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Wednesday, February 28 9:00 - 12:30

T1: SELF-SUPERVISED LEARNING AND THEIR APPLICATION IN SPEECH AND LANGUAGE MODELLING

Prof. Umesh Srinivasan, IIT Madras

Room: ICSR Hall 2

Abstract : Conventionally, many Machine Learning methods use supervised learning while training. For many tasks, this supervision is provided by human annotation which is expensive and slow. Over the last decade or so, there has been a lot of interest in self-supervised learning, where the supervision for learning is extracted from the training data itself. These methods have especially had a significant impact on Speech and Language Modelling. In this tutorial, I will cover some of the important self-supervised models in the speech and language domain including word2vec, BERT, GPT, wav2vec, HuBERT, wavLM and data2vec. I will start by briefly covering the basics of deep-learning, followed by sequence modelling and the theory of transformers. Then, I will discuss the various objective/loss functions that are used in Self-supervised Learning, especially masked token prediction and next token prediction. My Lab has worked on several objective functions to improve the SSL for speech Modelling, and I will cover ccc-wave2vec2.0 and data2vec-aqc which give competitive performance with limited data for training. I will also briefly talk about discrete units for speech processing, as well as some understanding of what these SSL methods learn. Similarly, Language Modelling (next word prediction) has significantly impacted the NLP domain - as seen in current Large Language Models (LLM). Finally, I will show how these SSL/Foundation Models have pushed state-of-the-art performance by using a limited amount of supervised data during the fine-tuning step in many areas of speech and language modelling. This includes instruction-tuning for LLMs as well as Automatic Speech Recognition, Text to Speech Synthesis, Speaker & Spoken Language Identification. I will wind up by showing demos of the various models that have been built in my lab whose source code, models as well APIs are open-sourced and are available in public domain. Bio : S. Umesh is a Professor of Electrical Engineering at the Indian Institute of Technology, Madras (IITM), where he heads the activities of the SPRING (formerly Speech) Lab -- asr.iitm.ac.in. He is also the Co-Coordinator of the Speech Consortium of National Language Technologies Mission project, where he coordinates the activities of 23 institutions in India in the areas of speech technology development in Indian languages. Umesh received the Ph.D. degree in electrical engineering from the University of Rhode Island, Kingston, in 1993. From 1993 to 1996, he was a Postdoctoral Fellow at the City University of New York. From 1996 to 2009, he was with the Indian Institute of Technology, Kanpur. Since 2009, he has been with the Indian Institute of Technology, Madras, where he is a Professor of electrical engineering. He has also been a Visiting Researcher at AT&T Research Laboratories, Machine Intelligence Laboratory, Cambridge University, U.K., and the Department of Computer Science (Lehrstuhl für Informatik VI), RWTH-Aachen, Germany. His recent research interests have been mainly in the area of self-supervised learning, speech representations, speaker-normalization and noise-robustness and their application in large-vocabulary continuous speech recognition systems. He has also worked in the areas of statistical signal processing and time-varying spectral analysis. Umesh is a recipient of the Indian AICTE Career Award for Young Teachers and the Alexander von Humboldt Research Fellowship.

T2: FUNDAMENTALS OF MOLECULAR COMMUNICATION: MODELING AND ANALYSIS

Dr. Abhishek Gupta, Electrical Engineering, IIT Kanpur

Room: ICSR Hall 3

Abstract : Molecular communication (MC) is a communication paradigm inspired from the nature that includes communication between nano-scale devices/organisms with the help of molecules as information carriers between these devices. An example of MC is the human body itself where most communications including intra-cellular inter-cellular, and inter-organ communications occur via various types of molecules. MC can enable nano-machines acting as transmitters or receivers to communicate with each other by sending and receiving messenger molecules. This tutorial will cover

fundamentals of MC and techniques to model and analyze them. We will first introduce the MC via many examples highlighting its various types. We will review chemical kinetics and molecular biology. We will present modeling techniques of MC, while focusing on MC via diffusion. We will discuss analytical approach to analyze systems with multiple transmitters and receivers. Bio : Dr. Abhishek K. Gupta received his B.Tech.- M.Tech dual degree in Electrical Engineering from IIT Kanpur in 2010 and PhD degree in the Department of Electrical and Computer Engineering at the University of Texas at Austin in 2016. He is currently working as an assistant professor in the Department of Electrical Engineering at Indian Institute of Technology Kanpur. He heads the modern wireless networks group at IITK. His research is in the area of stochastic geometry and modern communication systems, including 5G, mmWave, THz, vehicular, and molecular communication. He was recipient of IEI young engineer award (electronics and telecommunication discipline) by Institute of Engineers (India) in 2021, Class of 1986 young faculty fellowship by IIT Kanpur in 2022, IEEE wireless communication letters exemplary reviewer award in 2016, GE-FS leadership award by General Electric Foundation and Institute of International Education in 2009 and IITK academic excellence award for four consecutive years (2006-2009). He is author of the books, An introduction to stochastic geometry (Springer Morgan-Claypool, 2022), Numerical methods using MATLAB (Springer Apress, 2014), and MATLAB by examples (Finch, 2010). Before joining IITK, he was working as Sr. standards engineer at Samsung Research America in Dallas, TX, USA. In the past, he has worked in Applied Microelectronics Circuit Corporation (Pune), Futurewei Technologies (NJ) and Nokia Networks (IL). He serves as an Editor for IEEE Transactions on Wireless Communications.

