EECS Symposium 2021

May 7-8, 2021
Indian Institute of Science, Bangalore

Book of Abstracts

This was written on May 7-8, 2021
Indian Institute of Science, Bangalore .

Preface

The EECS Research Students Symposium - 2021 is the twelfth in the series of annual events initiated by Professor Anurag Kumar in 2010. The symposium is organized by the following six Departments following the best traditions of collaboration:

1. *Computational and Data Sciences (CDS)*
2. *Computer Science and Automation (CSA)*
3. *Electrical Communication Engineering (ECE)*
4. *Electrical Engineering (EE)*
5. *Electronic Systems Engineering (ESE)*
6. *Robert Bosch Centre for Cyber-Physical Systems (RBCCPS)*

For EECS 2021 symposium, a team of seven faculty members coordinated by Dipanjan Gope (ECE) and consisting of Konduri Aditya (CDS), Rahul Saladi (CSA), Sundeep Chepuri (ECE), Sriram Ganapathy (EE), P. Ramachandran (ESE), and Vaibhav Katewa (RBCCPS), assisted by an energetic team of student volunteers, has put in a spectacular effort to organise an excellent event.

The primary purpose of this event is to showcase the work of senior research students who are on the threshold of wrapping up their work. In this current edition, 55 doctoral students, 15 M.Tech. (Research) students, and 10 post doctoral fellows are presenting their work as a part of 10 research cluster sessions: Artificial Intelligence and Machine Learning; Brain and Computation; Computational Sciences; Computer Systems; Cyber-Physical Systems; Microelectronics; Power Engineering; Security and Cryptography; Signal Processing and Communications; and Visual Analytics. Each of these sessions also has keynote talks by leading researchers including industry experts. We are very lucky to get some of the best experts in the world delivering talks in these sessions.

The plenary talks form the highlight of this event every year. We are fortunate to have a great lineup of eminent researchers this year as well: Lalitesh Katragadda (Founder Director, Indihood); Jitendra Malik (UC, Berkeley and Facebook AI Research); Madhav Marathe (University of Virginia); and Milind Tambe (Harvard University and Google Research India).

Another highlight is a series of talks by recently joined faculty members in the six departments. This year, we will have talks by Phani Motamarri [CDS]; Chaya Ganesh [CSA]; Sundeep Chepuri [ECE]; Vishnu Mahadeva Iyer [EE]; Arup Polley [ESE]; and Jishnu Keshavan [RBCCPS].

Finally, we have a very special event this year of felicitating three of our most valued senior colleagues Professors K. Gopinath (CSA), P. Vijay Kumar (ECE), and Y.N. Srikant (CSA) who have been stellar in their contributions and services to the Institute. This is a miniscule way of expressing our gratefulness to them.

The organizing committee has assembled a splendid technical program for this event and the team

must be congratulated for a superlative effort. We are enthused by the excellent response received in registrations for this event which have crossed 500 as of May 6, 2021. We thank our alumni, industry collaborators, faculty members, and students for registering in such large numbers. We hope sincerely that the symposium will facilitate lively interactions among the participants and inspire everybody to attempt and solve intellectually challenging research problems in EECS and beyond.

Our thanks go out to ***Dr Shekhar Kirani (Accel Ventures)*** *for his generous sponsorship for this event. This is much appreciated.*

Please stay safe and healthy; do exercise extreme caution and care during these challenging times.

Warm wishes and regards,

Y. Narahari
Dean, Division of EECS,
IISc, Bangalore.

Contents

1. Organising Committee and Schedule

Committee

1.1 Faculty Organisers

Konduri Aditya	PhD/PostDoc Speakers
Rahul Saladi	Website
Sundeep Prabhakar	Cluster Structure/Coordinator
Sriram Ganapathy	Finance/Budget
Ramachandran, P.	Publications
Vaibhav Katewa	Platform, Plenary Speakers
Dipanjan Gope	Outreach, Conference Schedule
Prof. Narahari	

1.2 Student Organisers

Tutan Debnath	ESE	tutandebnath@iisc.ac.in	Computational Sciences; Power
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Alok Joshi	ECE	alokchandra@iisc.ac.in	Micro; SPCOM
Anand Kumar	ECE	anandkumar13@iisc.ac.in	Plenary
Aditya Rastogi	CDS	adityar@iisc.ac.in	Faculty Talks
Tejan Karmali	CDS	tejankarmali@iisc.ac.in	Visual Analytics
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Harini V	CPS	hariniv@iisc.ac.in	Publications
Anand Kumar	EE	anandkumar1@iisc.ac.in	Publications

1.3 Program At a Glance

EECS RESEARCH STUDENTS SYMPOSIUM – 2021
AT A GLANCE

May 7th (Friday)

09:00am-10:00am	10:15am-12:45pm	13:30pm-16:30pm	17:00pm-18:00pm	18:00pm-19:00pm
S1: Plenary-1 Umesh Mishra	S2: Faculty Talks Phani Motamarri Chaya Ganesh Sundeep Chepuri Vishnu Mahadev Iyer Arup Polley Jishnu Keshavan	S3A: Cluster Session AI & Machine Learning S3B: Cluster Session Microelectronics-1 S3C: Cluster Session Security and Cryptography	S4: Plenary-2 Lalitesh Katragadda	S5: Plenary-3 Milind Tambe

May 8th (Saturday)

09:00am-10:00am	10:15am-13:15pm	14:00pm-17:00pm	17:30pm-19:00pm
S6: Plenary-4 Jitendra Malik	S7A: Cluster Session Visual Analytics S7B: Cluster Session Microelectronics-2 S7C: Cluster Session Signal Processing and Communications S7D: Cluster Session Computer Systems	S8A: Cluster Session Cyber-Physical Systems S8B: Cluster Session Power Engineering S8C: Cluster Session Brain, Computation and Data S8D: Cluster Session Computational Sciences	Felicitation Prof. P. V. Kumar Prof. K. Gopinath Prof. Y. N. Srikant Awards Vote of Thanks

2. Day 1: 7^{th} May 2021(Friday)

2.1 Inauguration

Speaker: Prof. Y. Narahari, CSA, IISc

2.2 Session 1 | Plenary Talks

Chair: Mahesh Mehendale, Texas Instruments and Adjunct Professor, IISc
Student Organizer: Dhanaprakaash G. (RBCCPS)
Faculty Organizer: Vaibhav Katewa, RBCCPS

2.2.1 Computational Epidemiology: Challenges and Opportunities

Speaker: Prof. Madhav Marathe, University of Virginia Biocomplexity Institute

Abstract
Infectious diseases cause more than 13 million deaths a year worldwide. Globalization, urbanization, climate change, and ecological pressures increase the risk and impact of future pandemics. The ongoing COVID-19 pandemic has exemplified several of these issues. The social, economic, and health impact of the pandemic has been immense and will continue to be felt for decades to come. India is currently experiencing an unprecedented second wave that has claimed thousands of precious lives.

The talk will give an overview of the state of the art in real-time computational epidemiology. Then using COVID-19 as an exemplar, we will describe how scalable computing, AI and data science can play an important role in advancing real-time epidemic science. Computational challenges and directions for future research will be discussed.

Bio

Madhav Marathe is a Distinguished Professor in Biocomplexity, the division director of the Network Systems Science and Advanced Computing Division at the Biocomplexity Institute and Initiative, and a Professor in the Department of Computer Science at the University of Virginia (UVA). His research interests are in network science, computational epidemiology, AI, foundations of computing and high performance computing. Over the last 20 years, his division has supported federal and state authorities in their effort to combat epidemics in real-time, including the H1N1 pandemic in 2009, the Ebola outbreak in 2014 and most recently the COVID-19 pandemic. Before joining UVA, he held positions at Virginia Tech and the Los Alamos National Laboratory. He is a Fellow of the IEEE, ACM, SIAM and AAAS.

2.2.2 Break

2.3 Session 2 | Faculty Talks

Chair: Y. Narahari
Student Organizer: Aditya Rastogi, CDS
Faculty Organizer: Rahul Saladi, CSA

2.3.1 Towards fast and accurate exascale quantum-mechanical calculations for material modelling using finite-element discretization and mixed-precision arithmetic

Speaker: Phani Motamarri, CDS

Abstract

Quantum mechanical modelling of materials based on density functional theory (DFT) have been instrumental in providing crucial insights into materials behaviour and occupy a significant fraction of computational resources in the world today. However, the asymptotic cubic-scaling computational complexity of the underlying DFT eigenvalue problem and the stringent accuracy requirements in DFT, demand massive computational resources for accurate prediction of meaningful material properties. Thus, these calculations are routinely limited to material systems with at most a few thousands of electrons, employing plane-wave discretization despite all its limitations which has remained the method of choice for many materials science applications. In this talk, I will present some recent advances made in the state-of-the-art for accurate quantum-mechanical calculations using density functional theory (DFT) -via- the development of DFT-FE, employing adaptive finite-element discretization, in conjunction with mixed-precision strategies for the solution of governing equations alongside with implementation innovations focusing on significantly reducing the data movement costs and increasing arithmetic intensity on hybrid CPU-GPU architectures. The reported advance discussed in this talk has wide ranging implications in tackling critical scientific and technological problems by making use of the predictive capability of DFT calculations for large-scale material systems.

Bio

Dr. Phani Motamarri is currently an Assistant Professor at the Department of Computational and Data Sciences, IISc-Bangalore. Prior to this, he was a research faculty member at the University of Michigan, Ann Arbor, USA from where he received his PhD in the area of Computational Materials Physics from the Department of Mechanical Engineering. His primary research interests include development of mathematical techniques and HPC centric real-space computational algorithms that can leverage the latest heterogeneous parallel computing architectures and upcoming exa-scale machines for quantum-mechanical material modeling and furthermore, harnessing these computational capabilities to address complex materials science problems. He is one of the lead developers of DFT-FE — an open-source computational framework for massively parallel large-scale density functional theory calculations that was named as a finalist for 2019 ACM Gordon Bell Prize, the prestigious prize in scientific computing.

2.3.2 Computational integrity: succinct proofs in cryptography

Speaker: Chaya Ganesh, CSA

Abstract

A common denominator of conventional financial systems, trusted execution environments (like SGX), blockchain technology, and ZK rollups is the promise of computational integrity – doing the right computation, even when there is no trust. In this talk, we will define computational integrity and show how one can verify the correctness of a computation much more efficiently than having to re-perform the computation. We will introduce the notion of succinct proof systems that allow a prover to convince a verifier about the correctness of computation such that verification is exponentially faster than the computation itself. We will see applications of SNARKs (Succinct Non-interactive ARguments of Knowledge), a kind of succinct arguments in decentralized systems like blockchain technology for both privacy and scalability issues, and outline the design principle underlying SNARK constructions.

Bio

Chaya is an Assistant Professor in the Department of Computer Science and Automation at Indian Institute of Science . Her research interests are in Cryptography and Security. Before joining IISc, she was a post-doctoral researcher in the Crypto group at Aarhus University. She received her PhD from NYU's Courant Institute of Mathematical Sciences.

2.3.3 Graph Neural Networks

Speaker: Sundeep Prabhakar Chepuri, ECE

Abstract

Many science applications deal with data having an underlying graph structure, e.g., social networks, transportation networks, brain networks, sensor networks, chemical molecules, protein-protein interactions, and meshed surfaces in computer graphics, to list a few. For these applications, more recently, deep learning for graph-structured data is receiving a steady research attention from many scientific disciplines. In this talk, we discuss convolutions on graphs that form the basic building block of graph neural networks and discuss a graph neural network model with applications to COVID-19 drug repurposing.

Bio

He received the M.Sc. degree (cum laude) in Electrical Engineering and the Ph.D. degree (cum laude) from TU Delft, in July 2011 and January 2016, respectively. Currently, he is an Assistant Professor at the Electrical Communication Engineering department at IISc. He was an Associate Editor of the EURASIP Journal on Advances in Signal Processing (2016 - 2020). He is an elected member of the IEEE SPS Society's Sensor Array and Multichannel Technical Committee (2021 -) and EURASIP Signal Processing for Multisensor Systems' Special Area Team (2019 -).

His research interests include mathematical signal processing, statistical inference and learning, applied to communication systems, network sciences, and computational imaging. The main themes of hisresearch are computational sensing, sparse sampling, signal processing and machine learning for communications, graph signal processing, and machine learning over graphs.

2.3.4 An Approach Towards an Extreme Fast Charging Station Architecture for Electric Vehicles

Speaker: Vishnu Mahadeva Iyer, EE

Abstract

This talk introduces an extreme fast charging (XFC) station architecture concept for simultaneous charging of multiple electric vehicles (EVs). The XFC station architecture comprises several power electronic converters interfaced to form a microgrid. The first part of the talk discusses a brief overview of the ongoing developments in XFC. In the second part of the talk, the use of partial rated power electronic converters for enabling XFC is introduced. Partial power processing enables independent charging control over each EV while processing only a fraction of the total battery charging power. System-level benefits of the proposed approach include lower capital investments, lower operational costs, lower footprint, and improved power and energy efficiency.

Bio

Vishnu Mahadeva Iyer joined as an Assistant Professor in the Department of Electrical Engineering at the Indian Institute of Science (IISc), Bengaluru, in September 2020. Before joining IISc, he worked as a Lead Engineer at GE Research, Niskayuna, USA. He completed his Ph.D. in Electrical Engineering from the NSF FREEDM Systems Center, NC State University, Raleigh, USA.

He is interested in the broad area of power conversion. His current research and scholarly interests include power conversion systems for transportation electrification, DC microgrids, differential power processing, and control and stability of power electronic systems.

2.3.5 Integrated Sensor Systems

Speaker: Arup Polley, ESE

Abstract

There is an ever-increasing demand of lower cost, lower power and higher performance sensor systems with small form factor. Sensor ASICs play a ctical role in converting a sensor concept to a sensor solution that caters to these requirements. In the talk, an integrated Hall-effect sensor system will be presented that enables accurate, wide-band non-contact current sensing. Sensors in the non-CMOS platforms can also benefit from the signal processing schemes that can be effectively implemented using CMOS ASICs. Graphene and two-dimensional materials in general are sensor wonderland. However, typical graphene field effect devices suffer from low frequency noise that limits the sensor performance. A gate modulation technique that utilizes the unique ambipolar conduction in graphene to reduce the offset and flicker noise in graphene-based Hall-effect sensor will be presented.

Bio

Arup Polley received B. Tech. degree in Electronics and Electrical Communication Engineering from Indian Institute of Technology, Kharagpur in 2003. He received M.S. degree in Electrical Engineering (2005) and Physics (2008), and a Ph. D. in Electrical Engineering (2008) from Georgia Institute of Technology, Atlanta.

He joined the department of Electronic Systems Engineering, Indian Institute of Science, Bangalore as an Associate Professor in April 2021. From 2003 to 2008, he was a member of the Ultrafast Optical Communications Laboratory at the Georgia Institute of Technology, where he researched on holistic approaches for low-cost, high-speed multimode optical link involving co-development of transceiver and plastic optical fiber. In 2009, he joined the Storage Product Group at Texas Instruments, Dallas, where he developed advanced fly height sensing system for magnetic Hard Disk Drives. He joined Kilby Research Labs, Dallas of Texas Instruments in 2012, where

he first developed a low-power sensor platform for wearable devices. Following that, he architected and developed wideband, low offset CMOS Hall-effect sensor system-on-chip for non-contact, magnetic-field-based, current-sensing applications. He also led TI's internal and collaborative research with University of Texas at Dallas on graphene Hall-effect sensors.
He has authored and co-authored over 30 peer-reviewed journal and conference publications and holds 20 granted US patents. He is a senior member of IEEE.

2.3.6 Data-Augmented Control of Visual Autonomous Systems

Speaker: Jishnu Keshavan, RBCCPS

Abstract
Data-Augmented Control of Visual Autonomous Systems Abstract Vision-enabled robotic systems are a pervasive presence that have begun to enhance and redefine a variety of industries including automated package delivery and manufacturing. While these systems are beginning to be deployed in controlled settings for a variety of applications, their large-scale deployment across a range of diverse environments still eludes us. Satisfaction of performance guarantees is paramount to facilitate this transition. To this end, two data-driven strategies based on bioinspired learning are presented for endowing robotic systems with the ability to make rapid control decisions using noisy sensory data in uncertain and dynamic environments. To this end, two bioinspired strategies are presented and combined with traditional control theoretic tools for the synthesis of novel nonlinear closed loop systems for ensuring safe collision-free navigation in challenging environments. Numerous validation studies with aerial and ground systems are considered that attest to the efficacy of the proposed schemes. These results and their implications for the realization of autonomous systems suitable for real-world applications will be discussed.

