KOTAK IISc AI-ML CENTRE
A REPORT OF ACTIVITIES
April 2024–March 2025

CONTENTS

EXECUTIVE SUMMARY

The number of beneficiaries from the various opportunities provided by the Kotak IISc AI–ML Centre (KIAC) has seen more than double increase this financial year (6647) compared to last year (3342). These numbers exclude the beneficiaries (386) from the regular courses taught by distinguished KIAC faculty for the BTech (Mathematics and Computing) and MTech (Artificial Intelligence) programmes at the Indian Institute of Science (IISc). The total number of beneficiaries this year is 7033.

This year, in addition to its regular activities, the focus of the Centre has been to facilitate the development of deep tech solutions in the areas of artificial intelligence (AI), machine learning (ML), and their applications to practical domains. A call for proposals for deep tech solutions was released in October 2024 to IISc faculty. Out of the 23 proposals that were received, three proposals were selected for funding, namely, (1) CháksuAI: An open-source AI assistant for comprehensive ophthalmic diagnostics, (2) Photoplethysmography video analysis on retinal blood flow patterns, and (3) Development of an LLM-powered phenotyping tool to streamline genetic disease diagnosis.

The Centre has also extended support for the participation in and organisation of talks, courses, workshops, and competitions (13 in number) for the benefit of a multidisciplinary audience. A total of 61 students and fellows were supported through scholarships, 12 talks were organised as part of the Kotak IISc AI–ML talk series, and five seminars were organised as part of the KIAC distinguished seminar series. Twenty one students and faculty members from IISc were given support to present their accepted papers in leading international conferences related to AI.

Three eminent researchers were invited to the Centre as International Visiting Chair Professor and International Visiting Professors. Alan Bovik is the Cockrell Family Regents Endowed Chair Professor at the University of Texas at Austin; Srinath Sridhar leads the Interactive 3D Vision & Learning Lab at Brown University, Providence, Rhode Island; and Prabhat Mishra is Professor, Department of Computer and Information Science and Engineering, University of Florida, USA. As part of the Professorships, these eminent researchers gave lectures/seminars and conducted courses at IISc in addition to interacting with the students.

A curriculum consultation meeting on 'Computing Education for Schools in India' was co-hosted by IISc, Raspberry Pi Foundation, and CS Pathshala and aimed to address the need for a structured computing curriculum in Indian government schools, aligned with the National Education Policy (NEP) 2020 and global trends including AI. This meeting was initiated by KIAC faculty Viraj Kumar and has paved the way for potential research collaborations between IISc and Raspberry Pi's research group at Cambridge University and also between IISc and the Kotak Education Foundation.

Overall, in this financial year, KIAC has seen progress in the number of people that it has trained and benefited, in the variety of research it has supported, and in the deep tech solutions it has enabled. The Centre plans to continue this in the future as well.

ABOUT THE CENTRE

The Kotak IISc AI–ML Centre (KIAC) was conceived of with the vision of creating a state-of-the-art artificial intelligence–machine learning (AI–ML) Centre at the Indian Institute of Science (IISc). The Centre was established at IISc with a CSR (corporate social responsibility) grant from the Kotak Mahindra Bank Limited (KMBL). A memorandum of understanding (MoU) between both the parties was executed from 1 September 2022 to 31 March 2025. The activities of the Centre commenced from September 2022.

Objectives

The main objectives of the Centre were chalked out as follows.

1. To develop rigorously-trained human resources who will become future leaders in AI–ML and champion India's surge in this area.

2. To conduct cutting-edge research in this area leading to international visibility of the highest order.

3. To develop innovative, deep tech solutions to meet the current and emerging requirements of not only the country but also the world.

The Centre's activities have been planned and executed in keeping with the above objectives.

Organisation

The governance of the Kotak IISc AI–ML Centre is overseen by the following structure. The Convenor and his team of Professors are responsible for creating technical programmes that are in-line with the MoU between KMBL and IISc. These programmes are presented to the Scientific Advisory Board (SAB) to ensure that the conceived programmes are compatible with the MoU. The SAB reports to the Governing Board (GB). The Project Review Committee (PRC) also reports to the GB and reviews the overall functioning of the Centre.

The members of the three boards/committees have representatives from both IISc and KMBL and meet frequently to review the progress of the Centre and plan future initiatives.

Governing Board

Govindan Rangarajan
IISc (Chair)

Navakanta Bhat
IISc

Yadati Narahari
IISc

Kaushal Verma
IISc

Milind Nagnur
KMBL

Himanshu Nivsarkar
KMBL

Scientific Advisory Board

Rajesh Sundaresan
IISc (Chair)

Rajiv Soundararajan
KIAC Convenor

Srikanth Krishnan Iyer
IISc

Bhaskar Kumar
KMBL

Project Review Committee

S K Satheesh
IISc (Chair)

P S Anil Kumar
IISc

Rajesh Sundaresan
IISc

Himanshu Nivsarkar
KMBL

Prem Sagar Raju Addala
KMBL

KIAC Team

Rajiv Soundararajan
KIAC Convenor

Soma Biswas
Professor, IISc

Sriram Ganapathy
Professor, IISc

Chandrasekaran Pandu Rangan
Chair Visiting Professor, KIAC

Viraj Kumar
Visiting Professor, KIAC

KIAC Team

Grace Mathew Abraham
Program Manager

Neetha Ashtakar
Systems Administrator

Geethanjali Monto
Senior Editorial Assistant

Sudha Aithal
Secretary

Manoj Srinivas
Office Assistant

KIAC Team

Devnath Shah
BTech Instructor

Manpreet Singh
BTech Instructor

Sesha Kumar Nalluri
BTech Instructor

Kamla Kant Mishra
BTech Instructor

Vijaykumar Bhukya
Systems Administrator
(KIAC UG Computation
Lab)

KIAC ACTIVITIES: APRIL 2024–MARCH 2025

The activities and new initiatives of the Centre in this financial year (April 2024–March 2025) are described in this section. These activities are presented as achievements under the three objectives of KIAC.

Highlights
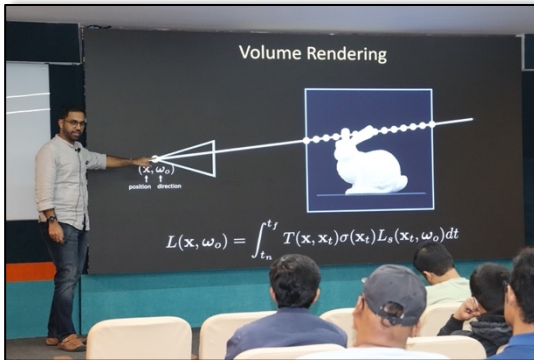
Short course on 'Radiance Fields in Visual Computing and Artificial Intelligence'
Instructor: Srinath Sridhar
Date: 06–15 January 2025

International Conference on Applied AI and Scientific Machine Learning
Date: 14–18 December 2024

European Conference on Computer Vision (ECCV) 2024
Date: 29 September–4 October 2024
Venue: Italy

Algorithms Festival–Unveiling the Beauty of Algorithms
Date: 20 October 2024

Distinguished seminar series: Towards transforming the Indian language technology ecosystem
Speaker: Mitesh M Khapra
Date: 20 September 2024

Objective 1: Rigorously-trained human resources

To develop rigorously-trained human resources who will become future leaders in AI–ML and champion India's surge in this area, KIAC offers opportunities through the Kotak scholarship for BTech students, MTech scholarship, PhD scholarship, internship, predoctoral fellowship, and postdoctoral fellowship. Furthermore, distinguished KIAC faculty, Viraj Kumar and Chandrasekaran Pandu Rangan, offer courses on a regular basis for the BTech and MTech students of IISc. They also give lectures and conduct courses, both online and in various Institutes across India.

KIAC facilitates the exposure of students to state-of-the-art research being carried out in academia and industry across the world. Information and training have been imparted to individuals from across the country and the world through the KIAC distinguished seminar series, AI–ML talks, courses, training sessions, and workshops. The Centre also encourages students to participate in competitions at various levels (in-house to international).

In this financial year, one International Visiting Chair Professor and two International Visiting Professors were selected. These Professors are experts in artificial intelligence and machine learning and their applications in various practical domains. As part of their Professorships, these eminent researchers gave lectures, conducted courses, and interacted with students and faculty members at IISc.

I. Scholarships and fellowships

KIAC offers opportunities for IISc students through the Kotak scholarship for BTech students, MTech scholarship, and PhD scholarship. Internships, predoctoral fellowships, and postdoctoral fellowships are offered to persons interested in AI–ML research.

