proposed in the literature will be discussed in detail.

Bio: Dr. R. SWAMINATHAN (Senior Member IEEE) received the B.Tech. degree in Electronics and Communication Engineering from SASTRA University, Thanjavur, in 2009, the M.E. degree in communication systems from the College of Engineering Guindy, Anna University, Chennai, in 2011, and the Ph.D. degree from IIT Kharagpur, in 2016. He worked as a Postdoctoral Research Fellow with Nanyang Technological University (NTU), Singapore, from 2015 to 2019. He is currently working as an Assistant Professor with the Department of Electrical Engineering, IIT Indore. He is also associated with the Center of Futuristic Defense and Space Technology (CFDST), Center for Electric Vehicle and Intelligent Transport Systems (CEVITS) at IIT Indore. He is currently serving as a CEO of IITI Advanced Centre for Entrepreneurship (ACE) Foundation (i.e. Incubation Centre of IIT Indore) and also as a Professor-In-Charge of Centre for Entrepreneurship Education and Development (CEED), IIT Indore. He is the author or co-author of more than 60 reputed journal and IEEE conference publications. His current research interests include broad areas in Wireless Communications, Communication Systems and Coding Theory. He received the Gold Medal from the College of Engineering Guindy, Anna University. He has given invited talks on entrepreneurship and wireless communications on several occasions at leading engineering institutions. He has organized five faculty development programs (FDPs), short-term courses (STCs), bootcamps, and workshops funded by SERB, ATAL Academy,

AICTE-QIP, TEQIP-III, and MP Startup Centre. Further, he has also secured four funded research projects as a Principal Investigator (PI) from DST-SERB and CSIR, as well as successfully completed two consultancy projects for Airtel and Danish Management, Denmark (consulting firm for India-European Union standardization project) with a total valuation of more than Rs 80 Lakhs. He has been serving as a reviewer for reputed IEEE journals and as a TPC member for reputed IEEE conferences. He has been honored as an Exemplary Reviewer by IEEE Communications Society, USA for the year 2021 towards significant contributions in reviewing IEEE Communications Letters journal.

INVITED SPEAKER

REINFORCEMENT LEARNING ALGORITHMS FOR RESTLESS MULTI-ARMED BANDIT PROBLEM

Dr. Rahul Meshram

Department of Electrical Engineering

Indian Institute of Technology Madras

Abstract: Many resource allocation problems in wireless communication systems (age of information, cognitive radio, opportunistic communication), and operation research (machine maintenance , healthcare, recommendation systems) are modeled as sequential decision problem using Markov decision processes and restless multi-armed bandit. We consider finite-state, finite-action Markov decision processes, and present simple value-iteration algorithm. We discuss model free reinforcement learning algorithms (Q-learning, DQN). We next consider finite state restless multi-armed bandit (RMAB) problem. The decision maker can act on M bandits out of N bandits in each time-step. The play of arm (active arm) yields state dependent rewards based on action and when the arm is not played, it also provides rewards based on the state and action. The objective of the decision maker is to maximize the infinite horizon discounted reward. We discuss the Whittle index policy, rollout policy and myopic policy. We present model free reinforcement learning algorithms (Q-learning and DQN) for RMAB. We analyse the reinforcement learning algorithm using two-timescale stochastic approximation scheme. We illustrate the performance proposed learning algorithm with numerical examples.

Bio: Dr. Rahul Meshram is an Assistant Professor at Department of Electrical Engineering, IIT Madras. He obtained B.E. from Nagpur University in 2006, M.E. from Indian Institute of Science Bangalore in 2010, and PhD from IIT Bombay 2017. He was a postdoctoral fellow at University of Waterloo, Canada in 2018. He was the institute postdoctoral fellow at IIT Madras from July 2019 till July 2020. He worked as Assistant Professor at ECE Dept. IIIT Allahabad from April 2021 till April 2023. His current area of interests are in Communication Systems, Stochastic optimization, Markov decision processes, and Reinforcement Learning.

INVITED SPEAKER

GAN - CHARACTERIZING ITS CONVERGENCE AND ITS APPLICATION FOR ZERO-SHOT LEARNING.

Dr. Narayanan C Krishnan,
Head, Department of Data science,
Indian Institute of Technology Palakkad

Title: GAN - Characterizing its convergence and its application for zero-shot learning.

Abstract: Generative Adversarial Networks (GANs) have revolutionized the field of machine learning by enabling the generation of realistic synthetic data. GANs consist of a generator and a discriminator that engage in a game-theoretic competition, driving the generator to produce increasingly convincing samples. In this talk we first discuss the application of GANs in zero-shot learning, Semantically Aligned Bias-Reducing Zero-Shot Learning that combines GANs with bias reduction techniques to mitigate the inherent bias in zero-shot learning systems, improving their generalization performance. Despite their impressive capabilities, the convergence behavior of GANs has been a challenging aspect to characterize. The second part of the talk aims to explore the concept of GAN convergence through perturbed and proximal duality gaps.