Bio
Dr. Jishnu Keshavan is an Assistant Professor in Mechanical Engineering at the Indian Institute of Science, Bangalore. His research interests are broadly in the areas of dynamical systems theory, nonlinear dynamics and control, and autonomous vision. He obtained a PhD (2012) and a MS (2007) in Aerospace Engineering from University of Maryland, College Park, and a BTech in Aerospace Engineering (2004) from the Indian Institute of Technology Bombay.

2.3.7 Lunch Break

2.4 Session 3 | Cluster Talks

2.4.1 Cluster: AI & Machine Learning

Cluster Coordinator: Chiranjib Bhattacharyya, CSA and Aditya Gopalan, ECE
Chair: TBD
Student Organizer: Varun Krishna, EE
Faculty Organizer: Konduri Aditya, CDS

Cluster Overview

Cluster Overview			
Time	Event	Speaker	Affiliation
13:30pm-13:42pm	Student Presentations	Ramakrishnan K	CSA,IISc
13:42pm-13:54pm		Amrutha Machireddy	ESE,IISc
13:54pm-14:06pm		Deep Patel	EE,IISc
14:06pm-14:18pm		Rameesh Paul	CSA,IISc
14:18pm-14:30pm		Shubham Gupta	CSA,IISc
14:30pm-15:00pm	Invited Talk 1	Sunita Sarawagi	IIT Bombay
15:00pm-15:30pm	Invited Talk 2	Prateek Jain	Google
15:30pm-15:42pm	Student Presentations	Anoop C S	EE,IISc
15:42pm-15:54pm		Prachi Singh	EE,IISc
15:54pm-16:06pm		Shreyas Ramoji	EE,IISc
16:06pm-16:18pm		Devyani Lambhate	CDS,IISc
16:18pm-16:30pm		Pradeep K G	EE,IISc
16:30pm-16:42pm		Ritika Jain	EE,IISc
16:42pm-16:54pm		Srikanth Raj Chetupalli	EE,IISc

Student Presentation 1: Optimal Algorithms for Range Searching over Multi-Armed Bandits

Siddharth Barman Ramakrishnan Krishnamurthy Saladi Rahul

Department of Computer Science and Automation
Indian Institute of Science

Abstract

This paper studies a multi-armed bandit (MAB) version of the range-searching problem. In its basic form, range searching considers as input a set of points (on the real line) and a collection of (real) intervals. Here, with each specified point, we have an associated weight, and the problem objective is to find a maximum-weight point within every given interval.

The current work addresses range searching with stochastic weights: each point corresponds to an arm (that admits sample access) and the point's weight is the (unknown) mean of the underlying distribution. In this MAB setup, we develop sample-efficient algorithms that find, with high probability, near-optimal arms within the given intervals, i.e., we obtain PAC (probably approximately correct) guarantees. We also provide an algorithm for a generalization wherein the weight of each

point is a multi-dimensional vector. The sample complexities of our algorithms depend, in particular, on the size of the optimal hitting set of the given intervals.

Finally, we establish lower bounds proving that the obtained sample complexities are essentially tight. Our results highlight the significance of geometric constructs—specifically, hitting sets—in our MAB setting.

Student Presentation 2: Learning non-linear mappings from data with applications to priority-based clustering, adaptive prediction, and detection

Amrutha Machireddy

Department of Electronic Systems Engineering
Indian Institute of Science

Abstract

With the drive for handling big data applications, algorithms to extract and understand the underlying relations within the data have gained momentum. In the unsupervised learning framework, we formulate a systematic theory for clustering data with different priority over the data attributes. We also formulate a potential function based on a spatio-temporal metric and create hierarchical vector quantization feature maps by embedding memory structures across the feature maps to learn the spatio-temporal correlations in the data across clusters. In the supervised learning framework, we propose an architecture for prediction and classification of video sequences based on an adaptive pooling layer along with detection of out-of-distribution classes. We also propose a learning algorithm towards the encoding of linear block codes over binary fields.

Student Presentation 3: Adaptive Sample Selection for Robust Learning under Label Noise

Deep Patel and Prof. P.S. Sastry

Department of Electrical Engineering
Indian Institute of Science

Abstract

Deep Neural Networks have been shown to be susceptible to overfitting in the presence of noisily-labelled data. For the problem of robust learning under such noisy data, several algorithms have been proposed. A prominent class of algorithms relies on sample selection strategies. For example, many algorithms use the 'small loss' trick wherein a fraction of samples with loss values below a certain threshold are selected for training. These algorithms are sensitive to such thresholds which often depend on (typically unknown) label noise rates, and it's difficult to fix or learn these thresholds. We propose a data-dependent, adaptive sample selection strategy that relies only on batch statistics of given mini-batch for robustness against label noise. The algorithm doesn't have any additional hyperparameters, doesn't need information on noise rates, and doesn't need access to extra data with clean labels. We empirically demonstrate the effectiveness of our algorithm on benchmark datasets.

Student Presentation 4: Independent Sets in Semi-random Hypergraphs

Yash Khanna, Anand Louis and Rameesh Paul

Department of Computer Science and Automation

Indian Institute of Science

Abstract
In this work, we study the independent set problem on hypergraphs in a natural semi-random family of instances. Our semi-random model is inspired by the Feige-Kilian model. This popular model has also been studied in multiple works including a recent paper by McKenzie, Mehta, and Trevisan where they gave algorithms for computing independent sets in such a semi-random family of graphs. The algorithms by McKenzie et al. are based on rounding a "crude-SDP". We generalize their results and techniques to hypergraphs for an analogous family of hypergraph instances. Our algorithms are based on rounding the "crude-SDP" of McKenzie et al., augmented with "Lasserre/SoS like" hierarchy of constraints. Analogous to the results of McKenzie et al., we study the ranges of input parameters where we can recover the planted independent set or a large independent set.

Student Presentation 5: A provably optimal algorithm for finding fair communities

Shubham Gupta and Ambedkar Dukkipati

Department of Computer Science and Automation
Indian Institute of Science

Abstract TBD

Invited Talk 1 : Sunita Sarawagi

Invited Talk 2 : Stochastic Gradient Descent: Marrying Theory with Practice

Speaker: Prateek Jain

Abstract
Stochastic Gradient Descent (SGD) is the workhorse of most modern ML based solutions. The method was discovered first in 1951 (Robbins-Monro algorithm) and has since generated tremendous interest and impact especially for training deep neural networks. However, there is a significant gap between the practical versions of SGD and the stylized versions used for theoretical understanding. In this talk, we will highlight some of the gaps and present a few latest results that attempt at bridging it. In particular, we will talk how we can rigorously understand the following practical variants of standard SGD: a) SGD + mini-batching, b) SGD + acceleration, c) SGD with random reshuffling, d) SGD with last point iterate.
The talk is based on joint works with Praneeth Netrapalli, Sham Kakade, Suhas Kaushik, Rahul Kidambi, Dheeraj Nagaraj, Aaron Sidford, Carrie Wu.

Bio
Prateek Jain is a research scientist at Google Research India and an adjunct faculty member at IIT Kanpur. Earlier, he was a Senior Principal Researcher at Microsoft Research India. He obtained his PhD degree from the Computer Science department at UT Austin and his BTech degree from IIT Kanpur. He works in the areas of large-scale and non-convex optimization, high-dimensional statistics, and ML for resource-constrained devices. He wrote a monograph on Non-convex Optimization in Machine Learning summarizing many of his results in non-convex optimization. Prateek regularly serves on the senior program committee of top ML conferences and is an action editor for JMLR, and an associate editor for SIMODS. He has also won ICML-2007,

CVPR-2008 best student paper award and more recently his work on alternating minimization has been selected as the 2020 Best Paper by the IEEE Signal Processing Society.

Student Presentation 6: ASR in Low-resource Languages Using Domain Adaptation Approaches

Anoop C S[1], Prathosh A P[2], A G Ramakrishnan[1]

[1]*Department of Electrical Engineering*
Indian Institute of Science, Bengaluru

[2]*Department of Electrical Engineering*
Indian Institute of Technology, Delhi

Abstract
Building an automatic speech recognition (ASR) system from scratch requires a large amount of annotated data. For many of the languages in the world, there are not enough annotated data to train an ASR. However, there are cases where the low-resource language shares a common acoustic space with a high-resource language, which has enough annotated data to build an ASR. In such cases, we show that the domain-independent acoustic models learnt from the high-resource language through deep domain adaptation approaches can perform well in the ASR task on the low-resource language. The assumption is that the low-resource language has limited audio data for domain training and good enough text data to build a reasonable language model. We use the specific example of Hindi in the source domain and Sanskrit in the target domain. The results suggest that domain adaptation approaches can help in the accelerated development of ASR systems for low-resource languages.

Student Presentation 7: Speaker Diarization for conversational speech using graph clustering

Prachi Singh

Department of Electrical Engineering,
Indian Institute of Science

Abstract
Speaker diarization is the task of automatic segmentation of the given audio recording into regions corresponding to different speakers. It is an important step in information extraction from conversational speech. The applications range from rich speech transcription to analysing turn-taking behavior in clinical diagnosis. The state-of-the-art approach involves extraction of short segment features called as speaker embeddings followed by computation of pairwise similarity scores which are then used to perform clustering using similarity scores. In this talk, I will discuss various challenges and popular clustering approaches in this field, followed by our recent work on representation learning and graph based path integral clustering (PIC). The representation learning is based on principles of self-supervised learning. It uses the cluster targets from PIC and the clustering step is performed on embeddings learned from the self-supervised deep model. Our results on telephone and meeting dataset shows improvements over the baseline approach.

Student Presentation 8: Neural PLDA Modeling for End-to-End Automatic Speaker Verification

Shreyas Ramoji

Department of Electrical Engineering
Indian Institute of Science

Abstract
Given an enrollment recording of a particular target speaker, automatic speaker verification (ASV) is the problem of determining whether a test speech segment is spoken by the enrolled target speaker or not. The state-of-the-art methods used for ASV involve an embedding extractor that takes a speech segment of arbitrary duration and transforms it into an embedding vector of fixed dimensions. As the embedding extractors are typically trained with classification objective, a separate back-end model is trained to determine if a pair of speech segment embeddings belong to the same speaker or a different speaker. In this talk, I will briefly discuss the popular approaches for Embedding extraction and back- end modeling, followed by our recent work on Neural Probabilistic Linear Discriminant Analysis (NPLDA) back-end using a verification cost function. I will then discuss a simple extension to train the embedding extractor and the NPLDA in an end-to-end framework.

Student Presentation 9: Simultaneous Identification of Gulf Stream and Rings from Concurrent Satellite Images of Sea Surface Temperature and Height Images

Devyani Lambhate, Deepak N. Subramani

Department of Computational and Data Sciences
Indian Institute of Science

Abstract
Accurate digitization of synoptic ocean features is crucial for climate studies and the operational forecasting of ocean and coupled ocean-atmosphere systems. For operational regional-models of the north Atlantic, skilled human operators visualize and extract the Gulf Stream and Rings (warm and cold eddies) through a time-consuming manual process. To automate this task, we develop a dynamics-inspired deep learning system(W-Net) that extracts the Gulf Stream and Rings from concurrent satellite images of sea surface temperature (SST) and sea surface height (SSH). Our approach's novelty is that the above extraction task is posed as a multi-label semantic image segmentation problem solved by developing and applying a deep convolutional neural network with two parallel Encoder-Decoder networks (one branch for SST and the other for SSH). We obtain 82.7% raw test accuracy for Gulf Stream and more than 70% raw eddy detection accuracy. Detailed ablation studies and an examination of both SST and SSH parts of the network is also performed.

Student Presentation 10: Functional Connectivity based EEG Biometrics

Pradeep Kumar G

Department of Electrical Engineering
Indian Institute of Science

Abstract
Resting state brain electrical activity has evidence of unique neural signatures motivating investigation of the discriminative information for person identification systems. In this talk, methods are discussed to extract features from high density electroencephalogram (EEG) for potential use in biometric applications. Functional connectivity (FC) metrics and graph based (GB) metrics derived from FC are

used as features in a support vector machine classifier. 184 subjects pooled from 3 different datasets obtained using different protocols and acquisition systems are used to investigate the performance of FC and GB metrics. Independent datasets are assessed for obtaining a consistent feature set and frequency band. An identification accuracy of 97.4% is obtained using phase locking value based measures extracted from the gamma oscillations of the EEG data. Increase in classification accuracy with higher frequency bands indicates the presence of unique neural signatures in those bands.

Student Presentation 11: Reliable sleep stage classification method using multiple EEG features and RUSBoost technique

Ritika Jain

Department of Electrical Engineering
Indian Institute of Science

Abstract
Sleep is extremely crucial for our physical and mental health, and deprivation or poor quality of sleep can lead to numerous health problems. Sleep patterns can also be used to diagnose neurological disorders like dementia, Alzheimer's etc. Therefore, it is important to analyze the sleep signals accurately. Traditionally, sleep scoring is done by the sleep experts by visual inspection of overnight polysomnography (PSG) data. However, this manual scoring suffers from issues like subjectivity, high cost, time-consuming and inter-rater variability. An automatic sleep scoring system can be useful to tackle these problems. This work proposes a reliable sleep scoring method by using a fusion of multiple EEG features and an ensemble classifier called random undersampling with boosting technique (RUSBoost). The results achieved with a single channel EEG are comparable or better than the state-of-the-art methods in the literature for both two-class (sleep-awake) and multi-class classifications, on three different publicly available sleep databases. The proposed method also provided promising results on the unseen test subjects using both 50%-holdout as well as 10-fold cross-validation approach, emphasizing the reliability of the method.

Student Presentation 12: Automatic speech recognition for speech conversations

Srikanth Raj Chetupalli, Sriram Ganapathy

Department of Electrical Engineering
Indian Institute of Science

Abstract: The transcription of long-form conversations between multiple speakers is challenging, due to the speaker variability, unknown segment end-points and the conversational language. Further, the speakers may speak simultaneously, leading to overlapped speech in single channel recordings. A "rich transcription" is often desired for downstream applications in speech analytics, recording archival, audio indexing, etc. In this talk, we discuss a novel approach for the transcription of speech conversations with natural speaker overlap, from single channel recordings. We propose a combination of a speaker diarization system and a hybrid automatic speech recognition (ASR) system with speaker activity assisted acoustic model (AM). An end-to-end neural network system is used for speaker diarization, and the acoustic model is trained to output speaker specific senones. Further, we propose enhancements to language model using conversation context. We illustrate the

benefits of the proposed multi-speaker ASR system for speech conversations using natural telephone conversations from Switchboard corpus.

2.4.2 Cluster: Nanodevices, VLSI Circuits and Microsystems-1

Cluster Coordinator: Mayank Shrivastava (ESE)
Chair: Mayank Shrivastava (ESE) and Dipanjan Gope (ECE)
Student Organizer: Alok Joshi, ECE
Faculty Organizer: Dipanjan Gope, ECE

Cluster Overview

Cluster Overview			
Time	Event	Speaker	Affiliation
13:30pm-14:00pm	Invited Talk 1	Martin Kuball	University of Bristol, UK
14:00pm-14:30pm	Invited Talk 2	Matteo Meneghini	University of Padua, Italy
14:30pm-14:40pm	Student Presentations	Mehak Mahajan	ECE,IISc
14:40pm-14:50pm		Sarthak Das	EE,IISc
14:50pm-15:00pm		Ansh	ESE,IISc
15:00pm-15:10pm		Sanchali Mitra	ESE,IISc
15:10pm-15:20pm		Tripti Jain	ESE,IISc
15:30pm-16:00pm	Invited Talk 3	Harald Gossner	Intel Corporation, Germany
16:00pm-16:30pm	Invited Talk 4	Yogesh Chauhan	IIT Kanpur

Invited Talk 1: Thermal Management of Electronics and Beyond – GaN & Gallium Oxide

Speaker: Martin Kuball, University of Bristol, UK

Invited Talk 2: GaN Power Transistors & Dynamic-Ron: Challenges Perspectives

Speaker: Matteo Meneghini, University of Padua, Italy

Student Presentation 1: CDW induced phase transition in layered heterostructures

Mehak Mahajan and Kausik Majumdar

Department of Electrical Communication Engineering
Indian Institute of Science

Abstract
1T-TaS_2 is a unique layered material exhibiting strong charge density wave (CDW) driven resistance switching that can be controlled by temperature, an external electric field as well as optical pulses. However, such resistivity switching effects are often weak, and cannot be modulated

by an external gate voltage – limiting their widespread usage. Using a back-gated 1T-TaS_2/2H-MoS_2 heterojunction, we achieve a gate-controlled resistivity switching during the nearly-commensurate (*NC*) to incommensurate (*IC*) phase transition of TaS_2, and the switching ratio is enhanced by a factor of ~ 14.5 compared to the standalone TaS_2 control. This will boost a plethora of device applications that exploit these phase transitions, such as ultra-broadband photodetection, negative differential conductance, fast oscillator and threshold switching in neuromorphic circuits. Interestingly, by simply changing the geomertry we demonstrate a negative differential resistor (NDR) in an asymmetrically designed 1T-TaS_2/2H-MoS_2 T-junction using an electrically driven CDW phase transition.