A. Student support

Students from IISc are supported in their academic and research pursuits through the Kotak scholarship for BTech students, MTech scholarship, and PhD scholarship.

Kotak scholarship for BTech students

This scholarship is awarded to women students with the top-most JEE Advanced Ranks joining the undergraduate BTech (Mathematics and Computing) programme at IISc. During this financial year, seven students were supported through the Kotak scholarship.

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MTech scholarship

The MTech scholarship is awarded to selected students pursuing the <u>MTech (Artificial Intelligence)</u> programme at IISc, who have joined the course through the <u>CFTI mode</u>. During this financial year, seven students were supported through the MTech scholarship.

PhD scholarship

The PhD scholarship is awarded to registered PhD students at IISc who have not completed five years and who are currently not availing any PhD fellowship other than the MHRD (Ministry of Human Resource Development) stipend from IISc. The MHRD stipend is replaced by the KIAC PhD scholarship.

An enhanced PhD scholarship (regular scholarship plus a 100 percent top-up) is awarded to registered PhD students fulfilling the above criteria and who have at least one regular paper published/accepted in indicated fora (AAAI, IJCAI, CVPR, ECCV, ICCV, ICLR, ICML, NeurIPS, KDD, ACL, EMNLP, NAACL, SIGIR, WWW or journals with a weight of 0.75 or higher in AI rankings: https://airankings.org/faq/?key=criteria) during the indicated time period.

During this financial year, three students were supported through the enhanced PhD scholarship and three students were supported through the normal PhD scholarship.

B. Research support

The research aspirations of persons interested in artificial intelligence and machine learning are supported through the Centre's internship, predoctoral fellowship, and postdoctoral fellowship programmes.

Internship

The internship programme is for students pursuing any relevant branch of engineering and who are interested to continue their career in the field of AI–ML. During this financial year, 17 interns were supported.

Predoctoral fellowship

The predoctoral fellowship programme is for students who have recently completed an undergraduate/postgraduate degree in any relevant branch of engineering and would like to pursue research in the field of AI–ML. In this financial year, 36 predoctoral fellows were supported.

Postdoctoral fellowship

The post-doctoral programme is for researchers who have recently completed their doctorate degree and wish to pursue cutting-edge research in the field of AI–ML. During this financial year, two postdoctoral fellows were supported.

II. Contributions by KIAC faculty

Distinguished KIAC faculty, Viraj Kumar and Chandrasekaran Pandu Rangan, offer courses on a regular basis for the BTech and MTech students of IISc. They also give lectures and conduct courses, both online and in-person, in various Institutes across India.

A. Courses offered for IISc students

Viraj Kumar and Chandrasekaran Pandu Rangan offered the following courses for the BTech and MTech students of IISc in this financial year.

Faculty name	Course title	For students of	Number of beneficiaries
Viraj Kumar	Data Structures and Graph Analytics	MTech (online) programme	60
	Algorithms and Programming	BTech (Mathematics and Computing) programme	133
Pandu Rangan	Discrete Mathematics	BTech (Mathematics and Computing) programme	64
	Data Structures and Algorithms	BTech (Mathematics and Computing) programme	62
	Data Structures and Algorithms	MTech (Artificial Intelligence) programme	67
		Total beneficiaries	**386**

B. Lectures, courses, and training sessions

A summary of the lectures, courses, and training sessions offered by KIAC distinguished faculty is presented in the table below.

| Faculty name	Title	Details; Venue	Number of beneficiaries
Viraj Kumar	Introducing Refute Problems in the Design and Analysis of Algorithms Course	Talk; Cambridge Institute of Technology, Bengaluru	104
	Programming in the GenAI Era: Rethinking Learning Outcomes	Talk; Christ University, Bengaluru	50
	AI in Teaching and Learning for Core Engineering	Faculty interaction; Nitte Meenakshi Institute of Technology, Bengaluru	20
	The Art of Prompts: Unlocking Generative AI	Online short-term training programme; organised by the Department of Computer Engineering, SCTR's Pune Institute of Computer Technology in association with ACM-W Pune Professional Chapter	288
	Faculty training programme, M S Ramaiah Institute of Technology, Bengaluru		50
	Faculty training programme, Nitte Meenakshi Institute of Technology, Bengaluru		50
	Programming with AI for Problem Solving	NPTEL (National Programme on Technology Enhanced Learning) course; online	143
	Programming with AI for Problem Solving	Faculty training programme; GITAM University, Bengaluru (hybrid mode)	112
Pandu Rangan	Zero Knowledge Protocols	Talk; part of the Winter School on Theoretical Computer Science, IISc	70
	Algorithmic Thinking	Institute colloquium; IIT Mandi	740
	Crypto Research in India: Opportunities and Challenges	Talk; part of the ACM Workshop on 'Research Opportunities in Computer Science', Amrita Vishwa Vidyapeetham, Amritapuri campus	130
	Introduction to Graph Algorithms	NPTEL course; online	1990
	Algorithms	Course for MTech (Information Security) online programme, IIT Madras	49
	Introduction to Cryptography	Course for MTech programme, IIT Madras (online)	42
		Total beneficiaries	**3838**

Talk on 'Programming in the GenAI Era: Rethinking Learning Outcomes'
<u>KIAC faculty:</u> Viraj Kumar
<u>Date:</u> 24 January 2025
<u>Venue:</u> Christ University, Bengaluru
<u>Number of participants:</u> 50
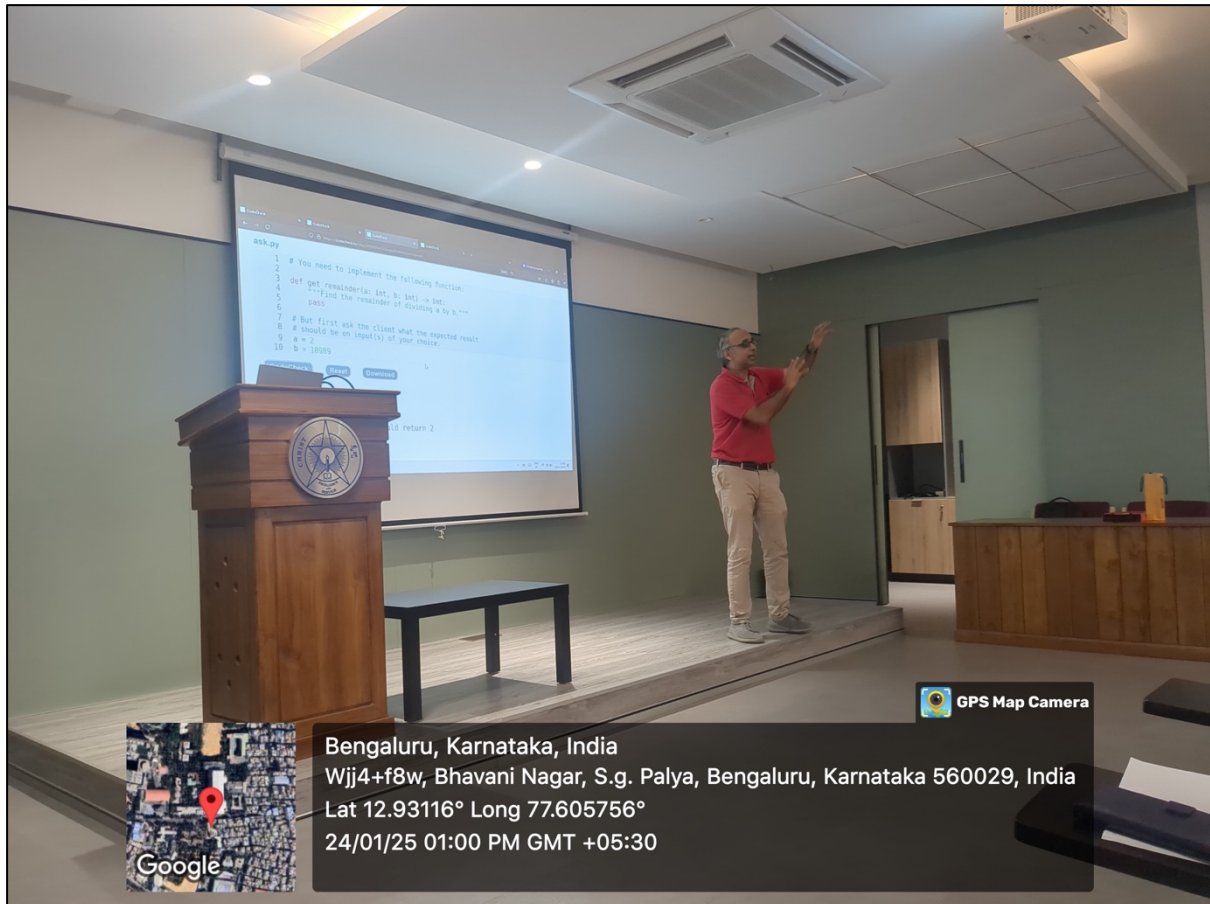
Viraj Kumar gave a talk on 'Programming in the GenAI Era: Rethinking Learning Outcomes' to about 50 faculty from computer science disciplines at Christ University.