W1: Workshop on "Standards Driven Research"

Paventhan Arumugam (ERNET India) Pranav Jha (IIT Bombay) Radha Krishna Ganti (IIT Madras) Ramya T. R. (CEWiT) Vishnu Ram OV (TSDSI)

Room: ICSR Main Auditorium

W2: Matlab Workshop

Room: ICSR Hall 1

Wednesday, February 28 14:00 - 17:30

T3: AN RF PERSPECTIVE TO INTELLIGENT REFLECTING SURFACES

Uday Khankhoje, Electrical Engineering, IIT Madras

Room: ICSR Hall 2

Abstract : Future generations of wireless communication systems promise higher datarates, achieved by an increase in carrier frequencies. However, this increase is accompanied by a drop in coverage, a simple consequence of wave physics. Thus, while a lower carrier frequency wave could have diffracted around an obstacle, the same is not possible with higher frequency waves. The proposed workaround to restore coverage is an intelligent reflecting surface. Such a surface can redirect electromagnetic waves dynamically based on the sensed location of a user, thereby illuminating an area that was previously in an electromagnetic shadow. In this tutorial, I will discuss the various aspects of intelligent reflecting surfaces from the point of view of wave physics. I will also discuss RF realizations of these surfaces using metasurfaces and highlight some of the hardware challenges that need to be overcome in the process. I will then expand on user-location sensing modalities via direction of arrival estimation approaches. Finally, I will discuss beamforming algorithms that are necessary to redirect electromagnetic waves to their desired recipients. Bio : Uday Khankhoje is an Associate Professor of Electrical Engineering at the Indian Institute of Technology Madras, India since 2021. He received a B.Tech. degree from the Indian Institute of Technology Bombay, India, in 2005, an M.S. and Ph.D. degrees from the California Institute of Technology, Pasadena, USA, in 2010, all in Electrical Engineering. He was a Caltech Postdoctoral Scholar at the Jet Propulsion Laboratory (NASA/Caltech) from 2011-2012, a Postdoctoral Research Associate in the Department of Electrical Engineering at the University of Southern California, Los Angeles, USA, from 2012-2013, an Assistant Professor of Electrical Engineering at the Indian Institute of Technology Delhi, India from 2013-16, and an Assistant Professor of Electrical Engineering at the Indian Institute of Technology Madras, India from 2016-21. His research interests are in computational

electromagnetics and its applications to inverse design and imaging.

T4: LOW-POWER, LOW-COST 5G SMALL CELL FOR DIGITAL TRANSFORMATION

Shashank Meti, Texas Instruments

Room: ICSR Hall 3

Abstract : The advent of 5G technology has brought about a significant transformation in the field of wireless communication. As 5G networks promise higher data rates, lower latency, and improved connectivity, the deployment of small cells has become a pivotal aspect of ensuring the seamless and efficient operation of these networks. Small cells are compact wireless access points that play a crucial role in extending network coverage and capacity, particularly in dense urban areas. With 5G, the demand for small cells has intensified, as the higher frequency bands used in 5G networks have limited propagation characteristics, necessitating the deployment of small cells in close proximity to users. One of the critical considerations in 5G small cell design is the deployment strategy. Small cells can be deployed indoors, outdoors, or in a hybrid fashion. The deployment strategy should align with the intended use case, such as urban hotspots, indoor venues, or enterprise networks. Moreover, small cells must be integrated seamlessly into the existing macrocell infrastructure to ensure efficient network operation. It is estimated that only 48.7% of the Indian population has access to the Internet and around 26% of the population does not have access to cell phones. More than 25,000 villages lack connectivity. Developing countries are beginning to use small cells to leapfrog into the era of digital communication. For this to be successful, we need affordable small cells which consume lower power & cost on implementation. In this tutorial, we will cover the small cell evolution till 5G and take a deep dive into the design of small cells. The proposed agenda of the tutorial is as follows: Small cell basics, deployment scenarios & adaptation in India – 15 – 20 minutes This will cover small cell use cases in India – why exactly it's needed, market study on small cell Challenges in Small cell design & with touch on ORAN splits and their use cases – 15-20 minutes Here will touch on how SCF & ORAN sees small cell, what will be the driving factors in future? Key parameters in Small cell design, deep dive into key specifications from Telco's – 30 minutes We will use specifications of TI based small cell reference design as an example & talk about how we defined these specifications & what it actually means in the implementation Implementation & design details of TI based complete 7.2x split Small cell reference design – 90 minutes Here will talk on details on the TI reference design on design aspects, implementation & key challenges faced. Bio :Shashank Meti is an Analog FAE at Texas Instruments, where he is responsible for design support for key customers of TI with focus on Wireless Infrastructure. Shashank has been with TI since 2015. Shashank has Bachelor's degree in Electronics & Communication and Master's degree in VLSI Design & Embedded Systems.