Bio: Narayanan (CK) Chatapuram Krishnan's research is driven by questions arising from the need to learn with limited supervision. Currently, his research interests are centered on building explainable, generative, and generalizable models. His research work has been published in conferences such as ICML, IJCAI, ECML, CVPR, IJCNN, and journals such as AIJ and TKDE. He serves as a program committee member at various conferences and has received outstanding reviewer awards at NeurIPS. He recently also served as a co-chair for the Indo-German Frontiers of Engineering Meeting 2021 organized by DST and Humboldt Foundation. His research is supported by funding from DST and the industry. He obtained his Ph.D. in Computer Science and Engineering from Arizona State University in 2010 and also worked as a research faculty at Washington State University. Prior to joining IIT Palakkad, he was a faculty in the department of computer science and engineering at IIT Ropar

WORKSHOP 1

REVISIT BAYES TECHNIQUE FOR MACHINE LEARNING FOR WIRELESS COMMUNICATION

Dr. E.S. Gopi

Department of Electronics and Communication Engineering

National Institute of Technology Tiruchirappalli

Abstract: Due to the availability of high speed computing system, there is the huge scope to still raise the standard of wireless communication in terms of massive connectivity, capacity enhancement, ultra-high reliability, low latency using Machine learning (ML), Deep learning (DL) and Computational intelligence (CI) algorithms. The talk describes the mathematical treatment on estimating the unknown parameters involved in the parametric Linear regression model using Bayes technique. The other related techniques like Maximum Likelihood estimation, Least square, Kernel smoothing, Gaussian process, Evidence Maximization are also covered in this talk.

Bio: Dr. E. S. Gopi has sole authored 9 books published by springer in the area of signal processing and pattern recognition. He has organized the first virtual international conference (MDCWC2020) at NIT, Tiruchirappalli and edited the proceedings published by Springer. He has several papers in reviewed book chapters, conference publications and journals to his credit. He has got several research papers published in the reputed journals, reviewed book chapters and conference proceedings. He has 25 years of teaching and research experience. He is the coordinator for the pattern recognition and the computational intelligence laboratory. He is currently an Associate Professor, Department of Electronics and Communication Engineering, National Institute of Technology, Trichy (Government of India). His books are widely used all over the world. His book on “Pattern recognition and Computational intelligence using Matlab”, Springer was recognized as one of the best ebook under “pattern recognition” and “Matlab” categories by the Book authority, the world’s leading site for book recommendations by thought leaders. He is the series editor for the series “Signals and Communication Technology”, Springer publication. He has completed the project offered by GTRE (DRDO) as the principal investigator on Hunting representative sensors and constructing regression model between sensor outcomes using ML”. His video course on “Pattern recognition”, “Statistical theory of Communication” and “Linear algebra and stochastic process” are well appreciated by the fellow students. His research interests include Machine intelligence, Pattern recognition, Statistical signal processing and Computational intelligence. He is also serving as one of the Workshops, Tutorials & Symposia officer for Machine Learning for Communications Emerging Technologies Initiative (IEEE ComSoc).

WORKSHOP 1

INTRODUCTION TO OTFS

Dr. P. Maheswaran

Department of Electronics and Communication Engineering

National Institute of Technology Tiruchirappalli

Abstract: Orthogonal Frequency Division Multiplexing (OFDM) is the waveform used in 4G and 5G. It effectively addresses the frequency selective fading caused by time dispersion of the fading channel in the wireless communication. But, the use cases in beyond 5G (B5G) encompasses high mobility scenarios such as UAV communication, drone communication, V2X, communication to high altitude platforms (HAPS), etc. The frequency spectrum of B5G also includes FR-2 (carrier frequency greater than 6 GHz) in addition to the legacy FR-1 (carrier frequency less than 6 GHz). The Doppler spread in FR-2 is high even for pedestrian velocities. For high velocities, the Doppler spread may go beyond tolerable region. This inevitably introduces time selective fading. OFDM does not mitigate time selective fading. To address this, a new waveform called Orthogonal Time Space Frequency (OTFS) modulation is introduced. In this talk, the audience will be introduced to the basics of OTFS.

Bio: Dr. P. Maheswaran obtained his PhD from IIITDM Kancheepuram in the area of wireless communication. At present, he is serving as an Assistant Professor in the Dept. of ECE, National Institute of Technology, Tiruchirappalli. Between 2011 and 2013, he was with Tata Consultancy Services as a Systems Engineer. He briefly served as an Assistant Professor in the Dept. of ECE, SRM Institute of Science and Technology, Chennai from 2017 to 2018. From 2019 to 2020, he was with IIT Madras as a postdoctoral fellow. His research areas include wireless communication, signal processing, cooperative communication, MIMO communication system, index modulation, spatial modulation, and OTFS.