Talk on 'AI in Teaching and Learning for Core Engineering'
<u>KIAC faculty:</u> Viraj Kumar
<u>Date:</u> 4 January 2025
<u>Venue:</u> Nitte Meenakshi Institute of Technology, Bengaluru
<u>Number of participants:</u> 20

This interaction was the first of a series of planned interactions with faculty from non-computing (core Engineering) disciplines who we are seeking to empower by leveraging computing for their teaching, research, and administrative tasks. This session was an introduction to what is possible, based on our experience with conducting the 6-month PG Certificate Programme with the All India Council for Technical Education (AICTE).

One week online short term training program on 'The Art of Prompts: Unlocking Generative AI'
<u>KIAC faculty:</u> Viraj Kumar
<u>Date:</u> 9-14 December 2024
<u>Venue:</u> online
<u>Number of participants:</u> 288

Viraj Kumar was a resource person in the AICTE Teaching Learning (ATAL) faculty development program on 'The Art of Prompts: Unlocking Generative AI'. His session was on 'Code generation with imprecise specifications'. The participants included faculty from various engineering colleges in India, research scholars, and postgraduate students.

Winter School on Theoretical Computer Science

<u>KIAC faculty:</u> Chandrasekaran Pandu Rangan

<u>Date:</u> 7–10 December 2024

<u>Venue:</u> Department of Computer Science and Automation, IISc

<u>Number of participants:</u> 70

Chandrasekaran Pandu Rangan delivered a lecture on 'Zero Knowledge Protocols' during the Winter School on Theoretical Computer Science.
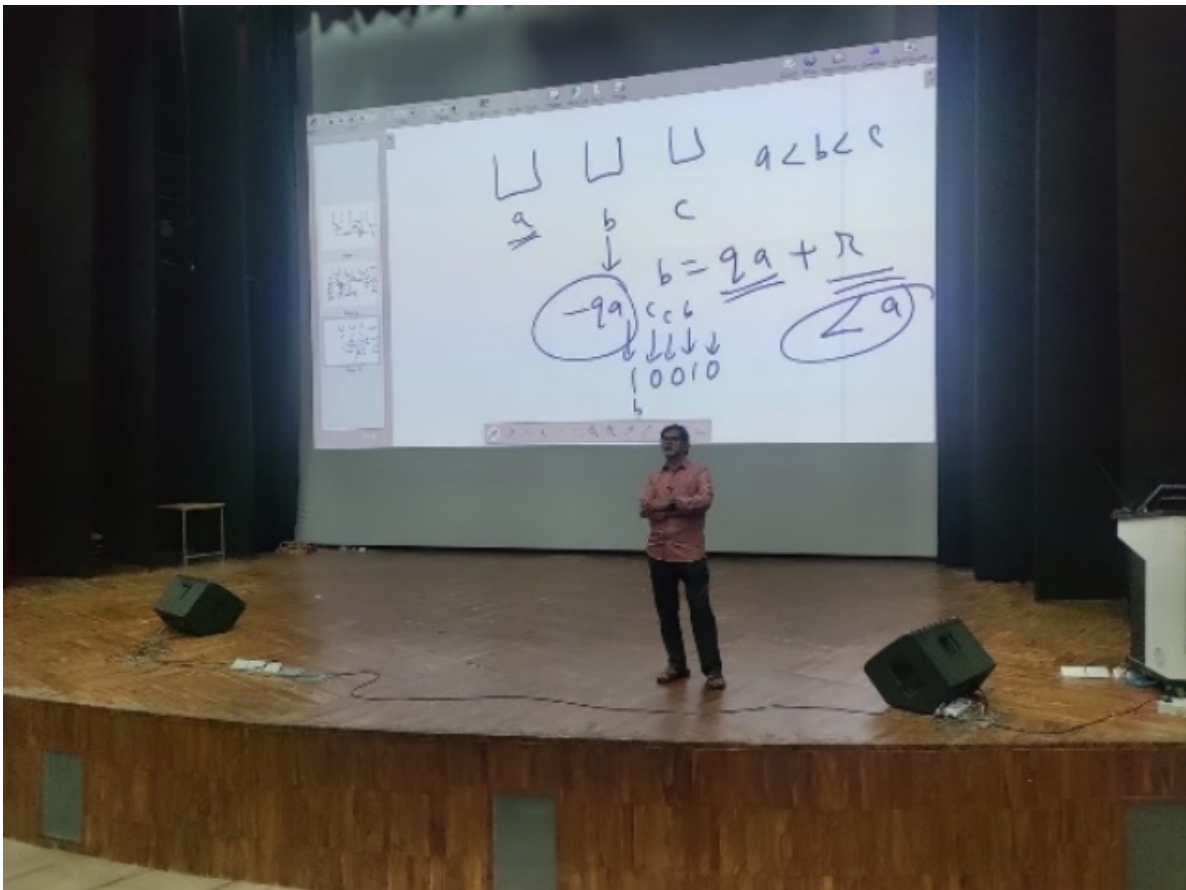
Institute colloquium on 'Algorithmic Thinking'
<u>KIAC faculty:</u> Chandrasekaran Pandu Rangan
<u>Date:</u> 8 November 2024
<u>Venue:</u> Indian Institute of Technology Mandi, Himachal Pradesh
<u>Number of participants:</u> 740

Chandrasekaran Pandu Rangan delivered the Institute colloquium at the Indian Institute of Technology Mandi on 'Algorithmic Thinking', which is a specialised way of thinking to solve problems. He discussed its unique aspects and argued why this is a core competence for mastering computer science. He discussed some case studies and walked through key historic moments to current state-of-the-art advancements and directions.

ACM workshop on 'Research Opportunities in Computer Science'
<u>KIAC faculty:</u> Chandrasekaran Pandu Rangan
<u>Date:</u> 19 October 2024
<u>Venue:</u> Amrita Vishwa Vidyapeetham, Amritapuri campus
<u>Number of participants:</u> 130

Chandrasekaran Pandu Rangan delivered a lecture on 'Crypto Research in India: Opportunities and Challenges' at the ACM Workshop on 'Research Opportunities in Computer Science'. The aim of these ROCS workshops is to raise awareness about the research opportunities in computer science, especially for Indian undergraduate students.

Faculty training programmes

<u>KIAC faculty:</u> Viraj Kumar

<u>Date:</u> August 2024

<u>Venues:</u> (i) M S Ramaiah Institute of Technology, Bengaluru and (ii) Nitte Meenakshi Institute of Technology, Bengaluru.