Student Presentation 2: Excitons in flatlands

Sarthak Das, Kausik Majumdar

Department of Electrical and Communication Engineering
Indian Institute of Science

Abstract

An exciton is a bound state of an electron and an electron hole which are attracted to each other by the electrostatic Coulomb force. When the dimensionality of the crystals reduced to atomic scale, the binding energy of the excitons enhance dramatically due reduced dielectric screening and increased quantum confinement. The larger binding energy in these low dimensional semiconductors persist even in multilayers compared to conventional semiconductors. In fact, in a multilayer system the excitons can form an even-odd type alternating pair and retain the 2d properties. In a bilayer system the excitons can be completely confined to a single layer (intralayer exciton) or the electron and hole can be in different layer (interlayer exciton). With an application of vertical electric field, the intralayer excitons can be converted to interlayer and the corresponding exciton oscillator strength can be significantly modulated. Further, by changing the carrier concentration the oscillator strength of excitons can also be tuned corresponding to the trions.

Student Presentation 3: Electro-Thermal Stress Induced Material Reconfiguration & Device Perturbations in monolayer 2D-TMD Transistors

Ansh

Department of Electronics Systems Engineering
Indian Institute of Science

Abstract

Device and material reliability of 2-dimensional materials, especially CVD-grown MoS_2, has remained unaddressed since 2011 when the first TMDC transistor was reported. For its potential application in next generation electronics, it is imperative to update our understanding of mechanisms through which MoS2 transistors' performance degrades under long-term electrical stress. We report, for CVD-grown monolayer MoS2, the very first results on temporal degradation of material and device performance under electrical stress. Both low and high field regimes of operation are explored at different temperatures, gate bias and stress cycles. During low field operation, current is found to saturate after hundreds of seconds of operation with the current decay time constant being a function of temperature and stress cycle. Current saturation after several seconds during low field operation occurs when a thermal equilibrium is established. However, high field operation, especially at low

temperature, leads to impact ionization assisted material and device degradation. It is found that high field operation at low temperature results in amorphization of the channel and is verified by device and Kelvin Probe Force Microscopy (KPFM) analyses. In general, a prolonged room temperature operation of CVD-grown MoS2 transistors lead to degraded gate control, higher OFF state current and negative shift in threshold voltage (VT). This is further verified, through micro-Raman and photoluminescence spectroscopy, which suggest that a steady state DC electrical stress leads to the formation of localized low resistance regions in the channel and a subsequent loss of transistor characteristics. Our findings unveil unique mechanism by which CVD MoS2 undergoes material degradation under electrical stress and subsequent breakdown of transistor behaviour. Such an understanding of material and device reliability helps in determining the safe operating regime from device as well as circuit perspective.

Student Presentation 4:Theory of nonvolatile resistive switching in monolayer molybdenum disulfide with passive electrodes

Sanchali Mitra, Arnab Kabiraj, Santanu Mahapatra

Department of Electronic Systems Engineering
Indian Institute of Science

Abstract
Resistive-memory devices promise to revolutionize modern computer architecture eliminating the data- shuttling bottleneck between memory and processing unit. Recent years have seen a surge of experimental demonstrations of 2D material-based metal-insulator-metal devices. However, the fundamental mechanism of switching has remained elusive. Here, we conduct reactive molecular dynamics simulations for sulfur vacancy inhabited monolayer molybdenum disulfide-based device to gain insight into such phenomena. We observe that with the application of a suitable electric field, at the vacancy positions, the sulfur atom from the other plane pops and gets arrested in the plane of the molybdenum atoms. Rigorous first-principles calculations surprisingly reveal localized metallic states (virtual filament) and stronger chemical bonding for this new atomic arrangement, explaining nonvolatile resistive switching. We further observe that localized Joule heating plays a crucial role in restoring the original position of popped sulfur atom. The proposed theory may provide useful guidelines for designing high-performance resistive-memory-based computing architecture.

Learning Based Classification of Magnetism in 2D material

Tripti Jain and Prof. Santanu Mahapatra

Department of Electronic System Engineering
Indian Institute of Science

Abstract
Predicting magnetism in two-dimensional materials with fundamental information about the crystal is a challenging task in the field of material science. So far, the magnetism in two-dimensional materials is being predicted computationally. With the popularity of machine learning algorithms in predicting material properties with accuracy close to ab initio calculations and computational speed order of magnitude faster, we have tried to use machine learning for predicting magnetism in two-dimensional materials. With a very small database of these materials, along with lots of

boundary cases and sparsity in data, make it a difficult task for the algorithms to build a classifier that can classify such imbalanced overlapped datasets. We have tried exploring the available crystal graph network for predicting magnetism. Here, we use basic information of crystal structure like atomic and bond features to design a model that can predict magnetism in such materials with good accuracy.

Invited Talk 3: Rethink ESD Robustness for Modular Technologies

Speaker: Harald Gossner, Intel Corporation, Germany

Invited Talk 4: Modeling and Simulation of FinFET and Nanosheet Transistors for Advanced Technology Nodes

Speaker: Yogesh Chauhan, IIT Kanpur:

2.4.3 Cluster: Security & Cryptography

Cluster Coordinator: Himanshu Tyagi, ECE
Chair: Himanshu Tyagi (ECE) and Chaya Ganesh (CSA)
Student Organizer: Prerna Arote (ESE)
Faculty Organizer: Sundeep Chepuri, ECE

Cluster Overview

Cluster Overview			
Time		Speaker	Affiliation
13:30pm-13:40pm	Student	Kripa Shanker	CSA,IISc
13:40pm-13:50pm	Presentations	Sruthi Sekar	Math/CSA,IISc
14:00pm-14:30pm	Keynote Talk 1	Kapil Vaswani	Microsoft Research
14:40pm-15:00pm	Industry Talk 1	Karthik Rao	CySecK
15:00pm-15:20pm	Industry Talk 2	Arun Babu	Data Kaveri
15:20pm-15:30pm	Student	Ajinkya Rajput	CSA,IISc
15:30pm-15:40pm	Presentations	Nilesh Rathi	CSA,IISc
15:40pm-15:50pm		Ajith S	CSA,IISc
16:00pm-16:30pm	Keynote Talk 2	Punkaj Dayana	IBM Research

Student Presentation 1: An Evaluation of Methods to Port Legacy Code to SGX Enclaves

Kripa Shanker, Arun Joseph, Vinod Ganapathy

Department of Computer Science and Automation
Indian Institute of Science

Abstract
The Intel Security Guard Extensions (SGX) architecture enables the abstraction of enclaved execution, using which an application can protect its code and data from powerful adversaries, including system software that executes with the highest processor privilege. While the Intel SGX architecture exports

an ISA with low-level instructions that enable applications to create enclaves, the task of writing applications using this ISA has been left to the software community.
We consider the problem of porting legacy applications to SGX enclaves. In the approximately four years to date since the Intel SGX became commercially available, the community has developed three different models to port applications to enclaves—the library OS, the library wrapper, and the instruction wrapper models.
In this paper, we conduct an empirical evaluation of the merits and costs of each model. We report on our attempt to port a handful of real-world application benchmarks (including OpenSSL, Memcached, a Web server and a Python interpreter) to SGX enclaves using prototypes that embody each of the above models. Our evaluation focuses on the merits and costs of each of these models from the perspective of the effort required to port code under each of these models, the effort to re-engineer an application to work with enclaves, the security offered by each model, and the runtime performance of the applications under these models.

Student Presentation 2:Non-malleable Codes

Sruthi Sekar

Department of Computer Science and Automation and Department of Mathematics
Indian Institute of Science

Abstract
Non-malleable codes are coding schemes that help in securing cryptographic protocols against a class of attacks called as “related-key attacks", which allow the adversary to tamper with the secret key (on which the security of the protocol relies) and observe additional input-output behaviour of the protocol on the tampered key, leading to a security breach. Non-malleable codes, informally, give a guarantee that, under a tampering attack, the recovered tampered message is either same as the original message, or is independent of it.
In this talk, I will be formally defining these primitives and further talk about my work towards building such codes for a strong adversarial setting with optimal rate. Furthermore, I would also talk about some applications of non-malleable codes to other interesting cryptographic primitives.

Keynote talk 1: Confidential Computing – Towards a new contract of data sharing

Speaker: Kapil Vaswani

Abstract
In a data-driven world, we have been co-opted into a contract where we pay for online services using our digital footprint. This contract places a lot of trust in the services providers, who often hide behind the fine print of privacy statements and misuse our data. Confidential computing is an emerging class of security systems and service that redefines this contract by giving data owners stronger technical control over how their data is used and shared. In this talk, I will describe the fundamentals and recent advances in confidential computing. I will also talk about how confidential computing can enable a new class of trustworthy data sharing scenarios that were not feasible or too expensive before.

Bio
Kapil Vaswani is a security researcher in the Confidential Computing group at Microsoft Research. His research focuses on building secure, robust, and transparent systems. He has pioneered work on designing secure services such as databases using confidential computing and new forms of

confidential computing hardware on devices like GPUs. He graduated from the Indian Institute of Science in Bangalore, where he worked on performance profiling and modeling techniques.

Industry Talk 1: Introduction to CySecK

Speaker: Karthik Rao, CySecK

Abstract CySecK is Karnataka state's Centre of Excellence in Cybersecurity, anchored by IISc. CySecK's key initiatives include

- cybersecurity awareness for general public
- skill building for tech community
- promote research in the critical domain of cybersecurity
- accelerator programme for cybersecurity start-ups

This talk will provide an overview of the various programmes at CySecK and the mentorship provided by IISc.

Bio

Industry Talk 2: DataSetu Confidential Data Sharing and Processing Framework

Speaker: Arun Babu, RBCCPS

Abstract

This talk presents the architecture of DataSetu for confidential data sharing. DataSetu is an open platform for allowing sharing of data (public as well as confidential) between various parties. This talk focuses on authentication, authorization, and use of confidential compute in sharing data. Some use cases of DataSetu will also be presented. **Bio**

Arun Babu is a researcher working in the areas of software engineering and cybersecurity. His main areas of interests are brute-force resistant cryptography, software quality, and AAA (Authentication, Authorization, and Accounting). He obtained his Ph.D from Indira Gandhi Center for Atomic Research (IGCAR), Kalpakkam.

Student Presentation 3: Heap Aware Symbolic Execution

Ajinkya Rajput, K.Gopinath

Department of Computer Science and Automation
Indian Institute of Science

Abstract In this paper, we show that dynamic symbolilc execution, when coupled with a well-defined model of the allocator behavior, can be effective in detecting heap-based vulnerabilities. Specifically, we model the behavior of heap memory allocator to avoid states that will not occur in a concrete execution and define precise conditions that represent heap based vulnerabilities by extracting metadata from the allocator. We develop a tool named RADAR that uses these techniques in tandem on ptmalloc memory allocator. RADAR effectively detects vulnerabilities in a set of micro-benchmarks and real-world projects fetched from github.

Student Presentation 4:Scaling Blockchains Using Coding Theory and Verifiable Computing

Nilesh Rathi

Department of Computer Science and Automation
Indian Institute of Science

Abstract
The issue of scalability has been restricting blockchains from their widespread adoption. In this talk, we will focus on blockchain scaling solutions inspired by coding theory. We first consider SeF, a blockchain archiving architecture using LT codes to reduce storage constraints by 1000x. SeF enables full nodes to store a small number of encoded blocks or droplets instead of a complete blockchain. While other rate-less codes utilizing two encoding levels are proven better than LT codes, we investigate their suitability in the proposed architecture. We propose and simulate three techniques about how to incorporate these coding strategies.
The other work we examine is PolyShard, which introduces the notion of coded-sharding, making sharding resilient to an adaptive adversary. However innovative, PolyShard requires decoding RS codes over large fields, making it computationally intensive and less practical. We propose replacing the decoding phase with verifiable computing, reducing the bottleneck, and making architecture practical for light verification functions.

Student Presentation 5:MPC for small population with applications to Privacy-Preserving Machine Learning

Ajith Suresh

Department of Computer Science and Automation
Indian Institute of Science

Abstract
Performing machine learning (ML) computation on private data while maintaining data privacy, aka Privacy-preserving Machine Learning (PPML), is an emergent field of research. Recently, PPML has seen a visible shift towards adopting the Secure Outsourced Computation (SOC) paradigm due to the heavy computation. In the SOC paradigm, computation is outsourced to a set of powerful and specially equipped servers that provide service on a pay-per-use basis. In this work, we propose a robust PPML framework using secure multi-party computation (MPC) for a range of ML algorithms in the SOC setting that guarantees output delivery to the users irrespective of any adversarial behaviour. Robustness, a highly desirable feature, evokes user participation without the fear of denial of service.

We demonstrate our framework's practical relevance by benchmarking popular ML algorithms such as Logistic Regression and deep Neural Networks such as VGG16 and LeNet, both over a 64-bit ring in a WAN setting.

Q&A Session : Live

Industry Talk 3: Trusted Multi-enterprise AI with Blockchaink

Speaker: Pankaj Dayama, IBM Research

Abstract
Blockchain technology provides greater transparency and security in carrying out business transactions by maintaining immutable transaction records within a distributed network of mutually untrusting entities. It has been seen as a very promising technology in supply chain as well as financial services industry. Applications related to product traceability, international trade finance, paperless trade, etc. are the initial ones that have gone into production. This talk will provide an overview of blockchain solutions we have developed for various industries. We will further deep-dive into some of the work we are doing at the intersection of Blockchain and AI.

Bio
Pankaj Dayama is a Senior Technical Staff Member and Master Inventor at IBM Research India. He is currently leading AI for Supply Chain Collaboration and Blockchain group at IRL. His current work spans different aspects of multi-enterprise business networks including building innovative solutions in supply chain space working directly with clients, and developing technologies to enable privacy preserving collaboration on the business networks. Pankaj is an alumnus of Indian Institute of Science, Bangalore. He has published about 20 papers in peer reviewed conferences and has more than 50 filed US patents.

2.4.4 Break

2.5 Session 4 | Plenary Talk

Chair: Mr. Rostow Ravanan, Former CEO, Mindtree
Student Organizer: Nishchal Hoysal, RBCCPS
Faculty Organizer: Vaibhav Katewa, RBCCPS

2.5.1 The Coding Revolutionary

Speaker: Lalitesh Katragadda, Indihood

Abstract
20th century societal transformations were created by the writing revolutionaries. However, we are far from done. Feudal oppressive choking forces keep all of India from its potential. The next wave of transformations will not be born in the written word, it will be born in code. However code as is today threatens to digitally colonize India, if not all of civilization. A few engineers in Indihood's research lab are dreaming up a new way to code that shifts power from software corporations to India's communities. This conversation will explore and debate this idea.

Bio

Dr. Lalitesh Katragadda is a pioneer in crowdsourcing. His creation, Google Map Maker, quadrupled the world's digital maps corpus, bringing maps to 4 billion in 187 countries that had no maps before. His startup was Google's first acquisition in 2002 after which he co-founded Google India, acting as Country Head, Google India Products until 2014.

He now builds population scale platforms for India's Billion including Avanti for financial inclusion and Indihood, crowdsourcing for communities and core development challenges. He architected the Fiber Grid for the state of Andhra, the worlds largest greenfield optical network in 2014, authored India's national Open API policy, is an advisor to MEITY and core contributor to Digitial India and India Stack.

Lalitesh has spoken at TED and The White House.

Lalitesh received his Ph.D. and MS from CMU in Robotics and Computer Science, where he led the CMU Lunar Rover Initiative. He holds an MS, Design Division, Stanford, MS, Aerospace, Iowa State and B-Tech, IIT-Bombay.