W3: Workshop on "Standards Driven Research"

Paventhan Arumugam (ERNET India) Pranav Jha (IIT Bombay) Radha Krishna Ganti (IIT Madras) Ramya T. R. (CEWiT) Vishnu Ram OV (TSDSI)

Room: ICSR Main Auditorium

Thursday, February 29 9:00 - 12:30

T5: INTEGRATING SENSING AND COMMUNICATION (ISAC) FOR 6G NETWORKS

Dr. Atul Kumar, IIT (BHU) Varanasi

Room: ICSR Hall 2

Abstract : The presentation on Integrating Sensing and Communication (ISAC) for 6G Networks systematically explores the transformative potential inherent in amalgamating sensing capabilities with communication networks. Commencing with an introduction to ISAC within the 6G context, the discourse delves into pivotal concepts, emphasizing the convergence of

sensing and communication and delineating the requisite elements of ISAC. The presentation then progresses to elucidate practical applications and use cases, illustrating how ISAC facilitates real-time enhancements in communication services. Additionally, the talk expounds on key performance indicators for ISAC and addresses the intricate design challenges associated with the Air Interface, specifically the physical layer, for ISAC systems. Furthermore, the presentation will delve into the beam forming aspect, addressing its significance in conjunction with the realization of the ISAC system in both mmWave and sub-THz band frequencies. The discussion extends to the contemporary challenges and opportunities within ISAC for 6G and beyond. A forward-looking perspective is provided as the presentation navigates through the existing landscape of research and development in ISAC for 6G networks. Emerging trends and potential use cases are underscored for further investigation, while a comprehensive understanding of key performance indicators for ISAC and the design challenges inherent in the Air Interface are reiterated. The concluding remarks underscore the profound significance of ISAC in shaping the trajectory of communication networks and extend an invitation for collaborative efforts to propel continuous advancements in the field. Bio : Dr. Atul Kumar is an accomplished professional who earned his B. Tech. degree in Electronics and Communication Engineering in 2013, followed by an M.S. degree in Electronics Engineering in September 2015. He completed his Ph.D. degree in Information Engineering at the Dipartimento di Elettronica, Informazione, and Bioingegneria in December 2018 from the prestigious Politecnico di Milano, Milan, Italy. From 2018 to 2021, Dr. Kumar served as a research associate with Gerhard Fettweis' Vodafone Chair at Dresden University of Technology (TU-Dresden). Currently, he holds the position of Assistant Professor in the Department of Electronics Engineering at IIT(BHU) Varanasi, India. Since 2017, Dr. Kumar has been the Director of "AtlaMedico TechSolutions Pvt Ltd", a company he founded. This venture focuses on the development of a wireless medical device for intensive care units in India, reflecting his commitment to technological innovation and addressing critical healthcare needs. The company serves as a technology start-up specializing in the design, optimization, and operation of advanced medical devices. Furthermore, in 2022, Dr. Atul Kumar extended his entrepreneurial ventures by founding another startup, "Delbrone Innovation Pvt Ltd." This company is dedicated to the development of anti-drone detection and neutralization systems. His main research interests include Joint sensing and communication technology (JSC), Quantum Communication, Quantum Sensing, Quantum Information Theory, Molecular communication, Prediction of Quality-of-Service (PQoS) parameters for Automotive and Robotics, Ultra-Reliable Low-Latency Communication (URLLC), Massive MIMO, Beamforming, 5G-NR, C-RAN, O-RAN, 6G.