<u>Number of participants:</u> 100

Viraj Kumar initiated a six-month faculty development programme (from July 2024 onwards) through an IISc–AICTE (All India Council for Technical Education) partnership. This course targeted faculty in non-computing disciplines. In August 2024, he conducted two one-day faculty training programmes for 50 participants each at (i) M S Ramaiah Institute of Technology, Bengaluru and (ii) Nitte Meenakshi Institute of Technology, Bengaluru.
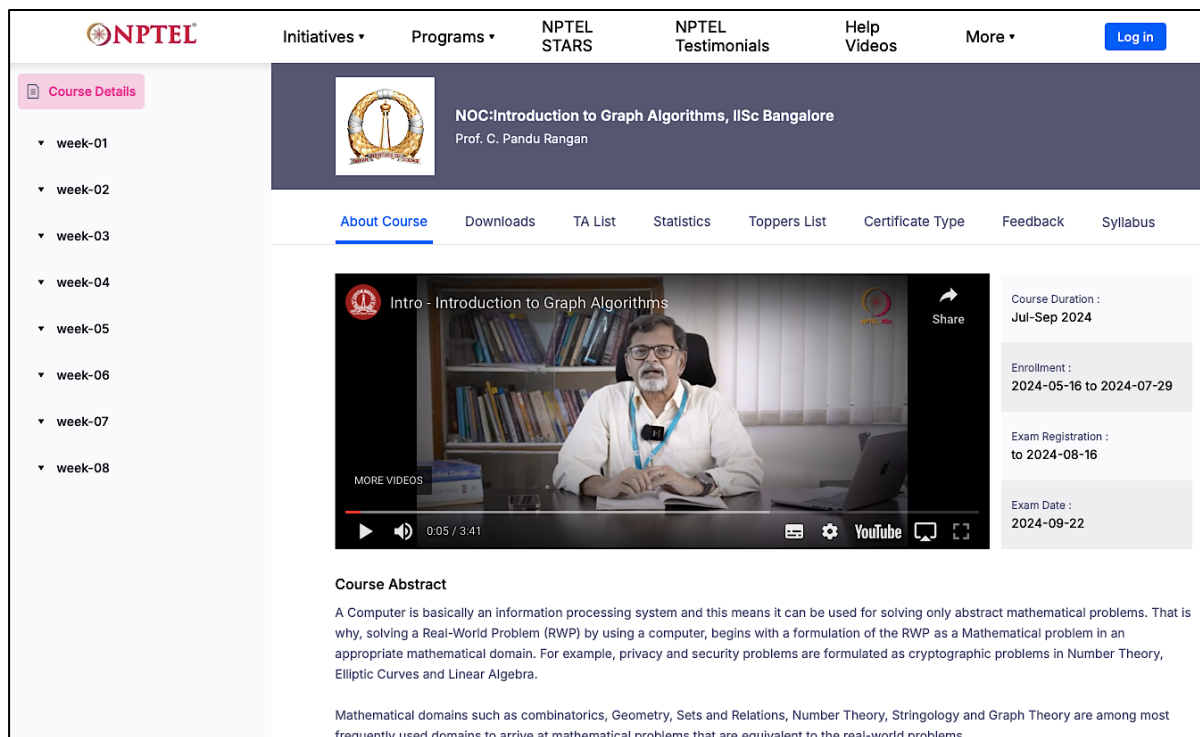
NPTEL course on 'Introduction to Graph Algorithms'

KIAC faculty: Chandrasekaran Pandu Rangan

Date: July–September 2024

Venue: online

Number of participants: 1990

Chandrasekaran Pandu Rangan conducted an NPTEL (National Programme on Technology Enhanced Learning) course on 'Introduction to Graph Algorithms'; the course was well attended with 1990 participants.

NPTEL course on 'Programming with AI for Problem Solving'
<u>KIAC faculty:</u> Viraj Kumar
<u>Date:</u> 1–29 June 2024
<u>Venue:</u> online
<u>Number of participants:</u> 143
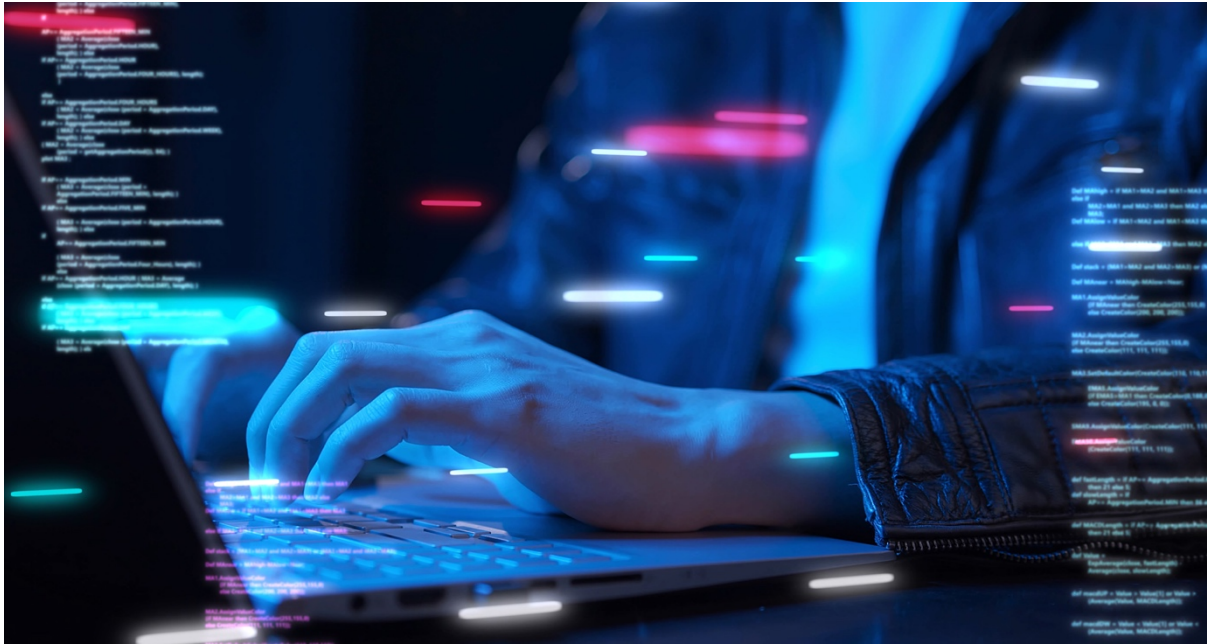
Many interesting and important problems can be solved efficiently with the help of computing. A traditional course on 'Programming for Problem Solving' develops a person's ability to manually translate solutions from natural language to programs so that they can be run on computers. Due to advances in Generative AI, much of this translation can be performed automatically via easy-to-access tools such as ChatGPT, Codeium, and GitHub Copilot.

A course was conducted by Viraj Kumar, through the National Programme on Technology Enhanced Learning (NPTEL), especially for BTech/BE students in all disciplines, as well as MTech/ME/PhD students and Engineering faculty in non-computing disciplines. This course sought to develop two main abilities, namely, (i) to express the solutions in natural language clearly enough so that Generative AI tools can translate them into programs, and (ii) to understand, test and debug programs (manually, and with AI support) to confirm that the translation is correct.

Faculty training programme on 'Programming with AI for Problem Solving'
KIAC faculty: Viraj Kumar
Date: 10–16 June 2024
Venue: GITAM University, Bengaluru (hybrid mode)
Number of participants: 112
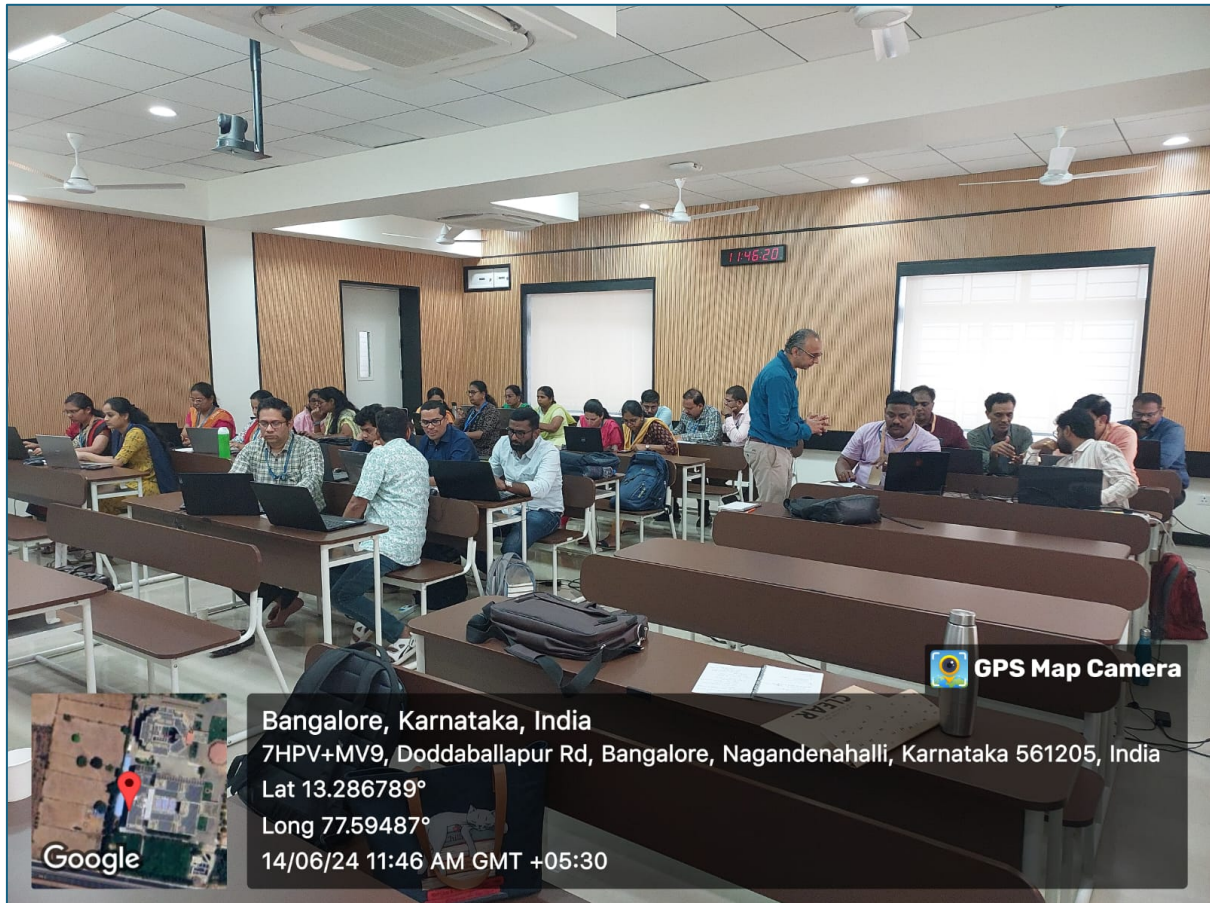
A six-day faculty training programme was conducted by Viraj Kumar for 112 computer science faculty at GITAM University, Bengaluru (hybrid mode). The topic was 'Programming with AI for Problem Solving'. The faculty were from the Bengaluru, Hyderabad, and Vizag campuses of GITAM University.