2.6 Session 5 | Plenary Talk

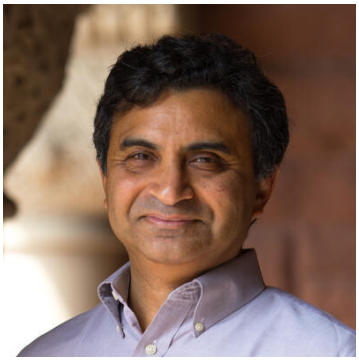
Chair: Dr. Ramesh Hariharan, CTO, Strand Life Sciences
Student Organizer: Dhanaprakaash G., RBCCPS
Faculty Organizer: Vaibhav Katewa, RBCCPS

2.6.1 Multiagent reasoning for social impact

Speaker: Milind Tambe, Harvard University and Google Research India

Abstract

With the maturing of AI and multiagent systems research, we have a tremendous opportunity to direct these advances towards addressing complex societal problems. I focus on the problems of public health and conservation, and address one key cross-cutting challenge: how to effectively deploy our limited intervention resources in these problem domains. I will present results from work around the globe in using AI for HIV prevention, Maternal and Child care interventions, TB prevention and COVID modeling, as well as for wildlife conservation. Achieving social impact in these domains often requires methodological advances. To that end, I will highlight key research advances in multiagent reasoning and learning, in particular in, computational game theory, restless bandits and influence maximization in social networks.In pushing this research agenda, our ultimate goal is to facilitate local communities and non-profits to directly benefit from advances in AI tools and techniques.



Bio

Milind Tambe is Gordon McKay Professor of Computer Science and Director of Center for Research in Computation and Society at Harvard University; concurrently, he is also Director 'AI for Social Good' at Google Research India. He is a recipient of the IJCAI John McCarthy Award, ACM/SIGAI Autonomous Agents Research Award from AAMAS, AAAI Robert S Engelmore Memorial Lecture award, INFORMS Wagner prize, Rist Prize of the Military Operations Research Society, Columbus Fellowship Foundation Homeland security award, over 25 best papers or honorable mentions at conferences such as AAMAS, AAAI, IJCAI and meritorious commendations from agencies such as the US Coast Guard and the Los Angeles Airport. Prof. Tambe is a fellow of AAAI and ACM.

END OF DAY 1

3. Day 2: 8th May 2021(Saturday)

3.1 Session 6 | Plenary Talk

Chair: Dr. Venkat Padmanabhan, Microsoft Research India
Student Organizer: Nishchal Hoysal, RBCCPS
Faculty Organizer: Vaibhav Katewa, RBCCPS

3.1.1 Perceiving and Acting in a 3D World

Speaker: Jitendra Malik, University of California, Berkeley and Facebook AI Research

Abstract

TBA.?

Bio

Professor Jitendra Malik is currently Arthur J. Chick Professor of EECS at UC Berkeley (formerly Department Chair), and Research Scientist Director at Facebook AI Research. Member of the National Academy of Sciences and the National Academy of Engineering, and Fellow, American Academy of Arts and Sciences. He received the 2016 ACM/AAAI Allen Newell Award, 2018 IJCAI Award for Research Excellence in AI, and the 2019 IEEE Computer Society's Computer Pioneer Award for "leading role in developing Computer Vision into a thriving discipline through pioneering research, leadership, and mentorship." He is a recipient of many other awards including IIT Kanpur's Distinguished Alumnus Award. He chaired an international review committee that conducted a comprehensive review of the Division of EECS, IISc in 2017.

3.1.2 Break

3.2 Session 7 | Cluster Talks

3.2.1 Cluster: Visual Analytics

Cluster Coordinator: Chandra Sekhar Seelamantula, CDS and Venkatesh Babu, CDS
Chair: Soma Biswas, EE and Venkatesh Babu, CDS
Student Organizer: Tejan Karmali, CDS
Faculty Organizer: Konduri Aditya, CDS

Cluster Overview			
Time	Event	Speaker	Affiliation
10:15am-10:25am	Student	Naveen P	CDS,IISc
10:25am-10:35am	Presentations	Arindam Dutta	CDS,IISc
10:35am-10:45am		Dhruv Jawali	EE/IMI,IISc
10:45am-10:55am		Jogendra Nath Kundu	CDS,IISc
10:55am-11:05am		Praveen Kumar Pokala	EE,IISc
11:05am-11:15am	Q&A Students		
11:15am-11:25am	Student	Titir Dutta	EE,IISc
11:25am-11:35am	Presentations	Utkarsh Gupta	CDS,IISc
11:35am-11:45am		Vijayalakshmi K	ECE,IISc
11:45am-11:55am		Vinayak Killedar	EE,IISc
11:55am-12:05Pm		Jitendra Kumar Dhiman	EE,IISc
12:05pm-12:15pm	Q&A Students		
12:15pm-12:45pm	Invited Talk 1	Mohan Kankanhalli	NUS Singapore
12:45pm-13:15pm	Invited Talk 2	Jayavardhana Gubbi	TCS Research

Student Presentation 1: Anamorphic Depth Embedding based Light-Weight CNN for Segmentation of Anomalies in COVID-19 Chest CT Images

Naveen Paluru

Department of Computational and Data Sciences
Indian Institute of Science

Abstract

— Chest computed tomography (CT) imaging has become indispensable for staging and managing coronavirus disease 2019 (COVID-19), and current evaluation of anomalies/abnormalities associated with COVID-19 has been performed majorly by the visual score. The development of automated methods for quantifying COVID-19 abnormalities in these CT images is invaluable to clinicians. The hallmark of COVID-19 in chest CT images is the presence of ground-glass opacities in the lung region, which are tedious to segment manually. We propose anamorphic depth embedding-based lightweight CNN, called Anam-Net, to segment anomalies in COVID-19 chest CT images. The proposed Anam-Net has 7.8 times fewer parameters compared to the state-of-the-art UNet (or its variants), making it lightweight capable of providing inferences in mobile or resource constraint (point-of-care) platforms. The results from chest CT images (test cases) across different experiments

showed that the proposed method could provide good Dice similarity scores for abnormal and normal regions in the lung. We have benchmarked Anam-Net with other state-of-the-art architectures, such as ENet, LEDNet, UNet++, SegNet, Attention UNet, and DeepLabV3+. The proposed Anam-Net was also deployed on embedded systems, such as Raspberry Pi 4, NVIDIA Jetson Xavier, and mobile-based Android application (CovSeg) embedded with Anam-Net to demonstrate its suitability for point-of-care platforms.

Student Presentation 2: Towards Deep Robust Deconvolution of Low-Dose Perfusion Computed Tomography

Arindam Dutta, Phaneendra K. Yalavarthy

Department of Computational and Data Sciences
Indian Institute of Science

Abstract
Computed Tomography Perfusion (CTP) has established itself as an economic, fast and reliable clinical modality for diagnosis of cerebrovascular diseases such as acute ischemia and vasospasm. To obtain the necessary perfusion maps for accurate diagnosis, it is mandatory to subject the patient to high radiation dosage, which in turn have several pernicious biological side effects. Thus, obtaining high-quality perfusion maps even at low radiation dosage remains an interesting and convoluted challenge. To combat the same, we propose a novel deep learning based end-to-end framework, to produce high quality Cerebral Blood Flow (CBF) maps from low-dose raw CTP data. The proposed model is able to perform the deconvolution without explicit information on the Arterial Input Function (AIF) and isn't susceptible to varying levels of noise. Our experiments and results validate the superiority of our framework over existing state of the art algorithms.

Student Presentation 3: Wavelet Design in a Learning Framework

Dhruv Jawali

National Mathematics Initiative & Department of Electrical Engineering
Indian Institute of Science

Abstract
The wavelet transform has proven to be a highly successful data representation tool, and is used in several signal and image processing applications, such as compression, denoising, singularity detection, etc. The problem of wavelet design has traditionally been approached from an analytical perspective, using tools from harmonic analysis to construct continuous-domain functions satisfying the admissibility criterion. In this talk, a learning based approach to wavelet design is introduced, which provides a coherent computational framework for addressing the design problem. Perfect reconstruction filterbanks are viewed as convolutional autoencoders, and wavelets are designed by training these *filterbank autoencoders*. The designed wavelets are data-independent, which precludes the need for customized datasets. In fact, high-dimensional Gaussian data vectors can be used for training, and it will be shown that a near-zero training loss implies that the learnt filters satisfy the perfect reconstruction property with very high probability. Properties of a wavelet such as orthogonality, compact support, smoothness, symmetry, and vanishing moments are incorporated by designing the autoencoder architecture appropriately, with a suitable regularization term added

to the mean-squared error cost when needed. The proposed approach not only recovers the well known Daubechies family of orthogonal wavelets and the Cohen-Daubechies-Feauveau family of symmetric biorthogonal wavelets, but also learns wavelets outside these families.

Student Presentation 4: Appearance Consensus Driven Self-Supervised Human Mesh Recovery

Jogendra Nath Kundu

Department of Computational and Data Sciences
Indian Institute of Science

Abstract

We present a self-supervised human mesh recovery framework to infer human pose and shape from monocular images in the absence of any paired supervision. Almost all the avalble approaches aims to regress a parametric human model by supervising on datasets with 2D landmark annotations. Different from these, we propose a novel appearance consensus driven self-supervised objective. To effectively disentangle the foreground (FG) human we rely on image pairs depicting the same person (consistent FG) in varied pose and background (BG) which are obtained from unlabeled wild videos. The proposed FG appearance consistency objective makes use of a novel, differentiable color-recovery module to obtain vertex colors without the need for any appearance network, via efficient realization of color-picking and reflectional symmetry. Furthermore, the resulting colored mesh prediction opens up the usage of our framework for a variety of appearance-related tasks beyond pose and shape estimation.

Student Presentation 5: Nonconvex Analysis-Sparse Model — Moreau Envelope Regularization and Projected Proximal Gradient Descent Optimization

Praveen Kumar Pokala

Department of Electrical Engineering
Indian Institute of Science

Abstract

We consider the problem of nonconvex analysis-sparse recovery in which the signal is assumed to be sparse in a highly redundant analysis operator. Standard non-convex sparsity promoting priors do not have a proximal operator in closed-form under a redundant analysis operator and therefore, proximal approaches cannot be applied directly. This motivated us to develop two alternatives – Moreau envelope regularization and projected transformation for solving the problem under consideration. First, we consider the Moreau envelope counterpart to nonconvex penalty defined in the analysis setting as a sparsity enforcing prior and develop algorithms for optimizing the corresponding cost. Second, we employ a projection transform that maps the analysis-sparse recovery problem into an equivalent constrained synthesis-sparse formulation, which can be optimized by the projected proximal algorithm. Finally, we demonstrate the efficacy of the proposed techniques in comparison with benchmark techniques in a real application, namely, 2-D magnetic resonance imaging (MRI) reconstruction considering shift-invariant discrete wavelet transform (SIDWT) as the redundant analysis operator.

Session: Q&A

Student Presentation 6: Zero-shot Sketch-based Image Retrieval

Titir Dutta

Department of Electrical Engineering
Indian Institute of Science

Abstract

Sketch-based image retrieval (SBIR) addresses the problem of ranking images in a database according to their relevance to a given hand-drawn sketch-query. It is an important research area, though earlier SBIR protocol assumed that the query always belongs to one of the training categories. Recently an evolved version, Zero-shot SBIR (ZS-SBIR), has emerged; which breaks down this restriction and thus the query may belong to categories, either seen or unseen to the model. The goal of my doctoral research is addressing different challenges, i.e. the assumption of paired sketch-image training data, attribute-augmented query etc. associated with ZS-SBIR. The focus of this talk is to discuss one such challenge, the effect of imbalance in training data. Towards this goal, we proposed an adaptive-margin based regularizer which can be seamlessly incorporated with any existing ZS-SBIR algorithm to improve its performance under imbalanced data. We discuss relevant experiments to demonstrate its effectiveness.

Student Presentation 7: Siamese-SR: A Siamese Super-Resolution model for boosting resolution of Digital Rock images for improved petrophysical property estimation

Utkarsh Gupta

Department of Computational and Data Sciences
Indian Institute of Science

Abstract

The Digital Rock workflow is an emerging framework utilizing advances in imaging technologies and state-of-the-art image processing algorithms to construct digital models of reservoir rocks, which are used to run physics simulations to calculate several petrophysical properties of interest. The accuracy of the digital rock workflow relies crucially on the resolution of the acquired images which is currently limited by the hardware of the micro-CT scanning technology. Super-resolution methods can effectively address this limitation by digitally boosting the resolution of images acquired using micro-CT scanners. We have proposed a novel deep learning based super-resolution model called Siamese-SR to improve the resolution of Digital Rock images whilst retaining the texture and providing optimal denoising. The Siamese-SR model consists of a generator which is adversarially trained with a Relativistic and a Siamese Discriminator utilizing Materials In Context (MINC) loss estimator. We also propose to move away from image-based metrics (SSIM & PSNR) to physics based quantification metrics which are based on running subsequent steps in the workflow mainly calculation of image based porosity and running Mercury Injection Capillary Pressure (MICP) simulations for calculation of accurate petrophysical parameters of interest.

Student Presentation 8: Revealing Disocclusions in Temporal View Synthesis for Frame Rate Upsampling

Vijayalakshmi Kanchana Nagabhushan Somraj Suraj Yadwad Rajiv Soundararajan

Department of Electrical Communication Engineering
Indian Institute of Science

Abstract

Suppose a user is exploring a virtual environment on a head mounted display device. Given the past view of a rendered video frame and the most recent head position, our goal is to directly predict a future video frame without having to graphically render it. We refer to the above problem as egomotion-aware temporal view synthesis. The biggest challenge in such view synthesis through warping is the disocclusion of the background. For infilling them, we introduce the idea of infilling vectors which point from disoccluded regions to known regions in the synthesized view. Tapping the correlation between camera motion in the past frames, we design a learning framework with temporal guidance to predict these infilling vectors. Our extensive experiments on a large scale dataset that we build for evaluating temporal view synthesis, in addition to the SceneNet RGB-D dataset, demonstrate that our infilling vector prediction approach achieves superior quantitative and qualitative infilling performance compared to other approaches in literature.

Student Presentation 9: Sparsity Driven Latent Space Sampling for Generative Prior based Compressive Sensing

Vinayak Killedar

Department of Electrical Engineering
Indian Institute of Science

Abstract

We address the problem of recovering signals from compressed measurements based on generative priors. Recently, generative model based compressive sensing (GMCS) methods have shown superior performance over traditional compressive sensing (CS) techniques in recovering signals from fewer measurements. However, it is possible to further improve the performance of GMCS by introducing controlled sparsity in the latent-space. We propose a proximal meta-learning (PML) algorithm to enforce sparsity in the latent space while training. Sparsity naturally divides the latent space and leads to a *union-of-submanifolds* model in the solution space. The overall framework is named as *sparsity driven latent space sampling* (SDLSS). In addition, we derive the sample complexity bounds for the proposed model. Furthermore, we demonstrate the efficacy of the proposed framework over the state-of-the-art techniques with application to CS on standard datasets such as MNIST and CIFAR-10. Our findings show that the proposed approach improves the accuracy and aids in faster recovery compared to GMCS.

Student Presentation 10: There is More to a Spectrogram Than Meets the Eye!

Jitendra Kumar Dhiman

Department of Electrical Engineering

Indian Institute of Science

Abstract
Developing methods for accurate speech analysis has a direct impact on applications such as speech synthesis, speaker recognition, speech recognition, and voice morphing, etc. A widely used tool to analyze speech is the spectrogram, which represents the time-varying spectral content of the speech signal. We model a spectrotemporal patch of the spectrogram by using 2-D amplitude-modulated and frequency-modulated (AM-FM) sinusoids and solve the demodulation problem in 2-D using a novel tool, namely, the *Riesz transform*. The AM and FM components correspond to the vocal tract smooth envelope and excitation signal. We demonstrate the impact of the Riesz transform technique for applications such as vocal tract filter estimation, voiced/unvoiced separation, pitch tracking, and aperiodicity estimation. The effectiveness of the new representation and speech parameters is shown for the task of speech reconstruction using *WaveNet*, a neural vocoder.