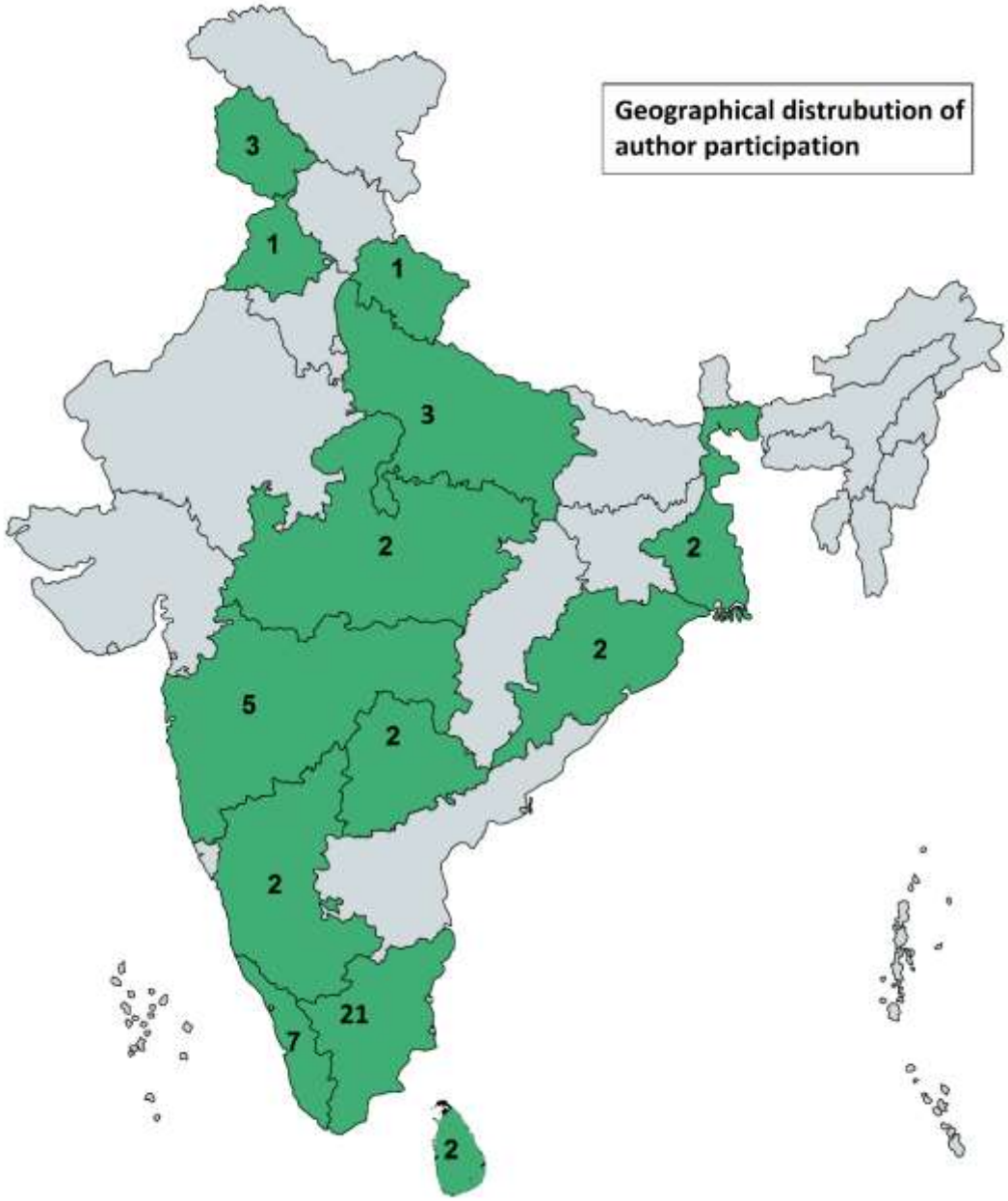
WORKSHOP 2

DEEP LEARNING BASED RF SIGNAL CLASSIFICATION: HANDS ON

Dr. Prabhu Chandhar, Director, Chandhar Research Labs, Chennai, India.

Abstract: Radio Frequency (RF) signal classification is a key technique of Dynamic Spectrum Access (DSA) to utilize the unused spectrum in Cognitive Radio (CR) to meet the ever-increasing traffic demands for the next generation 5G and beyond cellular networks. In recent years, the RF signal classification for CR-based applications using Deep Learning (DL) architectures has received considerable attention. This tutorial focuses on a DL-based framework with Convolution Neural Network (CNN) architecture for classifying various modulation schemes such as BPSK, QPSK and GMSK. The real-time GSM signals captured from the nearby base stations will be used to analyse the performance of the developed CNN architecture.

Bio: Prabhu Chandhar received the Ph.D. degree from IIT Kharagpur, India in 2015. From 2009 to 2010, he was a Senior Research Fellow at the Vodafone IIT KGP Centre of Excellence in Telecommunications, IIT Kharagpur. From 2015 to 2017, he was a Post-Doctoral Researcher at the Division of Communication Systems, Linköping University, Linköping, Sweden. Since 2018, he serves as the Director of Chandhar Research Labs, Chennai, India. His research interests are within the fields of Signal Processing and Communication Theory. https://bio.chandhar-labs.com



SUPPORTING TEAM (Research scholars)	
Ms. Vinodha K, RS	Ms Simy M Baby,RS
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