III. Outreach

KIAC facilitates the exposure of students to state-of-the-art research being carried out in academia and industry across the world. Information and training have been imparted to individuals from across the country and the world through the KIAC distinguished seminar series, AI-ML talks, courses, training sessions, events, and workshops.

A. KIAC distinguished seminar series

A special seminar series has been initiated from September 2024, named as the 'KIAC distinguished seminar series'. The objective is to invite eminent researchers to share their expertise and experiences. There were five seminars during April 2024 to March 2025.

Can We Make Machine Learning Safe for Safety-Critical Systems?

Speaker: Thomas G Dietterich, University Distinguished Professor Emeritus, School of Electrical Engineering and Computer Science, Oregon State University

Date: 14 February 2025

Number of attendees: 48

Talk summary: The impressive new capabilities of systems created using deep learning are encouraging engineers to apply these techniques in safety-critical applications such as medicine, aeronautics, and self-driving cars. This talk discussed the ways that machine learning methodologies are changing to operate in safety-critical systems. These changes include (a) building high-fidelity simulators for the domain, (b) adversarial collection of training data to ensure coverage of the so-called operational design domain (ODD) and, specifically, the hazardous regions within the ODD, (c) methods for verifying that the fitted models generalise well, and (d) methods for estimating the probability of harms in normal operation. There are many research challenges to achieving these.

But we must do more because traditional safety engineering only addresses the known hazards. We must design our systems to detect novel hazards as well. We adopt Leveson's view of safety as an ongoing hierarchical control problem in which controls are put in place to stabilise the system against disturbances. Disturbances include novel hazards but also management changes such as budget cuts, staff turnover, novel regulations, and so on. Traditionally, it has been the human operators and managers who have provided these stabilising controls. Are there ways that artificial intelligence (AI) methods, such as novelty detection, near-miss detection, diagnosis and repair, can be applied to help the human organisation manage these disturbances and maintain system safety? This talk addressed the above question.

Quantum AI for Scientists and Engineers

Speaker: Prabhat Mishra, Professor in the Department of Computer and Information Science and Engineering at the University of Florida, USA; Kotak Mahindra Bank's Visiting Chair Professor at the Kotak IISc AI-ML Centre, IISc

Date: 6 January 2025

Number of attendees: 52

Talk summary: Quantum technologies offer promising advantages over classical counterparts in a variety of tasks, including faster computation, secure communication, and high-precision sensors. This talk provided a comprehensive overview of both fundamental concepts and recent advances in quantum AI from the perspectives of computer scientists and engineers. Specifically, Prabhat Mishra explored how classical machine learning can be effectively utilised for robust quantum computing. He also provided a brief overview of different quantum computing stages, including quantum algorithms, quantum compilation, quantum state preparation, quantum error correction, quantum measurement, quantum security, and validation of quantum systems.

Secrets of Video Quality

Speaker: Alan Bovik, Director, Laboratory for Image & Video Engineering, The University of Texas at Austin, Texas, USA

Date: 13 December 2024

Number of attendees: 51

Talk summary: Predicting perceptual video quality is a hard problem that has been successfully addressed in many scenarios, such as quality control of streaming and sharing of videos. However, videos continue to 'get bigger' along every dimension including frame rate, bit depth, colour gamut, spatial dimensionality, and fusion with generative methods. In this talk, Alan Bovik addressed how perceptual video quality can be understood using principles of visual neuroscience and neuro-statistical models of distortion. In particular, he reviewed the basic vision science that makes accurate perceptual video quality prediction possible and how algorithms can be designed that are now used worldwide. He also discussed extensions to new and timely problems that involve the quality prediction of high/variable frame rate videos (HFR/VFR), which are of interest for future live sport streaming and high dynamic range videos (HDR), which are becoming common in video streaming of home cinema.

Visual Recognition and Cancer Detection

Speaker: Chetan Arora, Professor, Department of Computer Science and Engineering and Joint Faculty, Yardi School of Artificial Intelligence, Indian Institute of Technology Delhi

Date: 18 October 2024

Number of attendees: 36

Talk summary: In this talk, Chetan Arora spoke about some of their works in the detection of cancer using radiology images, specifically breast cancer detection from mammograms and gall bladder cancer detection from ultrasound images. Though many of these problems can be formally posed as visual recognition from computer vision, the low inter-class variance and large intra-class variance, along with small datasets pose unique challenges. He described how they solved some of these challenges using important clinical insights and modern deep neural network-based techniques.

Towards transforming the Indian language technology ecosystem

<u>Speaker:</u> Mitesh M Khapra, Associate Professor in the Department of Computer Science and Engineering at the Indian Institute of Technology Madras (IITM). He heads the <u>AI4Bharat Research Lab</u> at IIT Madras

<u>Date:</u> 20 September 2024

<u>Number of attendees:</u> 114

In this talk, Mitesh M Khapra reflected on his team's journey towards transforming the landscape of Indian language technology. He delved into their engineering-heavy approach in addressing the initial scarcity of data for Indian languages, while gradually establishing the necessary human resources to gather high-quality data on a larger scale through *Bhashini*. The objective is to share insights into developing high quality open-source technology for Indian languages. This involves curating extensive data from the internet, constructing multilingual models for transfer learning, and crafting high-quality datasets for fine-tuning and evaluation. He then transitioned into how their experiences can benefit the broader AI community, particularly as India aspires to create large language models (LLMs) for Indic languages.

B. Kotak IISc AI-ML talk series

The Kotak IISc AI–ML talk series facilitates exposure of students to the research work and state-of-the-art in their respective fields of expertise. It includes talks by eminent scientists and researchers from academia and the industry from all over the world, with whom IISc students and faculty can interact and collaborate on various projects. The talks are held at IISc and open to all; non-IIScians can attend upon request. There were 12 talks during April 2024 to March 2025.

Wearable Sensor Signal Processing and Data Analytics for Health Applications

<u>Speaker:</u> Gaurav Sharma, Professor in the Departments of Electrical and Computer Engineering, Computer Science, and Biostatistics and Computational Biology, and a Distinguished Researcher in the Center of Excellence in Data Science, Goergen Institute for Data Science, University of Rochester

<u>Date:</u> 24 January 2025

<u>Number of attendees:</u> 32

<u>Talk summary:</u> Advances in nano-fabrication and MEMS devices have led to radical improvements in sensing technologies in recent years. These improvements are most visible to all of us in our smart phones that already feature a panoply of miniaturised sensors. Many of the same sensors are also positively impacting several other application domains.

In this talk, Gaurav Sharma highlighted how smart light-weight body worn sensors are set to revolutionise healthcare and the practice of medicine by providing technologies for assessing biomarkers for physiological and physical attributes related to disease condition, treatment effectiveness, and longitudinal progression. In contrast with the subjective, sporadic in-clinic assessments that are in common use today, body-worn sensors can provide objective and repeatable measurements and based on extended periods of continuous monitoring. He presented examples from their recent and ongoing research that features light-weight, low-power sensors that can be affixed to the body like adhesive temporary tattoos, in a diverse set of health monitoring applications including quantification of movement disorders for Parkinson's and Huntington's diseases, stroke rehabilitation, and cardiac monitoring. He also presented examples of signal processing and data analytics for these applications that effectively exploit the sensor measurements. Finally, he highlighted the ongoing and emerging directions for research and development.