Invited Talk 1: Privacy-aware Analytics for Human Attributes from Images
Speaker: Mohan Kankanhalli, NUS Singapore

Invited Talk 2: Machine Vision in Industrial Automation
Speaker: Jayavardhana Gubbi, TCS Research

3.2.2 Cluster: Nanodevices, VLSI Circuits and Microsystems-2
Cluster Coordinator: Mayank Shrivastava (ESE)
Chair: Varun Raghunathan, ECE and Chetan Singh Thakur, ESE
Student Organizer: Alok Joshi, ECE
Faculty Organizer: Dipanjan Gope, ECE

Cluster Overview			
Time		Speaker	Affiliation
10:15am-10:45am	Invited Talk 1	Siddharth Tallur	IIT Bombay
10:45am-10:55am	Student	Sayak Dutta Gupta	ESE,IISc
10:55am-11:05am	Presentations	Ankit Soni	ESE,IISc
11:05am-11:15am		Rajarshi Roy Chaudhuri	ESE,IISc
11:15am-11:25am		Jayanta Deka	ECE,IISc
11:25am-11:35am		Sruti Menon	ECE,IISc
11:35am-11:45am		Alekya B	ESE,IISc
11:45am-11:55am		Anil Vishnu G K	ESE,IISc
11:55am-12:05pm		Sitaramgupta V S N V	ESE,IISc
12:05pm-12:15Pm		Uttam Pal	ESE,IISc
12:15pm-12:25Pm		Vaidya Girish Bhagwan	ESE,IISc
12:25pm-12:40pm	Q&A Students		
12:40pm-13:10pm	Invited Talk 2	Aravind Vijayaraghavan	Manchester University, UK

Invited Talk 1:Microsystems for structural health monitoring
Speaker: Siddharth Tallur, IIT Bombay

Student Presentation 1: Novel p-type AlTiO Gate Oxide based e-mode Operation in AlGaN/GaN HEMTs: 600V Technology with Record High Performance

Sayak Dutta Gupta and Mayank Shrivastava

Department of Electronic Systems Engineering
Indian Institute of Science, Bangalore

Abstract:
AlGaN/GaN High Electron Mobility Transistors (HEMTs) are potential candidates for power applications. However, while enhancement-mode (e-mode) is preferred for power applications, AlGaN/GaN HEMTs are depletion mode devices. This work experimentally demonstrates e-mode AlGaN/GaN HEMTs by introducing a novel p-type high-κ $Al_xTi_{1-x}O$ based ternary gate oxide. The threshold voltage (V_{th}) of the GaN HEMTs was found to be tuned by the concentration of Al in Al-Ti-O system, with increasing Al% resulting in a higher positive shift in V_{th}. Ternary oxide AlTiO was also demonstrated to be superior to regular binary p-oxides, like CuO and NiO_x. Using the high-κ and p-type AlTiO, in conjunction with a thinner AlGaN barrier under gate, 600 V e-mode GaN HEMTs are demonstrated with superior ON-state performance ($I_{ON} \sim$ 400 mA/mm and R_{ON} = 8.9 Ω-mm) and gate control over channel ($I_{ON}/I_{OFF} = 10^7$, SS = 73 mV/dec and gate leakage $<$ 200 nA/mm), beside improved safe operating area reliability.

Student Presentation 2: Gallium Nitride Hetero-structure based Schottky Barrier Diodes for Power and RF Applications

Ankit Soni and Mayank Shrivastava

Department of Electronic Systems Engineering
Indian Institute of Science

Abstract:
The Schottky Barrier Diode is a key component in any power electronic circuit or THz/mmW system. A comprehensive TCAD and experimental co-design strategies have been proposed for high power and THz SBD. The critical part of the SBD diode design involves modelling the non-idealities at the Schottky interface and designing physics based process experiments to fix these non-idealities. We have modelled the anode contact interface by accounting for these effects. In addition impact of recessed depth and nature of buffer traps are investigated. The repercussions of field plate design on other performance figures of merit parameters such as diode current collapse, reverse recovery time, reverse current overshoot, and electro-thermal behaviour is investigated. Using the systematic device design approach, we have experimentally demonstrated high power SBD with 15A forward current at 5.5V while having reverse blocking greater than 500V. The design metrics for THz SBD vastly differs from the one used for high power applications. It is imperative to account for the impact of associated device parasitic elements at high-frequency operating conditions. The planer, multi-finger SBD topology looks most promising due to the ease of integration and high cut-off frequencies demonstrated. We present the first report on the design and engineering of multi-finger THz SBD. The study investigates the design metrics of AlN/GaN-based multi-finger, lateral SBD and proposes guidelines to maximize THz operation performance.

Student Presentation 3: Unique Reliability Phenomena in AlGaN/GaN HEMTs

Rajarshi Roy Chaudhuri and Mayank Shrivastava

Department of Electronic Systems Engineering
Indian Institute of Science, Bangalore

Abstract:
AlGaN/GaN High Electron Mobility Transistors (HEMTs) are potential candidates for power applications. However, they suffer from wide range of reliability challenges under different operating conditions. In this work, we explore - (1) dynamic on-resistance (R_{ON}) increase post OFF-state stress, (2) gate leakage (I_G) current degradation during semi-ON state stress, and (3) OFF-state breakdown physics employing an electro-optic characterization setup and a well-calibrated TCAD simulation setup. Unique critical voltage (V_{Cr}) associated with dynamic R_{ON} effects was observed and attributed to carrier injection and trapping in Carbon doped GaN buffer governed by channel electric field. Similarly, unique V_{Cr} was noticed in semi-ON state beyond which I_G degraded permanently. It was attributed to crack/ pit formation in buffer governed by thermo-elastic stress buildup owing to hot electron-buffer trap interaction. OFF-state breakdown in GaN HEMTs was found to be a strong function of surface/buffer trap concentration and device design parameters based on which device design guideline have been established.

Student Presentation 4: Nonlinear Light Generation in Dielectric Metasurfaces

Jayanta Deka

Department of Electrical Communication Engineering
Indian Institute of Science, Bangalore

Abstract:

Student Presentation 5: Medium refractive index contrast sub-wavelength dielectric structures for nonlinear optics and sensing application

Sruti Hemachandran Menon

Department of Electrical Communication Engineering
Indian Institute of Science

Abstract
Dielectric metasurfaces have generated widespread interest in light generation, manipulation etc. at the nanoscale which stems from their ability to control light's amplitude, phase and polarization properties. These have been used to make chip scale light sources, ultrasmall sensing devices, narrowband filtering responses etc.. The resonant response of these metasurfaces is associated with enhancement of the electric field in the vicinity of the metasurfaces because of field confinement which could be used for enhanced nonlinear light generation. Here, in this presentation, the works that we have done in our lab regarding nonlinear light generation in Silicon metasurfaces will be presented. Third harmonic generation and four wave mixing in silicon metasurfaces would be presented, followed by second harmonic enhancement from a 2D GaSe layer coupled to a silicon metasurface would also be presented.

Student Presentation 6: Design and Development of a Dual-Functional Intubation Catheter for Chronic Airway Management

Alekya B and Hardik J. Pandya

Department of Electronic Systems Engineering
Indian Institute of Science

Abstract:
In this work, we report the design and development of an intubation catheter for grading stenosis in the pediatric upper airway. Severely constricted airways often warrant continuous monitoring as resistance to flow increases to fourth power for every one-degree reduction in tracheal patency. The complexities and impediments with conventional diagnostic tools such as misclassification on the degree of narrowing and long radiation exposure make them sub-optimal for emergent diagnosis. We propose an intraoperative diagnostic tool integrated with an array of flow sensors and tactile sensors mounted at the distal end of the manoeuvrable catheter. The flow sensors generate localised flow patterns across various segments of the tracheobronchial tree with unique peaks corresponding to the site of obstruction. While the flow patterns allow for locating stenosis, the tactile sensors can determine the target tissue stiffness. Quantitative evaluation of alteration in the airway column biomechanics facilitates targeted diagnosis and expedites on-site decision making.

Student Presentation 7: Title: A portable MEMS-based platform for the electro-thermal phenotyping of breast biopsy tissue: towards a system for tumour delineation

Anil Vishnu G K[a], Annapoorni Rangarajan[b], Hardik J. Pandya[c]

[a]*Centre for BioSystems, Science and Engineering*
Indian Institute of Science, Bengaluru

[b]*Department of Molecular Reproduction, Development and Genetics*
Indian Institute of Science, Bengaluru

[c]*Department of Electronic Systems Engineering*
Indian Institute of Science, Bengaluru

Abstract:
We report a portable diagnostic platform integrated with MEMS-based biochips for rapid phenotyping of breast biopsy tissues using electro-thermal modalities. The biochips fabricated on a silicon substrate using microfabrication techniques measure the bulk resistivity (ρ_B), surface resistivity (ρ_S), and thermal conductivity (k) of the samples. Measurements were performed from deparaffinized and formalin-fixed tumour and adjacent normal breast biopsy samples from N = 8 patients. For formalin-fixed samples, the mean ρ_B for tumour reported a statistically significant fold change of 4.42 (p = 0.014) when the tissue was heated from 25 ^{o}C to 37 ^{o}C, while for normal the fold change was 3.47. The mean S measurements also reported similar trend. The normal tissue reported a mean k of 0.563 ± 0.028 $\mathrm{Wm^{-1}K^{-1}}$, while tumour reported significantly lower k of 0.309 ± 0.02 $\mathrm{Wm^{-1}K^{-1}}$. These observations, after validation with fresh tissues, could potentially be used for rapid tumour delineation.

Student Presentation 9: Design and Development of a Micro-Force Sensor for Ablation Catheters

V S N Sitaramgupta V and Hardik J. Pandya

Department of Electronic Systems Engineering
Indian Institute of Science

Abstract
In this work, we present simulation, fabrication, and characterization of a micro force sensor that has the potential to integrate with the ablation catheters for real-time measurement of catheter tip contact forces. FEM analysis was used to optimize the sensor design. The sensor was charac- terized using a custom-built micro-indentation setup and automated using LabVIEW. The sensor characteristics such as linearity, sensitivity, and hysteresis were evaluated. The sensor showed a linear response with R^2–value of 0.995 for the force ranging from 0 –1.2 N. The sensitivity and hys- teresis were found to be 108 $\pm 11 \Omega N^{-1}$ and 5% respectively. The fabricated sensor was integrated into a customized catheter tip and tested on the porcine heart tissues for evaluating the tip contact forces.

Student Presentation 10: Design and development of Opto-Thermo-Acoustic (OTA) based measurement techniques to aid breast cancer diagnosis

Uttam M. Pal and Hardik J. Pandya

Department of Electronic Systems Engineering
Indian Institute of Science

Abstract
Breast cancer is among the leading cause of mortality among women worldwide. Histopathology that accounts for the microscopic evaluation of thin slices of breast biopsy tissue under a microscope to study cell structure and morphology is considered the gold standard. We design and develop a system that combines the optical, thermal, and acoustic modalities to estimate the bulk tissue optical properties (reduced scattering and absorption coefficient), thermal properties (thermal conductivity and specific heat), and acoustic (attenuation coefficient). The additional information gauged through these measurements can potentially aid the pathologist in confirming the breast cancer diagnosis. The measurements were performed on formalin-fixed (FF) and deparaffinized (DP) breast biopsy tissues from a total of N = 24 subjects.

Towards unique device identification using Physically Unclonable Functions

Girish Vaidya and Dr. T.V. Prabhakar

Department of Electronic Systems Engineering
Indian Institute of Science

Abstract
Uniqueness of device-ID is critical to ensure trustworthiness of the data reported by the device. This work presents a novel device-specific identifier - IoT-ID, based on Physically Unclonable Functions (PUFs) that exploits variations in the semiconductor manufacturing process. We design novel PUFs

for Commercially Off the Shelf (COTS) components such as clock oscillators and ADC, to derive IoT-ID for a device. Hitherto, system component PUFs are either invasive or rely on additional dedicated hardware circuitry to create a unique fingerprint. A highlight of our PUFs is doing away with special hardware. IoT-ID is non-invasive and can be invoked using simple software APIs running on COTS components. During our evaluation, IoT-ID has demonstrated 100% accuracy in uniquely identifying 50 devices in our deployment. We show the scalability of IoT-ID with the help of numerical analysis on 1000s of IoT devices.

Invited Talk 2: Graphene-polymer heterostructure membrane for MEMS devices

Speaker:- Aravind Vijayaraghavan, Manchester University, UK

3.2.3 Cluster: Signal Processing and Communications

Cluster Coordinator: Neelesh Mehta, ECE
Chair: TBD
Student Organizer: Anand Kumar, ECE
Faculty Organizer: Sundeep Chepuri, ECE

Cluster Overview			
Time		Speaker	Affiliation
10:15am-10:26am	Student	Deepchand Meshineni	EE,IISc
10:26am-10:37am	Presentations	Bala Venkta R G	ECE,IISc
10:37am-10:48am	+Q&A	Shubham Sharma	ECE,IISc
10:48am-10:59am		Vinay Kumar B R	ECE,IISc
10:59am-11:10am		Deekshith	ECE,IISc
11:10am-11:40am	Invited Talk 1	Ajit Rajwade	IIT Bombay
11:40am-11:51am	Student	Govindu Saikesava	ECE,IISc
11:51am-12:02pm	Presentations	Vinayak Ramkumar	ECE,IISc
12:02pm-12:13pm		Rama Kiran	ECE,IISc
12:13pm-12:24pm		Ram Kumar	ECE,IISc
12:25pm-13:00pm	Invited Talk 2	Adrian Sharples	British Telecom

Student Presentation 1: Vital signs monitoring using FMCW radar

Deepchand Meshineni

Department of Electrical Engineering
Indian Institute of Science

Abstract
In this talk, the discussion is on non-contact vital signs monitoring using a frequency modulated continuous wave (FMCW) radar. Here, we analyse phase of the Intermediate Frequency signal (IF) in detail. Any human or clutters which is exposed to FMCW radar signal is able to reflect the chirp, the reflected chirp goes to mixer to produce IF signal. This paper deals with extracting vital signs such as breathing rate, heart rate from a subject who sits in front of radar irrespective of the chest orientation towards the radar. Phase of the IF signal is processed to obtain the spectrum in desired

range-bin. The spectrum is further subjected to filtering and threshold as will be detailed. Random body movements are detected and those samples are discarded for calculation of heart-rate. We also classify the subjects based on breathe apnea using avaialble data set.

Student Presentation 2: Resource Allocation with Limited Feedback in Underlay D2D Networks

Bala Venkata Ramulu Gorantla

Department of Electrical Communication Engineering
Indian Institute of Science

Abstract
Device-to-device (D2D) communication enables direct communication between the devices. In underlay D2D, D2D users reuse the subchannels assigned to cellular users (CUs), which leads to interference between them. We explore the problem of allocating multiple D2D pairs per subchannel and the resulting trade-off between the spatial reuse and inter-D2D interference. We study the practical partial and statistical channel state information (CSI) models in which the D2D user only knows the statistics of inter-D2D and inter-cell interferences. We propose a limited feedback scheme, where the D2D user computes its rate with a reliability guarantee despite the limited CSI and feeds it back to the base station. We propose interference-aware resource allocation algorithms that allocate multiple D2D pairs per subchannel to maximize D2D sum rate while guaranteeing minimum rate for the CUs. The proposed algorithms provably achieve at least one-third and half of the optimal sum rate. Numerically, they achieve near-optimal performance.

Student Presentation 3: Design of k-space trajectories to reduce scan time for an MRI system

Shubham Sharma, K.V.S. Hari

Department of Electrical Communication Engineering
Indian Institute of Science

Abstract
MRI is an essential non-invasive medical imaging modality. However, it is limited by long scan times. The sampling in MRI happens in the 2D/3D Fourier domain called as the k-space. It is traversed along continuous paths called trajectories. One of the more recent ways to reduce scan time in MRI is using compressed sensing (CS) methods which allow random undersampling of the k-space. However, this does not satisfy system constraints of MRI. Here, the design of feasible trajectories to traverse the k-space is discussed. We propose a generalized framework that encompasses projection-based methods to generate feasible trajectories. This framework allows to construct feasible trajectories from both random and structured initial trajectories, e.g., based on the traveling salesman problem (TSP). It is observed that the proposed TSP-based and random-like trajectories provide better reconstruction performance than the state-of-the art methods with a shorter scan time. In particular, the SIP-random method improves reconstruction performance with a 26% reduction in scan time.

Student Presentation 4: Probabilistic Forwarding with Coding for Network-wide Broadcast

Vinay Kumar B.R.

Department of ECE
Indian Institute of Science

Abstract
Broadcasting information is crucial in ad-hoc networks such as Internet of Things and Wireless Sensor Networks which have no centralized infrastructure. Mechanisms such as flooding are not suitable as they involve redundant transmissions. In our work, we propose and analyze a completely distributed, low complexity, energy-efficient broadcast algorithm for these networks.