W4: Workshop on Quantum Information and Quantum Communication 2024

Keynote Speakers: Pavel Panteleev, Moscow State University Rahul Jain, CQT, National University of Singapore Invited Speakers: Vikesh Siddhu, IBM India Sounak Kar, University of Delft Siddhartha Santra, IIT Bombay

Room: ICSR Main Auditorium

W5: Workshop on Optical Communication

Jose Azana, INRS Saurabh Saxena, IITM Gupteswar Majhi, CDOT Deepak Jain, IIT Delhi Rakesh Desai, TEC, DOT Ravi Mehta, Quanfluence

Room: ICSR Hall 1

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Thursday, February 29 14:00 - 14:15

I1: Inauguration

Room: ICSR Main Auditorium

Thursday, February 29 14:15 - 15:15

P1: Plenary #1

Prof A Chockalingam, Indian Institute of Science, Bengaluru, India

Room: ICSR Main Auditorium

Chair: Andrew Thangaraj (IIT Madras, India)

Thursday, February 29 15:45 - 17:45

PS1: Multicarrier Systems

Room: ICSR Main Auditorium

Chair: Rimalapudi Sarvendranath (IIT Guwahati, India)

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Thursday, February 29 15:45 - 17:55

PS3: RF Communication

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Room: ICSR Hall 3

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W6: Workshop on Optical Communication

Room: ICSR Hall 1

Thursday, February 29 18:00 - 19:00

I2: JTG Meeting

Room: ICSR Hall 2

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I3: Banquet

Room: ICSR Main Auditorium

Friday, March 1 9:00 - 10:00

P2: Distributed Compression in the Era of Machine Learning

Prof. Elza Erkip (IEEE Fellow, New York)

Room: ICSR Main Auditorium

Chair: Srikrishna Bhashyam (Indian Institute of Technology Madras, India)

Abstract : Many applications from camera arrays to sensor networks require efficient compression and processing of correlated data, which in general is collected in a distributed fashion. While information-theoretic foundations of distributed compression are well investigated, the impact of theory in practice has been somewhat limited. As the field of data compression is undergoing a transformation with the emergence of learning-based techniques, machine learning is becoming an important tool to reap the long-promised benefits of distributed compression. In this talk, we review the recent progress in the broad area of learned distributed compression, focusing on images as well as abstract sources. In particular, we discuss approaches that provide interpretable results operating close to information-theoretic bounds. We also discuss how learned distributed compression can impact multi-hop communications. Bio : Elza Erkip is an Institute Professor in the Electrical and Computer Engineering Department at New York University Tandon School of Engineering. She received the B.S. degree in Electrical and Electronics Engineering from Middle East Technical University, Ankara, Turkey, and the M.S. and Ph.D. degrees in Electrical Engineering from Stanford University, Stanford, CA, USA. Her research interests are in information theory, communication theory, and wireless communications. Dr. Erkip is a member of the Science Academy of Turkey and is a Fellow of the IEEE. She received the NSF CAREER award in 2001, the IEEE Communications Society WICE Outstanding Achievement Award in 2016, the IEEE Communications Society Communication Theory Technical Committee (CTTC) Technical Achievement Award in 2018, and the IEEE Communications Society Edwin Howard Armstrong Achievement Award in 2021. She was the Padovani Lecturer of the IEEE Information Theory Society in 2022. Her paper awards include the IEEE Communications Society Stephen O. Rice Paper Prize in 2004, the IEEE Communications Society Award for Advances in Communication in 2013 and the IEEE Communications Society Best Tutorial Paper Award in 2019. She was a member of the Board of Governors of the IEEE Information Theory Society 2012-2020, where she was the President in 2018. She was a Distinguished Lecturer of the IEEE Information Theory Society from 2013 to 2014.

Friday, March 1 10:20 - 12:30

PS4: Information Theory and Coding

Amitalok Budkuley (Indian Institute of Technology Kharagpur)

Room: ICSR Main Auditorium

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P3: Six Blind Men of Indostan: Theory and Applications of Distributed Inference

Prof. Pramod K. Varshney

Room: ICSR Main Auditorium

Chair: Lakshmi Narasimhan Theagarajan (Indian Institute of Technology Madras, India)

Saturday, March 2 9:00 - 10:00

P4: Plenary Talk

Prof. Jose Azana, Institut National de la Recherche Scientifque, Montreal, QC, Canada

Room: ICSR Main Auditorium

Chair: Uday Khankhoje (Indian Institute of Technology Madras, India)

Saturday, March 2 10:30 - 12:30

PS11: RIS-aided Communication

Room: ICSR Main Auditorium

Chair: Neelesh B. Mehta (Indian Institute of Science, India)

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PS13: Machine Learning and Adaptive Signal Processing - 1

Sundeep C (IISc Bangalore)

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P5: Industry Keynote

Dr. Kumar N. Sivarajan, CTO, Tejas Networks

Room: ICSR Main Auditorium

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