Formal Models for Sudden Learning of Capabilities in Neural Networks

Speaker: Ekdeep Singh Lubana, Postdoctoral Fellow at CBS-NTT Program, Harvard University

Date: 9 January 2025

Number of attendees: 84

Talk summary: Neural networks' scaling has been argued to yield sudden learning of capabilities (a.k.a. emergent abilities). In this talk, Ekdeep Singh Lubana first summarised their recent work on formal models that help explain the mechanisms underlying such sudden learning via data scaling, implicating the compositional nature of a task and formation of structured representations that are shared across several tasks involved in the broader data composition. Then, focussing on in-context learning (ICL)—one such suddenly learned capability—he demonstrated that the precise configurations used for training can lead to learning of fundamentally different algorithms for performing an ICL task. This indicates that the phenomenology of ICL established in past work may not be universal. Further, he discussed how merely scaling the context size can lead to a crossover between different ICL algorithms used by the model. This can be explained via a competition of algorithms lens, which also yields a new theory on the transient nature of ICL. The talk was based on a mix of published, in-submission, and currently unpublished work.

Knowledge-guided Machine Learning: Advances in an Emerging Paradigm Combining Scientific Knowledge with Machine Learning for Accelerating Scientific Discovery

<u>Speaker:</u> Anuj Karpatne, Associate Professor, Department of Computer Science, Virginia Tech

<u>Date:</u> 7 January 2025

<u>Number of attendees:</u> 50

<u>Talk summary:</u> In this talk, Anuj Karpatne introduced knowledge-guided machine learning (KGML), a rapidly growing field of research where scientific knowledge is deeply integrated in machine learning frameworks to produce scientifically grounded, explainable, and generalisable predictions even on out-of-distribution data. He presented a multi-dimensional view to organise prior research in KGML in terms of the nature and format of scientific knowledge used, the form of knowledge-ML integration explored, and the method for incorporating scientific knowledge in ML for diverse scientific use-cases. These KGML concepts were illustrated using a variety of case studies in physics, ecology, and biology applications including modelling the quality of water in lakes across the US and discovering novel biological traits of organisms linked with evolution from biodiversity images. He concluded with a discussion of emerging opportunities in KGML especially in the age of foundation models with potential applications in a broad range of scientific disciplines.

AI Revolution: Algorithms, Semiconductors, and Supporting Infrastructure

Speaker: Arogyaswami Paulraj, Emeritus Professor, Stanford University

Date: 6 January 2025

Number of attendees: 65

Arogyaswami Paulraj explored the transformative potential of artificial intelligence, focussing on its core technological foundations: algorithms, semiconductors, and supporting infrastructure. He also examined of the role of academic institutions and startups in driving AI innovation.

Use of Data, ML, and AI to Accelerate the Energy Transition

Speaker: Geoffrey G Parker, Faculty Director, Arthur L Irving Institute for Energy & Society; Charles E Hutchinson Professor of Engineering, Thayer School of Engineering at Dartmouth

Date: 13 December 2024

Number of attendees: 29

Talk summary: The world is engaged in a multi-decade, multi-trillion-dollar effort to decarbonise energy systems. Critical scientific advancements are needed to tackle challenges like carbon removal and energy storage. The rapid growth in information capture, storage, processing, and transmission offers opportunities to boost efficiency in manufacturing, logistics, and mobility. Integrating previously isolated systems will also unlock new capabilities. Geoffrey G Parker discussed these and other considerations of decarbonisation in this IISc–Dartmouth keynote lecture.

Multimodal Spatial Intelligence for Interacting in a Dynamic World

Speaker: Deva Ramanan, Professor, Robotics Institute, Carnegie-Mellon University; former Director, CMU Center for Autonomous Vehicle Research

Date: 12 December 2024

Number of attendees: 112

Talk summary: Artificial intelligence and machine learning are enjoying a period of tremendous progress, driven in large part by scale, compute, and learnable neural representations. However, such innovations have yet to translate to the physical world, as technologies such as self-driving vehicles are still restricted to limited deployments. In this talk, Deva Ramanan argued that autonomy requires spatial three-dimensional understanding integrated with intuitive physical models of a changing world. To do so, he discussed a variety of models that revisit classic 'analysis by synthesis' approaches to scene understanding, taking advantage of recent advances in differentiable rendering and simulation. But to enable data-driven autonomy for safety-critical applications, he argued that the community needs new perspectives on data curation and annotation. Toward this end, he discussed approaches that leverage multimodal vision-language models to better characterise datasets and models.

A Paradigm Shift in Nonvisual Programming

<u>Speaker:</u> Venkatesh Potluri, Assistant Professor, School of Information, University of Michigan, Ann Arbor

<u>Date:</u> 12 December 2024

<u>Number of attendees:</u> 15

<u>Talk summary:</u> Programming and software engineering are of keen interest to the blind or visually impaired (BVI) community, spurring accessibility enhancements to programming tools that simplify nonvisual code navigation and debugging. Though these enhancements improve the general accessibility of software engineering, they fail to address accessibility of specialised programming domains, such as user interface design, physical computing, and data science due to their reliance on visual code outputs. Consequently, these domains have become inaccessible to BVI developers. In this talk, Venkatesh Potluri presented his work contributing new interaction techniques, access to data representations, and data-driven studies to make this visual information in widely-used programming tools accessible, thereby increasing accessibility of the aforementioned programming domains. He concluded with recommendations drawn from BVI developer experiences, to ensure that the paradigm shift in programming ushered in by the recent adoption of Generative AI tools remains accessible.

Teaching with and about AI in K-12 education: A clear-eyed approach to navigating the road ahead

<u>Speaker:</u> Shuchi Grover, Director of AI and Education Research at Looking Glass Ventures in Austin, TX

<u>Date:</u> 3 December 2024

<u>Number of attendees:</u> 43

<u>Talk summary:</u> Shuchi Grover explored the dual aspects of artificial intelligence in K-12 education, focussing both on its potential as a teaching tool and the necessity of fostering AI literacy. She addressed 'teaching with AI', highlighting the uses of Generative AI (in particular) in STEM (science, technology, engineering, and mathematics) classrooms to support teaching and learning while also examining the ethical considerations of integrating AI technologies into K-12 learning designs. She also covered 'teaching about AI', which includes developing both, a foundational AI literacy as well as AI concepts as a part of computer science curricula, aimed at developing students' understanding of AI and machine learning as well as AI ethics. Through concrete examples and recently-developed frameworks, this she also shared practical insights to navigating the future of K-12 education in the age of AI.

Protein Sequence Annotation using Language Models

<u>Speaker:</u> Kumaresh Krishnan, Postdoctoral Fellow, The Eddy Laboratory, Harvard University, USA

<u>Date:</u> 05 August 2024

<u>Number of attendees:</u> 21

<u>Talk summary:</u> Protein function inference relies on annotating protein domains via sequence similarity, often modelled through profile hidden Markov models (profile HMMs), which capture evolutionary diversity within related domains. However, profile HMMs make strong simplifying independence assumptions when modelling residues in a sequence. In this talk, Kumaresh Krishnan introduced PSALM (protein sequence annotation with language models), a hierarchical approach that relaxes these assumptions and uses representations of protein sequences learned by protein language models to enable high-sensitivity, high-specificity residue-level protein sequence annotation. He validated PSALM's performance on a curated set of 'ground truth' annotations determined by a profile HMM-based method and highlighted PSALM as a promising alternative for protein sequence annotation.