We consider a network with a distinguished source node that has data packets to broadcast. It encodes these data packets into n coded packets in such a way that, any node receiving at least k out of the n coded packets can retrieve the original data packets. The source transmits the n coded packets to its one-hop neighbours. Every other node in the network follows a probabilistic forwarding protocol: it forwards a previously unreceived packet to all its neighbours with probability p and does nothing with probability $1-p$.

Our primary interest is to analyze this mechanism on random geometric graphs (RGGs) which are used to model deployments of ad-hoc networks. We find that with a judicious choice of n and the forwarding probability p, we can significantly reduce the expected total number of transmissions needed to broadcast data from the source. Moreover, while this holds for other well-connected graphs (grids, lattices etc.), it is not true for trees. We provide theoretical justifications for the same.

Student Presentation 5: Second-order Rate Bounds for a Block Fading Channel Powered by an Energy Harvesting Transmitter

Deekshith P K and Vinod Sharma

Department of ECE
Indian Institute of Science

Abstract
In this talk, we illustrate how second-order lower and upper bounds can be derived for a point-to-point complex Gaussian fading channel with an energy harvesting transmitter, and fading gains available at the transmitter and the receiver. A standard approach to derive such results for a channel with finite states makes use of the method of types, especially in the derivation of upper bound. Such an approach is not feasible in our case as the number of states is uncountable. Further, a dynamic power constraint on the codeword symbols, imposed by the energy harvesting transmitter, has to be met. We illustrate how *strong approximation principle* turns in handy in deriving bounds in such a scenario, especially while deriving upper bounds. As a special case, we obtain corresponding results for no state information at the transmitter and full state information at the receiver.

Invited Talk 1: Pooled testing for COVID19 samples

Speaker: Ajit Rajwade

Abstract
We propose 'Tapestry', a novel approach to pooled testing with application to COVID-19 testing with quantitative Reverse Transcription Polymerase Chain Reaction (RT-PCR) that can result in shorter testing time and conservation of reagents and testing kits. Tapestry combines ideas from compressed sensing and combinatorial group testing with a novel noise model for RT-PCR used for

generation of synthetic data. Unlike Boolean group testing algorithms, the input is a quantitative readout from each test and the output is a list of viral loads for each sample relative to the pool with the highest viral load. While other pooling techniques require a second confirmatory assay, Tapestry obtains individual sample-level results in a single round of testing, at clinically acceptable false positive or false negative rates. We also propose designs for pooling matrices that facilitate good prediction of the infected samples while remaining practically viable. When testing n samples out of which k « n are infected, our method needs only O(k log n) tests when using random binary pooling matrices, with high probability. However, we also use deterministic binary pooling matrices based on combinatorial design ideas of Kirkman Triple Systems to balance between good reconstruction properties and matrix sparsity for ease of pooling. A lower bound on the number of tests with these matrices for satisfying a sufficient condition for guaranteed recovery is k $\sqrt{n}$. In practice, we have observed the need for fewer tests with such matrices than with random pooling matrices. This makes Tapestry capable of very large savings at low prevalence rates, while simultaneously remaining viable even at prevalence rates as high as 9.5%. Empirically we find that single-round Tapestry pooling improves over two-round Dorfman pooling by almost a factor of 2 in the number of tests required. We describe how to combine combinatorial group testing and compressed sensing algorithmic ideas together to create a new kind of algorithm that is very effective in deconvoluting pooled tests. We validate Tapestry in simulations and wet lab experiments with oligomers in quantitative RT-PCR assays. An accompanying Android application Byom Smart Testing makes the Tapestry protocol straightforward to implement in testing centres, and is made available for free download. Lastly, we describe use-case scenarios for deployment.

Bio

Ajit Rajwade is an Associate Professor in the Department of Computer Science and Engineering at IIT Bombay. Prior to that, he was a postdoctoral researcher in the Department of Electrical Engineering at Duke University in 2011 and 2012. He obtained his PhD from the University of Florida in 2010, his masters degree from McGill University in 2004 and his bachelors degree from the University of Pune in 2001, all in computer science and engineering. His research interests are in image processing, signal processing and computer vision, with a focus on compressed sensing, group testing, image restoration, image compression, tomography and non-parametric probability density estimation. He is a senior member of the IEEE and has won an Excellence in Teaching Award at IIT Bombay in 2019.

Student Presentation 6: MCS selection algorithms for URLLC in Multi-connectivity

Govindu Saikesava

Department of Electrical Communication Engineering
Indian Institute of Science

Abstract

Ultra-reliable and low-latency communications, is a new field in 5G, requires very high reliability and very low latency. It will deliver services like factory automation, telesurgery and autonomous driving. Multi-connectivity, in which multiple base stations (BSs) send the same information to the receiver, is crucial for improving reliability. In addition, to satisfy the latency requirement, URLLC data must be scheduled immediately, preempting conventional traffic. We propose an algorithm

that selects one or more BSs and their modulation and coding schemes (MCSs) to minimize the degradation of the broadband data while meeting the reliability requirements of URLLC.

We then generalize our approach to account for the time-varying nature of the wireless channel, which causes the periodic channel quality feedback reports to become outdated. For this scenario, we propose a novel outage probability-based definition of reliability and a new algorithm to determine the BSs and their MCSs.

Student Presentation 7: Streaming Codes for Reliable, Low-Latency Communication

Vinayak Ramkumar

Department of Electrical Communication Engineering
Indian Institute of Science

Abstract

Reliable, low-latency communication is key to many envisaged next-generation communication applications such as assisted driving, augmented reality and telesurgery. Streaming codes represent an approach to forward error-correction at the packet level in which a dropped or lost packet is viewed as an erased code symbol and where the codes are designed to be operated under a decoding-delay constraint.

This talk will focus on our recent constructions of streaming code. These constructions are based on careful embedding of code symbols belonging to a scalar block code within the packet stream. Different embedding approaches and attendant constructions will be presented and compared.

Student Presentation 8: Design of Reduced Feedback Scheme, User Scheduling, and MAC protocols for Full-Duplex Communication Systems

Rama Kiran and Prof. Neelesh B. Mehta

Department of ECE
Indian Institute of Science

Abstract

Full-duplex (FD) promises to double the data rates by enabling simultaneous transmission and reception over the same frequency band. Enabling FD in cellular networks creates inter- user interference between uplink and downlink. We propose a novel user-pair scheduling and mode selection algorithm (UPSMA) that maximizes sum spectral efficiency, and we characterize its asymptotic behaviour. We also propose a reduced feedback scheme for it, in which each user feeds back a limited number of inter-user interferences. We then study FD wireless local area networks (WLANs). We propose a medium access control (MAC) protocol called asymmetric FD-MAC (AFD-MAC). AFD-MAC intelligently uses hidden users to exploit FD. It uses the random back-off counter-based channel contention mechanism of 802.11 and introduces two new signals to provide as many FD transmission and reception opportunities to the AP as possible.

Student Presentation 9: Scheduling and Power Control for Wireless Multicast Systems via Deep Reinforcement Learning

Ramkumar Raghu, Mahadesh Panju, Vinod Sharma, Vaneet Aggarwal

Department of Electrical Communication Engineering
Indian Institute of Science

Abstract
Multicasting in wireless systems exploits the redundancy in user requests in a Content Centric Networks. Power control and optimal scheduling can significantly improve the wireless multicast network's performance under fading. Model-based approaches for power control and scheduling are not scalable to large state space or changing system dynamics. Here, we propose a constrained Deep RL approach to obtain a power control policy that matches the optimal policy for a small network. We show that power control policy can be learnt for reasonably large systems via this approach. Further we use multi-timescale stochastic optimization to maintain the average power. Finally, we extend the multi-time scale approach to simultaneously learn the optimal queueing strategy along with power control. We demonstrate scalability, tracking and cross-layer optimization capabilities of our algorithms via simulations. The proposed approach can be used in general large state-space dynamical systems with multiple objectives and may be of independent interest.

Invited Talk 2: Beyond the 5G Launch: The Future of Personal Communications

Speaker: Adrian Sharples, British Telecom

3.2.4 Cluster: Computer Systems

Cluster Coordinator: Matthew Jacob, CSA and Jayant Haritsa, CSA
Chair: TBD
Student Organizer: Rameesh Paul, CSA
Faculty Organizer: Rahul Saladi, CSA

Cluster Overview			
Time		Speaker	Affiliation
10:15am-11:15am	Invited Talk 1	Suparna Bhattacharyya	Hewlett-Packard Enterprise
11:15am-12:15pm	Invited Talk 2	C. Pandu Rangan	IIT Madras
12:15pm-12:27pm	Student Presentations	Aakash Khochare	CDS,IISc
12:27pm-12:39pm		Devyani Gupta	ESE,IISc
12:39pm-12:51pm		Geetam Chawla	CSA,IISc
12:51pm-13:03pm		Ramakant Joshi	ESE,IISc

Invited Talk 1: The Silent Learner and the Oblivious Teacher - Meaning Aware Storage for AI

Speaker: Suparna Bhattacharyya, Hewlett-Packard Enterprise

Invited Talk 2: Impossible Trinities and Blockchain Trilemma

Speaker: C. Pandu Rangan, IIT Madras

Student Presentation 1: Algorithms for Co-scheduling of Edge Analytics and Routes for UAV Fleet Missions

Aakash Khochare

Department of Computational and Data Sciences
Indian Institute of Science

Abstract
Unmanned Aerial Vehicles (UAVs), or drones, are increasingly used for urban applications like traffic monitoring and construction surveys. A common activity is to hover and observe a location using on-board cameras. Advances in Deep Neural Networks (DNNs) allow such videos to be analyzed for automated decision making. UAVs also host edge computing capability for on-board inferencing by such DNNs. Here, we propose a novel Mission Scheduling Problem (MSP) for co-scheduling the flight route to visit and record video at waypoints, and their subsequent on-board analysis, for a fleet of drones. The schedule maximizes the utility from the activities, while meeting activity deadlines, and the energy and computing constraints. We provide two efficient heuristic algorithms, JSC and VRC, to obtain fast, sub-optimal solutions. Our detailed evaluation of these algorithms using real drone benchmarks show the utility-runtime trade-offs of the 3 schedulers under diverse workloads.

Student Presentation 2: Optimal Link Capacity Selection and Edge Server Placement using Column Generation

Devyani Gupta and Joy Kuri

Department of Electronic Systems Engineering
Indian Institute of Science

Abstract
When an end user wants to subscribe to a gaming service, he expects the network to respond quickly and provide good Quality of Service and Quality of Experience. Any network has few Data Centers (DC), and they are placed deep inside the core network. Therefore, it becomes challenging to provide a service to a user which requires high bandwidth and very low latency. Placing servers near the user and on the edge of the core network can help overcome this challenge. Thus, the question of optimal placement of these servers arises. Also, to reduce the total cost incurred, it is essential to activate only those links which connect users to the DC and assign appropriate capacities to these links. We present the Network Design Problem of optimal server placement and link capacity selection. The problem formulated is a Large Integer Linear Program and we provide exact and fast solution by using the Column Generation (CG) Technique.

Student Presentation 3: Automatically finding bugs in web applications

Geetam Chawla

Department of CSA
Indian Institute of Science

Abstract
Most modern web applications are based on the Model-view-controller design pattern. It is desirable to detect bugs automatically in controllers based on specifications given by developers. We propose an approach for this problem. The core step of our approach is to automatically extract a formal model of a controller using program analysis techniques. The model is based on relational algebra, and represents the database accesses and queries performed by the controller. We then feed this

model to a pre-existing constraint solver along with the user's specification. We have implemented our approach as a tool. We evaluated our tool on a set of 56 specifications. The tool found 34 of these to be satisfied; of the rest, upon manual analysis, we found that two were genuinely violated, while the remaining 20 'unsatisfied' warnings were actually false positives. Apart from verification purposes our model can also aid in developer understanding.

Student Presentation 4: Hardware Accelerator For Particle Transport Simulation

Ramakant Joshi, Kuruvilla Varghese

Department of Electronic Systems Engineering
Indian Institute of Science

Abstract
Simulating Particle Transport through matter lies at the heart of Particle Physics applications, including Nuclear and High Energy Physics, extending to medical physics for treatment planning and radiation dose calculation. Our current work investigates the principle of particle transport simulation, identifying major computational elements involved and developing an efficient architecture for accelerating the computation on hardware. The ultimate goal is to implement the system on a Field Programmable Gate Array (FPGA). For a non-physicist, it is cumbersome to develop such a system from scratch. We show how we can leverage the power of High-Level Synthesis Tools to directly convert existing C/C++ Code for Particle Transport to hardware implementation, highlighting the benefits and downsides of such an approach. The final System Architecture is based on the Xilinx Vitis tool targeted to the Xilinx Alveo U250 FPGA card. The execution model for the same will also be discussed.

3.2.5 Break: 13:15pm - 14:00pm

3.2.6 Cluster: Cyber-Physical Systems

Cluster Coordinator: Amrutur Bharadwaj, RBCCPS
Chair: Vaibhav Katewa (ECE/RBCCPS), Shishir N. Y. Kolathaya (CSA/RBCCPS)
Student Organizer: Dhanaprakaash G., RBCCPS
Faculty Organizer: Vaibhav Katewa, RBCCPS

Cluster Overview

Cluster Overview			
Time	Event	Speaker	Affiliation
14:00pm-14:30pm	Invited Talk 1	Henning Sanneck	Nokia, Germany
14:30pm-15:00pm	Invited Talk 2	Amit Singhee	IBM Research, India
15:00pm-15:45pm	Invited Talk 3	Pavithra Prabhakar	Kansas State Univ. USA
15:45pm-16:00pm	Student Presentations	Chetan Kumar K	ECE,IISc
16:00pm-16:15pm		Rooji Jinan	RBCCPS,IISc
16:15pm-16:30pm		Sagar Gubbi Venkatesh	ECE,IISc
16:30pm-16:45pm		Saraswathy Ramanathan	ECE,IISc

Invited Talk 1: Cognitive Network Management in Mobile Cyber-Physical Systems

Speaker: Henning Sanneck, Nokia Strategy and Technology, Germany

Invited Talk 2: AI and Hybrid Cloud

Speaker: Amit Singhee, IBM Research, India

Invited Talk 3: Abstractions for Scalable Verification of AI-Controlled Cyber-Physical Systems

Speaker: Pavithra Prabhakar, Kansas State University, USA

Student Presentation 1: Transmission Line Outage Identification - A Sequential Testing Framework

Chetan Kumar Kuraganti

Department of Electrical Communication Engineering
Indian Institute of Science

Abstract

In this work, the problem of identifying transmission line failures in a power system is investigated. Identifying such failures in the shortest possible time is of importance due to cascading nature of these failures. With this motivation, a state estimation-based sequential hypothesis testing procedure to localize the failed lines is proposed. The primary focus is on single-line outages as these are more frequently occurring failures. The state estimation (SE) is performed using conventional power measurements (SCADA) and synchronized phasor measurement units (PMUs). The idea is that if there is an outage, then this information is embedded in the state estimation results, and this information can be utilized to infer the topology of the power system. The proposed framework involves a Kalman filter-based state estimation followed by a generalized likelihood ratio testing procedure to locate the failed lines. This work considers both centralized and decentralized state estimation approaches. In a centralized approach, all the information from various parts of the power system is available to the system operator. However, in a decentralized approach, only limited information is considered to reduce the communication and computational overhead. The proposed algorithms are evaluated on the IEEE 14 and the IEEE 118 bus systems, and results show that all the high-risk line failures were identified quickly. Furthermore, simulation results show that the use of PMUs enables accurate and quicker detection than conventional power measurements.

Student Presentation 2: Tracking an AR(1) Process with limited communication per unit time

Rooji Jinan, Parimal Parag and Himanshu Tyagi

Department of Robert Bosch Centre for Cyberphysical Systems
Indian Institute of Science

Abstract

Samples from a high-dimensional AR[1] process are quantized and sent over a communication channel of finite capacity. The receiver seeks to form an estimate of the process in real-time. We consider a time-slotted communication model in slow-sampling regime where multiple communication slots occur between two sampling instants. We propose a successive update scheme which uses communication between sampling instants to refine estimates of the latest sample. We study the following question: Is it better to form refined estimates and send them over multiple communication

slots, making the receiver wait more for an update, or to be fast but loose and send new information in every communication opportunity? We show that the fast but loose successive update scheme with spherical codes is universally optimal asymptotically for large dimension.