Scene Understanding for Safe and Autonomous Navigation

<u>Speaker:</u> Amit K Roy-Chowdhury, Professor, University of California

<u>Date:</u> 18 July 2024

<u>Number of attendees:</u> 38
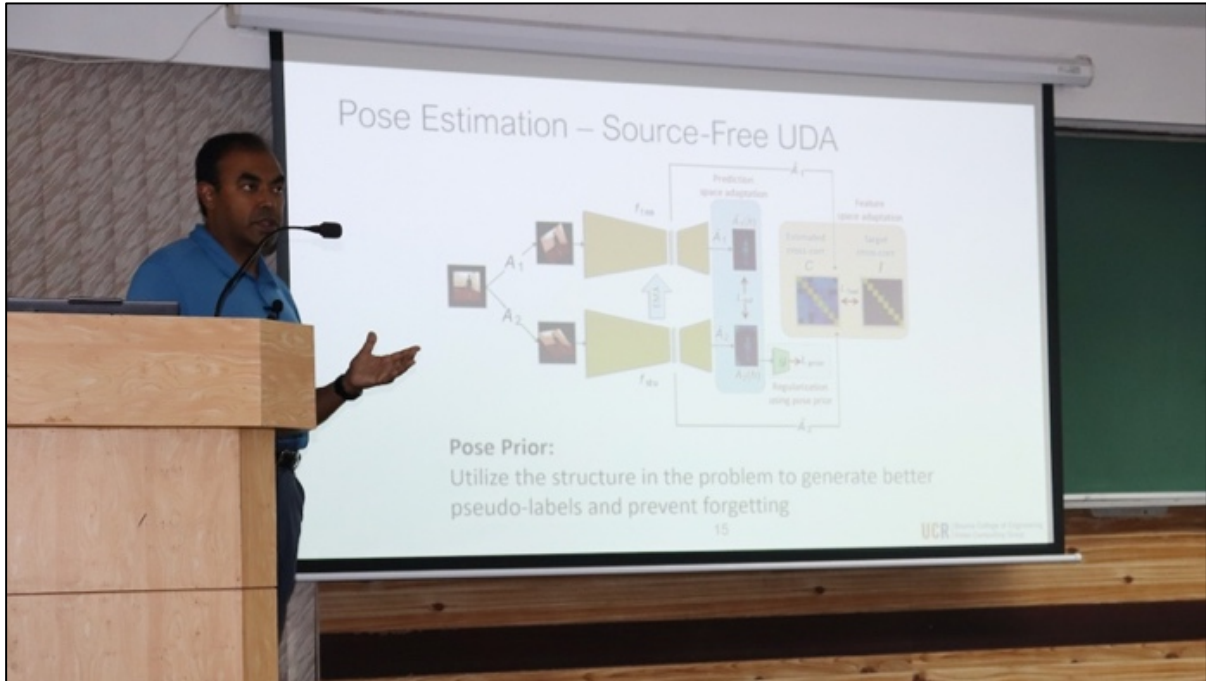
<u>Talk summary:</u> Autonomous navigation remains one of the most challenging problems in intelligent systems largely because of the close integration of scene understanding and planning that needs to happen. The scene understanding requires analysis of objects and their collections across various scales, from individual people and their actions to wide-area analysis that could span the interactions of these people with many other objects in the scene. An integrated view that is able to span across these ranges of scale is necessary for robust decision making.

In this talk, Amit K Roy-Chowdhury considered a variety of scene understanding problems that need to be solved for autonomous navigation to be successful. At the level of individual people, he showed how to estimate the pose of each individual person under challenging real-life conditions such as significant occlusions. At the next higher scale when there are interactions among small groups of individuals and objects, he demonstrated the power of scene graphs to model the semantics of the scene. At a yet higher level, he showed how to track objects across non-overlapping cameras spread over large areas. Robustness to a variety of operational domains was considered through all of these tasks. In spite of this, it is unlikely that perfect scene understanding will be achieved, and any autonomous agent will need to occasionally interact with human experts; he showed how this can be achieved with natural

language feedback leveraging upon the power of recently developed vision–language models.

Decoding Movies: Holistic Understanding of Situations and Characters

Speaker: Makarand Tapaswi, Assistant Professor, Center for Visual Information Technology, International Institute of Information Technology Hyderabad

Date: 11 June 2024

Number of attendees: 42

Talk summary: Despite tremendous advances in LLMs (large language models) and VLMs (vision language models), fine-grained visual understanding remains elusive. With the additional complexity of time, even short video clips are easily misunderstood. In this talk, Tapaswi described his research group's efforts on holistic video understanding. Starting with situation recognition that answers "who is doing what to whom, where, and how", he introduced a new approach for weakly supervised spatio-temporal grounding of such concepts in the video. Next, he showed how dense captions derived from video clips can be used to efficiently and effectively adapt vision–language models like CLIP. Beyond structured outputs and towards coherent video descriptions, characters are an important prerequisite for long video understanding. Tapaswi explored enhancing existing captions through fill-in-the-

blanks or generating identity-aware captions. Finally, he shared a quick overview of other related works on predicting movie character emotions, generating television episode summaries, improving image captioning systems, and a new benchmark for evaluating VLMs.

Three Things Everyone should know about View Synthesis
Speaker: Aayush Bansal, Principal Scientist and Head of Research, SpreeAI
Date: 18 April 2024
Number of attendees: 29

Talk summary: In this talk, Aayush Bansal spoke about three experiments from his work on view synthesis. In the first part of the talk, he demonstrated how we can leverage simple two-dimensional (2D) pixels at no additional cost to get detailed three-dimensional (3D) view synthesis. In this work, he used simple low-level image statistics to efficiently mine hard examples for better learning. Simply biasing ray sampling towards hard ray examples enables learning of neural fields with more accurate high-frequency detail in less time.

In the second part of the talk, he moved away from neural radiance fields and used simple insights from image-based rendering methods to obtain detailed 3D-4D (four-dimensional) view synthesis from multi-view inputs. He demonstrated how we can

build a representation of a pixel that contains colour and depth information accumulated from multi-views for a particular location and time along a line of sight. This pixel-based representation alongside a multi-layer perceptron allows us to synthesise novel views given a discrete set of multi-view observations as input. The proposed formulation reliably operates on sparse and wide-baseline multi-view images/videos and can be trained efficiently within a few seconds to 10 minutes for hi-resolution (12MP) content.

Finally, he presented a simple yet highly effective approach to modelling high-fidelity volumetric avatars from sparse views. He demonstrated the importance of encoding relative spatial 3D information via sparse 3D key points. These insights allow us to outperform state-of-the-art methods for head reconstruction. On human body reconstruction for unseen subjects, they also achieve performance comparable to prior art that uses a parametric human body model and temporal feature aggregation.

C. Courses/training sessions/workshops/events/competitions
KIAC extends support to IISc faculty to organise and conduct events that would benefit a multidisciplinary group of persons from around the world.
Short course on 'A Gentle introduction to Large Language Models'
Instructor: Danish Pruthi, Assistant Professor, Department of Computational and Data Sciences, IISc
Date: 08–22 March 2025
Number of participants: 487 (online) and 50 (in-person)

We interact with language models and derivates, such as ChatGPT, on a daily basis (at times, unknowingly). Such models answer the questions we ask, autocomplete words we are likely to type, help translate text from languages we do not know, and most importantly, complete our assignments and homework. This short course by Danish Pruthi gently introduced language models, starting with N-gram models building all the way up to transformers, and how they are pre-trained and aligned to be safe. Module 1 focussed on N-gram language models, module 2 on neural networks, module 3 on recurrent neural networks, module 4 on attention and transformers, and module 5 on transformers and pre-training.

Curriculum consultation meeting on 'Computing Education for Schools in India'

Date: 7 March 2025
Number of participants: 40

A curriculum consultation meeting on 'Computing Education for Schools in India' was co-hosted by IISc, Raspberry Pi Foundation (RPF), and CS Pathshala and aimed to address the need for a structured computing curriculum in Indian government schools, aligned with the National Education Policy (NEP) 2020 and global trends including artificial intelligence. This consultation meeting brought together key

stakeholders, including academics, government representatives, industry experts, school educators, and the RPF and CS Pathshala teams. The teams presented proposed computing curriculum frameworks designed for government schools, discussed implementation challenges, and explored collaborations to develop a roadmap for large-scale adoption.

AI/ML optimisation and product development workshop for engineers
Date: 27–30 January 2025
Number of participants: 62

The aim of this workshop was to delve into the potential of artificial intelligence and machine learning in driving optimisation and product development in engineering. It was held in conjunction with the Aerospace Engineering Research Students' Symposium (AERES) 2025. Organised in collaboration with Intel and Ansys, the goal of this workshop was that engineering students should get hands-on experience in using the latest Intel hardware designed for AI optimisation and in learning to use Ansys AI/ML tools to accelerate engineering product development. In addition, students would get the opportunity to learn and interact with leading experts from academia and industry working in AI/ML through keynote lectures.

The workshop was divided into segments as follows: (a) Workshop on 'Turek Benchmarking for FSI – Aeroelasticity', (b) Workshop on 'Accelerating Product Development Using AI/ML', (c) keynote talks and expert-led sessions. One such keynote talk was on 'Accelerating Innovation in Aerospace through Digital Twins and AI' by Mr Ajinkya from Siemens and one of the sessions was on 'Unleashing the Potential of Intel AI PC'.

Collectively, these workshops equipped students and researchers with practical skills in simulation-driven product development and AI-enhanced engineering. They provided a platform for learning state-of-the-art tools and methodologies, setting the

stage for future innovation in simulation science and computational mechanics. The participants of the keynote talks were left with a deeper understanding of AI/ML's role in next-generation aerospace innovation and gained exposure to tools and methodologies that will define future engineering practices.