Student Presentation 3: Translating Natural Language Instructions to Computer Programs for Robot Manipulation

Sagar Gubbi Venkatesh, Raviteja Upadrashta, and Bharadwaj Amrutur

Department of Electrical Communication Engineering
Indian Institute of Science

Abstract
It is highly desirable for robots that work alongside humans to be able to understand instructions in natural language. Existing language conditioned imitation learning models directly predict the actuator commands from the image observation and the instruction text. Rather than directly predicting actuator commands, we propose translating the natural language instruction to a Python function which queries the scene by accessing the output of the object detector and controls the robot to perform the specified task. This enables the use of non-differentiable modules such as a constraint solver when computing commands to the robot. Moreover, the labels in this setup are significantly more informative computer programs that capture the intent of the expert rather than teleoperated demonstrations. We show that the proposed method performs better than training a neural network to directly predict the robot actions.

Student Presentation 4: Latency Redundancy Tradeoff in Distributed Read-Write Systems

Saraswathy Ramanathan, Parimal Parag and Vikram Srinivasan

Department of Electrical Communication Engineering
Indian Institute of Science

Abstract
Data is replicated and stored redundantly over multiple servers for availability in distributed databases. We focus on databases with frequent reads and writes, where both read and write latencies are important. This is in contrast to databases designed primarily for either read or write applications. Redundancy has contrasting effects on read and write latency. Read latency can be reduced by potential parallel access from multiple servers, whereas write latency increases as a larger number of replicas have to be updated. We quantify this tradeoff between read and write latency as a function of redundancy, and provide a closed-form approximation when the request arrival is Poisson and the service is memoryless. We empirically show that this approximation is tight across all ranges of system parameters. Thus, we provide guidelines for redundancy selection in distributed databases.

Session: Q&A

3.2.7 Cluster: Power Engineering

Cluster Coordinator: Kaushik Basu, EE
Chair: Kaushik Basu, EE
Student Organizer: Tutan Debnath, ESE

Faculty Organizer: Sriram Ganapathy, EE

Cluster Overview

Cluster Overview			
Time	Event	Speaker	Affiliation
14:00pm-14:30pm	Keynote Talk	Vivek Agarwal	IIT,Bombay
14:30pm-14:55pm	Industry Talk 1	Ranganathan Gurunathan	Bloom Energy
14:55pm-15:20pm	Invited Talk 2	Shailesh Ghotgalkar	Texas Instruments
15:20pm-15:40pm	Inspire Faculty Talk	Ustab Kundu	EE,IISc
15:40pm-15:50pm	Student	Rupam Pal	EE,IISc
15:50pm-16:00pm	Presentations	Shamibrota Kishore Roy	EE,IISc
16:00pm-16:10pm		Tanmay Mishra	EE,IISc
16:10pm-16:20pm	Q&A Students		
16:20pm-16:30pm		Kamisetti N V Prasad	EE,IISc
16:30pm-16:40pm		Kiran Kumar Challa	EE,IISc
16:40pm-16:50pm		Meenu Jayamohan	EE,IISC
16:50pm-17:00pm		Nakul Narayanan K	ESE,IISC
17:00pm-17:10pm	Q&A Students		

Keynote talk 1: Realizing Multilevel Inverter Properties by Cascading Switched Capacitor Networks with Two Level Inverters

Speaker: Vivek Agarwal, IIT Bombay

Industry Talk 2: Fuel Cell and its applications in Power

Speaker: Ranganathan Gurunathan, Bloom Energy

Invited Talk 3: Digital power control in emerging industrial and automotive applications

Speaker: Shailesh Ghotgalkar, Texas Instruments

Inspire Faculty Talk: An Overview of Power Management in Server Application

Speaker: Utsab Kundu, EE

Student Presentation 1: Influence of soil's electrical parameters on lightning stroke-current evolution

Rupam Pal

Department of Electrical Engineering
Indian Institute of Science

Abstract

The lightning return stroke forms one of the severest natural sources of electromagnetic interference for systems, both in the air and soil. Several physical fields govern this complex physical phenomenon, and most of the engineering applications resort to much simplifications. Several pertinent aspects are somewhat unclear, and one such important aspect is the influence of soil's electrical properties on the stroke current evolution. This is investigated in the present work in a

theoretical framework using the 'Self-consistent return stroke' model. The 'Finite difference time domain' (FDTD) method is suitably adopted for the modelling. The developed FDTD formulation is then used to investigate and ascertain the role of soil's electrical properties on the stroke current evolution. For the first time, it is shown that the soil's electrical conductivity has some noticeable influence on the stroke current magnitude.

Student Presentation 2: Characterization and Modelling of Switching Dynamics of SiC MOSFET

Shamibrota Kishore Roy, Kaushik Basu

Department of Electrical Engineering
Indian Institute of Science

Abstract

SiC MOSFET is a wide bandgap (WBG) power device and commercially available in the voltage range of 600-1700V. With superior switching, conduction, and thermal performance, it is in close competition with the state-of-the-art Si IGBTs in this voltage range.

Fast switching transient of SiC MOSFET reduces switching loss but may induce prolonged oscillations, spurious turn on, high device stress and EMI related issues, etc. The nonlinearity of the device characteristics and impact of circuit parasitic makes the switching transient of SiC MOSFET different from its Si counterpart. So, modelling the switching dynamics and estimate the switching loss of SiC MOSFET is essential.

Analytical models are derived through the simplification of complex switching dynamics. Estimation using this type of model is computationally efficient and can be easily implemented with freely available programming platforms such as C or Python. This approach is beneficial at the early stage of the converter design when switching loss and junction temperature need to be evaluated over several operating points for many available devices from different vendors. Analytical models require parameters given in the datasheet.

This talk presents an analytical model to capture the switching dynamics of SiC MOSFET. A detailed non-linear model of the device along with circuit parasitic is considered. It results in accurate estimation of transition time, switching loss, (dv/dt), (di/dt), and transient over-voltage. Also, an analytical model to capture capacitor-assisted turn-off switching transient will be presented. It helps design the optimal value of the external snubber capacitor for capacitor-assisted zero voltage switching (ZVS) converter. In this talk, we will present simple measurement techniques to determine important circuit parasitic that impacts switching dynamics, such as the common-source inductance. We will also demonstrate software developed using Python based on the presented analytical model.

Student Presentation 3: Generalized Source emulation approach on micro-alternator

Tanmay Mishra

Department of Electrical Engineering
Indian Institute of Science

Abstract

This talk presents an approach to emulate different power system sources (different synchronous generators with excitation systems). A testbed consists of a micro-alternator having an open-loop H-bridge chopper as an exciter has been developed. To replicate a large machine's dynamics, a

digital time constant regulator has been incorporated to increase the d-axis transient time constant of the micro-alternator. The mathematical models of standard IEEE excitation systems are used as references, and their behaviors have been emulated. The proposed excitation emulation approach is tested under fault and step change in reference terminal voltage. The experimental results of a Single Machine infinite bus with these excitation systems have been compared with simulation for validity. This experimental platform is essential to test the different control and protection prototypes for validating the technologies.

Further, a dynamic inversion-based non-linear control approach is presented to replicate different synchronous generators' behavior on a micro-alternator. This approach is validated in simulation under different test cases.

Session: Q&A
Student Presentation 4: Design Of Active Magnetic Bearing

Kamisetti N V Prasad

Department of Electrical Engineering
Indian Institute of Science

Abstract
Bearings are crucial parts in any rotating machine, such as a motor, generator, or turbine. Majority ($> 50\%$) of the reported faults in electrical machines are related to bearing life and maintenance. These problems are particularly pronounced in high-speed rotating machines. Active magnetic bearing (AMB) is a contactless bearing, which supports the rotor of a high-speed electric machine or turbine by controlling the magnetic forces produced by a set of electromagnets positioned around the rotor. AMBs are increasingly used in high-speed aerospace, industrial, and energy applications. Due to its contact-less and lubrication-free operation, AMBs are suitable for harsh operating conditions (e.g., extreme temperatures, extreme pressures, corrosive environment) as well as for clean environments (e.g., food processing and pharmaceutical industries). This presentation discusses the operating principle of AMB, its components, and a system-level overview of AMB. The state-of-the-art differential-mode current control of AMB and the resulting force-current relationship is explained. The main specifications of an AMB, namely, load capacity and force slew rate, are discussed. The existing design procedure of AMB is based on linearized magnetic circuit analysis, which cannot account for the saturation in iron. An improved design procedure is presented, which accounts for magnetic saturation and ensures that the force generated is proportional to the control current up to the desired load capacity. The improved design procedure can achieve both desired load capacity and linear characteristics while balancing the compactness requirement. The improved design also achieves the desired force slew rate, faster dynamic response, and enhances the stability of the AMB.

Student Presentation 5: An Algorithm for Fitting Passive Equivalent Circuits for Lumped Parameter Frequency Dependent Transmission Line models

Kiran Kumar Challa

Department of Electrical Engineering
Indian Institute of Science

Abstract

Accurately fitting rational functions to the frequency response of modal impedances is very crucial for including frequency dependency in lumped parameter models of transmission lines. Vector fitting is widely used for fitting rational functions to the frequency response of modal impedancesand then an R-L equivalent circuit is obtained to get lumped parameter transmission line model.A single-step method based on the properties of Foster equivalent circuit is proposed in this paper to directly fit an R-L equivalent circuit to the frequency response of modal impedances. A close enough fitting is achieved using the proposed method with less number of passive elements. The proposed line model is validated by studying the switching transients in 400 kV, 765 kV and 1200 kV transmission lines and comparing the results with the constant parameter cascaded π-model and the Marti's Model in EMTP-RV. The prototype of an experimental scaled-down 230 kV line is developed using amorphous core inductors and the Clarke's transformation using 1-ϕ transformers.

Student Presentation 6: Impact Of Inverter Based Generation On Transmission Protection

Meenu Jayamohan, Dr. Sarasij Das

Department of Electrical Engineering
Indian Institute of Science

Abstract

The generation mix in the electric power grids around the world is undergoing a significant change from synchronous machines to inverter based resources (IBR). As a result, it is essential for the conventional system to adapt to these changes to bring reliability to the bulk power system(BPS). The increasing penetration of IBR has affected the conventional protection schemes. While synchronous machines were capable of providing sufficient amount of fault currents, IBR inverter controls reduce the fault current levels and short circuit strength. This talk presents a detailed review on the issues faced by conventional protection schemes in presence of an IBR.

Student Presentation 7: Switched Capacitor Converters for High Power Applications

Nakul Narayanan K and Prof. L Umanand

Department of Electronic Systems Engineering
Indian Institute of Science

Abstract

The switched capacitor (SC) converters are more compact and have higher power density when compared with the conventional switched inductor converters. Due to this, SC converter is being considered for high-power DC-DC applications like offshore HVDC, electric vehicles and grid integration. A new SC converter topology is presented with minimum capacitor volt-ampere rating and minimum voltage rating for active switches. The converter is then modified with multiple resonant inductors to achieve zero-current switching, reducing the switching losses considerably. Two variants of the proposed SC converter topology are further discussed with a reduced number of resonant inductors.

Session: Q&A

3.2.8 Cluster: Brain, Computation and Data

Cluster Coordinator: Prasanta Ghosh, EE and P. S. Sastry, EE
Chair: P. S. Sastry
Student Organizer: Nishchal Hoysal, EE
Faculty Organizer: Sriram Ganapathy, EE

Cluster Overview

Cluster Overview			
Time	Event	Speaker	Affiliation
14:00pm-14:30pm	Invited Talk 1	Suvarna Alladi	NIMHANS
14:30pm-15:00pm	Industry Talk 2	Gurupreet Singh Kalsi	Intel Labs, India
15:00pm-15:30pm	Open Discussion	Moderator: P S Sastry	EE, IISc
15:30pm-15:40pm	Student Presentations	Aditya Rastogi	CDS, IISc
15:40pm-15:50pm		Georgin Jacob	ECE,IISc
15:50pm-16:00pm		Jaswanth Reddy Katthi	EE,IISc
16:00pm-16:10pm		Jerrin Thomas Panachakel	EE,IISc
16:10pm-16:20pm		Rathin K. Joshi	EE,IISc
16:20pm-16:30pm	Q&A Students		
16:30pm-17:00pm	Invited talk 3	Neeraj Sharma	EE,IISC

Invited Talk 1: Brain connectivity in health and disease: Joining the dots towards a multidisciplinary approach

Speaker: Suvarna Alladi, NIMHANS
Abstract
Recent understanding of how the human brain processes cognition has evolved from traditional notions of isolated functions of single brain regions, to an emerging knowledge that cognition results from the dynamic interactions of areas distributed across the brain that operate in large networks. This understanding has emerged simultaneously from multiple disciplines, and offers exciting possibilities of exploring the brain and applying this knowledge towards the benefit of society. In this talk I will discuss how the area of brain-connectivity has helped us understand neurological disorders of cognition and helped to provide novel solutions to prevent, diagnose and treat these diseases. The focus will be on the potential contributions that could come from the disciplines of medical, engineering, social sciences as well as humanities to reduce burden of cognitive disorders.

Industry Talk 2: Look-Up Table based Energy Efficient Processing in Cache Support for Neural Network Acceleration

Speaker: Gurpreet Singh Kalsi, Intel Labs India
Abstract
Processing-in-memory is desired, but it comes at cost of modifying SRAM bit-cell which costs loss in density. This talk will present Look-Up Table (LUT) based Processing-In-Memory (PIM) technique with the potential for running Neural Network inference tasks. proposed LUT based PIM methodology exploits substantial parallelism using look-up tables, which does not alter the memory structure/organization, that is, preserving the bitcell and peripherals of the existing SRAM monolithic arrays.

Open Discussion:

Moderator: P. S. Sastry

Student Presentation 1: SpiNet: A Deep Neural Network for Schatten p-norm Regularized Medical Image Reconstruction

Aditya Rastogi and Dr. Phaeendra K Yalavarthy

Department of Computational and Data Sciences
Indian Institute of Science

Abstract

Model based deep learning architectures for solving inverse problems consists of two parts, a deep learning based denoiser and an iterative data consistency solver. The former has either L2 norm or L1 norm enforced on it, which are convex and can be easily minimized. This work proposes a method to enforce any p norm on the noise prior where $0 < p \leq 2$. This is achieved by using Majorization Minimisation algorithm, which upper bounds the cost function with a convex function, thus can be easily minimised. The proposed SpiNet has the capability to work for a fixed p or it can learn p based on the data. The network was tested for solving the inverse problem of reconstructing magnetic resonance (MR) images from undersampled k space data and the results were compared with a popular model based deep learning architecture MoDL which enforces L2 norm along with other compressive sensing based algorithms. This comparison between MoDL and proposed SpiNet was performed for undersampling rates ($\mathbf{R}$) of $2\times$, $4\times$, $6\times$, $8\times$, $12\times$, $16\times$ and $20\times$. Multiple figures of merit such as PSNR, SSIM and NRMSE were utilized in this comparison. A two tailed t-test was performed for all undersampling rates and for all metrices for proving the superior performance of proposed SpiNet compared to MoDL. For training and testing, the same dataset that was utilized in MoDL implementation was deployed. We also validated our algorithm on chest and dyanmic breast MRI data.

Student Presentation 2: Do deep networks see the way we do?

Georgin Jacob, Pramod R.T., Harish Katti, and S. P. Arun

Department of Electrical Communication Engineering
and Centre for Neuroscience
Indian Institute of Science

Abstract

Deep neural networks have recently revolutionized computer vision with their impressive performance on vision tasks. Their object representations have been found to match neural representations in the ventral pathway. But do deep neural networks see the way we do? This is an important question because it will elucidate the conditions and computations under which perceptual phenomena might arise in neural networks optimized for object classification. Here, we uncover the qualitative similarities and differences between brains and deep networks by comparing the representations of human perception eliciting objects. The main findings are: (1) Perceptual phenomena like Thatcher effect, Mirror confusion, and Weber's law emerge when deep networks are trained for object recognition; (2) Perceptual phenomena like 3D shape processing, surface invariance, and

the global advantage are absent. These results show us when we can consider deep networks good models of vision and how deep networks can be improved.

Student Presentation 3: Deep Learning Methods For Audio EEG Analysis

Jaswanth Reddy Katthi, Sriram Ganapathy

Department of Electrical Engineering
Indian Institute of Science

Abstract
Brain activations capturing techniques like electroencephalogram (EEG) capture signals not related to the stimuli, which distort the stimulus-response analysis, and their effect becomes more evident for naturalistic stimuli. To reduce the inter-subject redundancies, the EEG responses from multiple subjects can be normalized. Linear methods are the most prominent methods for single-trial analysis. But, they assume a simplistic linear transfer function. In this talk, we discuss a deep learning framework for audio-EEG data for intra-subject and inter-subject analyses. This boosts the signals common across the subjects and improves the intra-subject analysis for each subject. Experiments performed on naturalistic speech and music stimuli listening datasets show that the deep methods obtain better representations than the linear methods, and that the results are statistically significant. As an extension work, we compare the linear and deep methods for the task of speech reconstruction from the EEG recordings.

Student Presentation 4: Decoding Imagined Speech from EEG using Transfer Learning

Jerrin Thomas Panachakel

Department of Electrical Engineering
Indian Institute of Science

Abstract
In this talk, we present a transfer learning based approach for decoding imagined speech from electroencephalogram (EEG). Rather than extracting features separately from individual EEG channels, features are extracted simultaneously from multiple EEG channels. This helps in capturing the information transfer between the cortical regions. To alleviate the problem of lack of enough data for training deep networks, sliding window based data augmentation is performed. Mean phase coherence (MPC) and magnitude-squared coherence (MSC), two popular measures used in EEG connectivity analysis are used for extracting the features. These features are compactly arranged, exploiting their symmetry, to obtain a three-dimensional "image-like" representation. A deep network with ResNet50 as the base model is used for classifying the imagined prompts. The proposed method is tested on a publicly available EEG dataset recorded during speech imagery. The accuracies obtained are comparable to the state-of-the-art methods, especially in decoding prompts of different complexities.

Student Presentation 5: Design and Developement of a Headband for Cortical Response Extraction

Rathin K. Joshi and Hardik J. Pandya

Department of Electronic Systems Engineering
Indian Institute of Science

Abstract
Hearing Deficit is the most prevalent chronic neonatal sensory deficit. Considering adverse repercussions and congenital deafness statistics, early identification and subsequent intervention significantly save a newborn from lifelong deficiency. Brainstem Evoked Response Audiometry (BERA) and Otoacoustic Emissions (OAE) are the existing methods for Neonatal Hearing Screening (NHS). BERA and OAE do not scan the complete auditory system. Additionally, the lack of clinicians, expensive equipment, specialized hospitals with audiometry tools, and patient follow-up are the challenges for the NHS in India. We developed a quick, non-invasive, cost-effective, objective headband to assess the complete auditory pathway. The cortical auditory evoked response provides important information about the functionality of subsequent elements of the auditory pathway, making it a comprehensive signature to evaluate the entire auditory pathway. We obtained a cortical response (Mismatch Negativity) from n=3 young adults. We aim to replicate a similar headband for Neonatal Hearing Screening.

Invited Talk 3: Language familiarity impacts brain processing of speech

Speaker: Neeraj Sharma, EE, IISc

Abstract
Spoken communication is fundamental to the human experience. There are 7000 plus spoken languages. Does knowing a language impact how the "listening brain" processes the spoken utterance? In the talk, I will describe our research exploring this question. We designed a listening test experiment in which human participants detect talker changes in two natural, multi-talker speech stimulus sets - a familiar language (English) and an unfamiliar language (Chinese). Miss rate, false-alarm rate, and response times (RT) showed a significant dependence on language familiarity. This suggests interaction between talker and linguistic perception even when the task required focussing on the former, and indicate a robustness in talker change detection. Detecting talker changes in conversational speech recordings is also of huge importance for the speech recognition machine systems. Benchmarking the same human listening task against a state-of-the-art machine diarization system showed that the machine system achieved human parity for the familiar language but not for the unfamiliar language.

Bio
Neeraj Sharma is a Raman Postdoctoral Researcher at Dept. EE, Indian Institute of Science. He is interested in understanding what, how, and why of human speech processing. He uses signal processing, auditory neuroscience, and machine learning in his research. He obtained his Masters and PhD from ECE, IISc in 2018. He was a visiting researcher at the Ecole Normale Superieure, Paris, and has worked as a BrainHub postdoctoral fellow at the Carnegie Mellon University, Pittsburgh. He is a contributor to the Project Coswara (https://coswara.iisc.ac.in/), analyzing detection of COVID-19 using acoustics.

3.2.9 Cluster: Computational Sciences

Cluster Coordinator: Sashikumaar Ganesan, CDS
Chair: TBD
Student Organizer: Tutan Debnath, ESE
Faculty Organizer: Ramachandran Ponnuswamy, ECE

Cluster Overview

Cluster Overview			
Time	Event	Speaker	Affiliation
14:00pm-14:30pm	Keynote Talk 1	Giridhara R Babu	PHFI
14:30pm-15:00pm	Keynote Talk 2	Deepak Subramani	CDS,IISc
15:00pm-15:30pm	Keynote Talk 3	Gautam Menon	Ashoka University
15:30pm-16:00pm	Keynote Talk 4	Ani Vullikanti	Virginia Tech
16:00pm-16:10pm	Student Presentations	Amrita Namtirtha	CDS,IISc
16:10pm-16:20pm		Tushar Sakorikar	ESE,IISc
16:20pm-16:30pm		Subodh Madhav Joshi	CDS,IISc
16:30pm-16:40pm		Abhijith B N	ECE,IISc
16:40pm-16:50pm		Harikiran Muniganti	ECE,IISc
16:50pm-17:00pm		Raghavendra GS	CSA, IISc
17:00pm-17:10pm		Sangeeta Yadav	CDS,IISc
17:10pm-17:20pm		Vinod J. Matthew	CDS, IISc
17:20pm-17:30pm	Q&A Students		

Keynote Talk 1:Role of data in public health response against covid19

Speaker: Giridhara R Babu

Keynote Talk 2:Spatio-temporal Prediction of Epidemic Spread: Data, Models and Ensemble

Speaker: Deepak Subramani

Keynote Talk 3: Designing Optimal Vaccination Policies for COVID-19

Speaker: Gautam Menon

Keynote Talk 4: Designing interventions in networked models of epidemic spread

Speaker: Ani Vullikanti

Student Presentation 1:Best influential spreaders identification using network global structural properties

Amrita Namtirtha, Yogesh Simmhan

Department of Computational and Data Science
Indian Institute of Science

Abstract
Influential spreaders are the crucial nodes in a complex network that can act as a controller in case of epidemic spreading or maximizer for information propagation. We have noticed that each individual

network holds different connectivity structures; complete, incomplete, or in-between based on their components and density. These affect the accuracy of existing indexing methods in the identification of the best influential spreaders. Thus, no single indexing strategy is sufficient for all varieties of network connectivity structures. This article proposes a new indexing method Network Global Structure-based Centrality (ngsc), which intelligently combines existing kshell and sum of neighbors' degree methods with knowledge of the network's global structural properties, the giant component, average degree, and percolation threshold. The experimental results show the proposed method yields a better spreading performance over a large variety of network connectivity structures and correlates well with the SIR model used as ground truth.

Student Presentation 2:Modelling Electrical Transport in Biological Tissues

Tushar Sakorikar[a], Anil Vishnu GK[a,b], Hardik J. Pandya[a]

[a]*Department of Electronic Systems Engineering*
[b]*Centre for BioSystems Science and Engineering*
Indian Institute of Science

Abstract
Electrical transport in disordered systems such as biological tissues is characterized by scaling laws which provide a quantifiable description of the system. In this work, two modes of transport viz. temperature and frequency dependent electrical transport, are studied using formalin-fixed breast biopsy tissues. Experiments were performed using an in-house electronic platform integrated with a device that has on-chip electrodes and a microheater. Temperature dependent direct current (DC) transport studies were modelled under the realm of general effective medium theory, with critical temperature (T_c) as a model fit parameter showing higher value for adjacent normal compared to tumour tissue. Frequency dependent alternating current (AC) transport studies were modelled using a universal scaling law, with onset frequency f_c as a model fit parameter showing higher values for adjacent normal samples compared to tumour indicating higher disorder in tumour. We use these model fit parameters to delineate normal from tumour breast biopsy tissues.

Presentation 3:Sensitivity Analysis of ANNs for Fluid Flow Simulation

Subodh Joshi, Sashikumaar Ganesan

Department of Computational and Data Sciences
Indian Institute of Science

Abstract

Numerical simulation of convection dominated flows requires numerical schemes which are high-order accurate and stable. A numerical scheme can be stabilized by adding the right amount of *artificial dissipation* to the flux residual. Our ongoing work focuses on developing a strategy in which the traditional finite element methods are augmented with Artificial Neural Networks (ANN) to enhance their stability and efficiency. However, selection of hyper-parameters of the ANN is a non-trivial task. In this work, we try to address this issue by carrying out a systematic global sensitivity analysis of ANN hyper-parameters using a technique called Analysis of Variance (ANOVA) based on four performance metrics. This analysis highlights the effect of different

hyper-parameters on the performance of the ANN as well as helps us identify the network architectures better suited for our application.

Student Presentation 4:Estimation of stochastic responses due to multiple variabilities in electromagnetic finite element modelling

B. N. Abhijith

Department of Electrical Communication Engineering
Indian Institute of Science

Abstract
A practical electromagnetic system involves several uncertainties like material properties, sur- face defects, orientation of radiating systems etc. These deviations which are random and dis- tributed all over the domain cannot be taken into account from the model specifications in a standard FEM simulation. This work formulates a way to predict the variation of the electromag- netic system response with respect to the random variation of the input parameters (material and geometric uncertainties) in a full wave 3D edge element FEM, for electromagnetic problems. A spec- tral stochastic finite element method (SSFEM) is implemented in 3D full wave edge element-based EM problems successfully for multiple material variations. The method works well for microwave circuit involving waveguides or microstrip lines. This is then used to formulate geometric variation where the mesh coordinates are varied as random parameters. This method is found to be faster than the generally used stochastic collocation and Monte Carlo methods.

Student Presentation 5:Inverse Problems in 3D Full-Wave Electromagnetics

Harikiran Muniganti

Department of Electrical Communication Engineering
Indian Institute of Science

Abstract
This talk addresses inverse problems specific to the area of electromagnetics, arising in three different scenarios. The first problem is 3-D quantitative imaging primarily targeted towards bio-medical applications. Two approaches are proposed for solving the first problem, a multilevel methodology approach and Machine Learning classification followed by optimization (ML-OPT) approach. The second problem is in the domain of high-speed circuits and is focused on synthesis of transmission line physical parameters given the desired electrical parameters like characteristic impedance and propagation constant. A forward solver is used to train Neural network for several different configurations for analysis and an optimization algorithm is used for synthesis. The third problem is focused on finding the source of radiation in an electronic system e.g. an automotive ECU, given the measured field at the antenna in the radiated emissions setup. A method based on Huygens box is proposed to quantify the radiation from cable and DUT at each frequency. Some part of the presented work is used via technology-transfer at Simyog Technology Pvt. Ltd., an IISc incubated startup, to develop a simulation software called Compliance-scope which allows the hardware designer to predict the EMI/EMC performance of electronics modules from an early design stage.

Student Presentation 6:Comparative Analysis of Topological Structures

Raghavendra G S

Department of Computer Science and Automation
Indian Institute of Science

Abstract
Scientific processes often result in scalar fields, whose comprehensive analysis leads to a better understanding of the underlying phenomena. The feature rich nature of the scalar fields demands for a summarized representation which has been addressed by topological structures like persistence diagrams, merge/contour trees, etc. Many such processes result in a set of fields which may be related temporally, be part of an ensemble, or unrelated. Thus it also requires methods to compare them meaningfully.

We develop two global measures, for merge trees, both based on tree edit distances. One, based on the assumption that they are ordered rooted trees, and the second, called MTED, a metric, assumes unordered rooted trees. Then, we develop a local comparison measure LMTED, also a metric, to compare hierarchical substructures of scalar fields. We propose dynamic programming algorithms for all these measures along with intuitive cost models and applications to highlight their utility.

Student Presentation 7:SPDE-Net: Predict an optimal stabilization parameter for SUPG technique to solve Singularly Perturbed PDEs

Sangeeta Yadav, Prof. Sashikumaar Ganesan

Department of Computational and Data Sciences
Indian Institute of Science

Abstract
Numerical techniques for solving Singularly Perturbed Differential Equations(SPDE) suffer low accuracy and high numerical instability in presence of interior and boundary layers. Stabilization techniques are often employed to reduce the spurious oscillations in the numerical solution. Such techniques are highly dependent on user chosen stabilization parameter. Here we propose SPDE-Net, a novel neural network training technique to predict the stabilization parameter. The prediction task is modeled as a regression problem and is solved using semi supervised learning. Global and local variants of stabilization parameter τ are demonstrated. Experiments on a bench-mark case of 1-dimensional convection diffusion equation show a reasonable performance as compared to the conventional supervised training. This makes the proposed technique eligible for extension to higher dimensions and other cases where the analytical formula for stabilization parameter is unknown, therefore making supervised learning impossible.

Student Presentation 8:Scalable Asynchrony-Tolerant PDE Solver for Multi-GPU Systems

Vinod Jacob Matthew, Dr. Konduri Aditya

Department of Computational and Data Science
Indian Institute of Science

Abstract
Data communication and synchronization between processing elements are likely pose a bottleneck in scalability of partial differential equation(PDE) solvers on future exascale machines. Recently, asynchrony-tolerant(AT) finite-difference schemes, which compute accurate solutions while relaxing data movement and synchronization, were developed using wider stencils in space and/or time to improve the scalability. As CPU-hardware struggles to keep pace with Moore's law, GPUs are significantly contributing towards the compute capability of supercomputers. However, the GPUs, which possess high throughput, suffer high latency costs. In this work, we use AT schemes to develop an asynchronous solver for multi-GPUs and demonstrate their capability to hide the high latency costs. The code, implemented with CUDA+MPI, solves the compressible fluid-flow equations. Two algorithms —communication and synchronisation avoiding— were used to develop the solver. Comparison against a synchronous solver was performed to verify the accuracy and demonstrate the scalability. On a single node with 8 A100 GPUs a 2X speed-up was observed. Scalability study on a large number of nodes is currently under progress.

3.2.10 Break

3.3 Felicitation Program

Coordinators: Prof. Y. Narahari & Dipanjan Gope

The felication program is to honor the contributions of the following faculty members who will be superannuating this year.

3.3.1 Prof. K. Gopinath, CSA, IISc

K. Gopinath is a Professor at the Indian Institute of Science in the Department of Computer Science and Automation. His research interests are primarily in the computer systems area (Operating Systems, Storage Systems, Systems Security and Systems Verification). He is a co-author of a recently published book on "Resource Proportional Software Design for Emerging Systems," Chapman and Hall/CRC, 2020. He has been in the past an associate editor of IEEE Computer Society Letters and that of ACM Transactions on Storage. His education has been at IIT-Madras (B.Tech'77), University of Wisconsin, Madison (MS'80) and Stanford University (PhD'88). He has also worked at AMD (Sunnyvale) ('80-'82), and as a PostDoc ('88-'89) at Stanford.

3.3.2 Prof. P.V. Kumar, ECE, IISc

P. Vijay Kumar received the B.Tech. and M.Tech. degrees from IIT Kharagpur and IIT Kanpur respectively, and the Ph.D. degree from USC in 1983, all in Electrical Engineering. From 1983 to 2003 he was on the faculty of the EE-Systems Department at USC. Since 2003, he has been on the faculty of IISc Bengaluru.
His current research interests include streaming codes for low-latency communication, codes for distributed storage, polar codes and coded computation including coded block chains. He is a recipient of the 1995 IEEE Information Theory Society Prize-Paper award and the IEEE Data Storage Best Paper Award of 2011/2012. He is a J. C. Bose National Fellow, a plenary speaker at ISIT 2014, and a TPC Co-Chair of ISIT 2015. He is a Fellow of the INAE, IASc, and INSA.

3.3.3 Prof. Y.N. Srikant, CSA, IISc

Prof. Srikant is currently the Dean of the Faculty of Engineering at the Indian Institute of Science. Earlier he was chairperson of the Department of Computer Science and Automation during 2001-2005. Having completed his Ph.D. at the Department of CSA, he has been on the faculty of the Department since 1986. Prof. Srikant's areas of expertise include compiling techniques, program analysis, and parallel programming languages. In these areas, he has authored a large number of papers in leading journals and conferences. He has graduated 20 Ph.D. students and 27 Master's students by Research, and about 100 M.Tech. project students.

4. List of Session Speakers

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7, 8 MAY 2021

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Signal Processing and Communications | Visual Analytics

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