Short course on 'Radiance Fields in Visual Computing and Artificial Intelligence'

Instructor: Srinath Sridhar, Assistant Professor of Computer Science at Brown University and Visiting Professor at the Kotak IISc AI-ML Centre, IISc

Date: 06–15 January 2025

Number of participants: 55
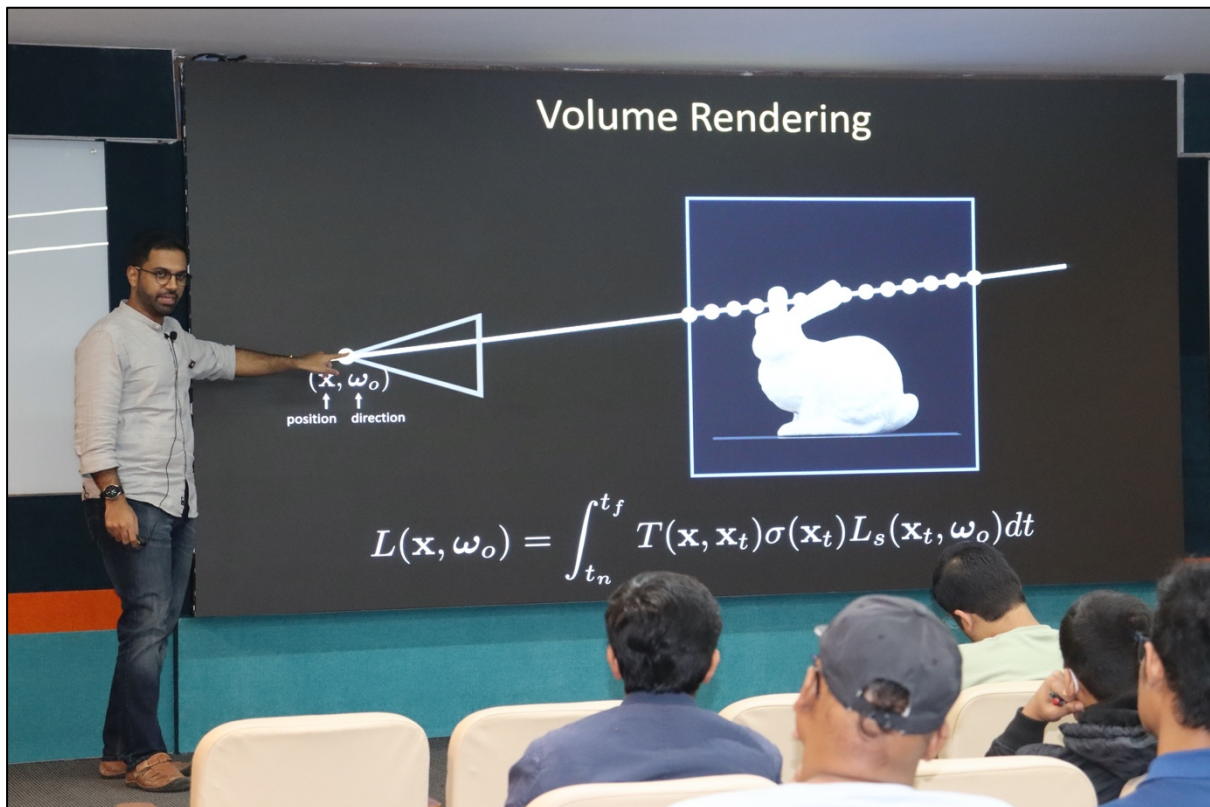
Srinath Sridhar offered a five-part tutorial on 'Radiance Fields in Visual Computing and Artificial Intelligence' in January 2025 during his visit to IISc. This course was an introduction to radiance fields, a technique for modelling the three-dimensional shape and appearance from images, that has wide applications in visual computing and artificial intelligence.

Part I introduced radiance fields with concrete examples and applications and traced the history of radiance fields across computer vision, graphics, and medical imaging communities. Part II introduced neural radiance fields (NeRFs) and related

techniques that kick-started new interest in radiance fields. Part III focussed on 3D Gaussian splatting (3DGS), a radically different way of representing radiance fields that re-ignited community interest. Part IV discussed the broad applications of radiance fields, and part V provided an outlook of the bleeding edge of radiance fields in both academia and industry.

Bangalore Neuromorphic Engineering Workshop
Date: 05–15 January 2025
Number of participants: 150

The Bangalore Neuromorphic Engineering Workshop (BNEW) 2025, held from 05–15 January 2025 at IISc), marked a milestone in advancing neuromorphic technologies in the Asia-Pacific region. Modelled after the Telluride and Capo Caccia workshops, BNEW aimed to empower the next generation of researchers through immersive, hands-on training in this cutting-edge field. The event fostered a dynamic research community by bringing together leading academics, industry experts, and students committed to pushing the frontiers of neuromorphic engineering.

Over 11 intensive days, the workshop hosted around 70 participants (including 55 external attendees) from a wide array of disciplines such as neuroscience, cognitive science, robotics, machine learning, computer vision, signal processing, and electrical engineering. Organised by a distinguished team, with strategic guidance from an

eminent steering committee, BNEW 2025 featured a rich lineup of international speakers. The workshop was thoughtfully structured with expert-led lectures in the mornings, hands-on tutorials and group sessions in the afternoons, and focussed neuroscience talks in the evenings, offering participants a comprehensive and well-rounded learning experience in neuromorphic engineering.

International Conference on Applied AI and Scientific Machine Learning
Date: 14-18 December 2024
Number of participants: 262

The International Conference on Applied AI and Scientific Machine Learning (CASML 2024) focussed on applying machine learning in scientific computing and applied AI techniques. The five-day event began with a two-day pre-conference workshop from 14–15 December 2024, followed by a three-day conference from 16–18 December 2024. The conference featured keynote talks by distinguished speakers from academia and industry, as well as peer-reviewed presentations, fostering collaboration between academic researchers and industry practitioners in the fields of applied AI and scientific machine learning. The core areas of interest in the conference included physics-informed neural networks, neural operators, generative AI for science and engineering, digital twins and surrogate modelling, SciMLOps and high-performance computing, and explainable and interpretable AI.

Short course on 'Graph Theory and Machine Learning: From Fundamentals to Advanced Applications'

Instructor: Ananda Shankar Chowdhury, Professor, Jadavpur University, Kolkata

Date: 5–7 November 2024

Number of participants: 40 (in-person) and 110 (online)

This short course consisted of three lectures on three days. The first lecture started with the basics of graphs (sparse/dense graphs, connectivity in graphs). Ananda Shankar Chowdhury discussed labelling problems in a weakly supervised setup and focussed on random walks, mentioning how such a setup can be improvised with and without deep learning. He also showed some use cases.

In the second lecture, the focus was on graph cuts (basic formulation including graph construction and energy optimisation). Chowdhury discussed typical problems such as segmentation and registration where graph cuts can be applied, mentioning how such a setup can be improvised with and without deep learning. He also showed some use cases.

The focus of the third lecture was on graph convolution networks (GCNs; both the forward and the backward pass). Chowdhury discussed typical problems in GCNs such as node labelling, edge labelling, and graph labelling, mentioning how such a setup can be improvised with and without deep learning. He also showed some use cases.

Algorithms Festival – Unveiling the Beauty of Algorithms

Date: 20 October 2024

Organised by: Databased (IISc's UG CS Club), IISc ACM-W Student Chapter, and Kotak IISc AI-ML Centre

Number of participants: 130

The highlight of the festival was a series of nine engaging presentations by talented second- and third-year undergraduate students. These presentations spanned diverse topics in computer science, showcasing the depth and breadth of algorithmic research, namely, (1) Secure Multiparty Computation, (2) Optimal Resource Management with Online Decision Making Strategies, (3) From Monkeys to Markets: Harnessing Genetic Algorithms for Financial Forecasting, (4) Shor's Algorithm, (5) Dicing with Dice, (6) Efficient Register Allocation with Chaitin's Graph-Colouring Algorithm, (7) Spectral Clustering Algorithm, (8) Understanding Protein Behaviour: The Power of MCMC Algorithms, and (9) Monte Carlo Tree Search.

The festival served as a platform for participants to explore advanced topics, share insights, and engage in discussions, fostering a collaborative learning environment. This was a celebration of algorithms, as a part of Chandrasekaran Pandu Rangan's course for the undergraduate students of IISc.

Cyber-Physical Systems Symposium

<u>Date:</u> 25–27 July 2024

<u>Number of participants:</u> 58
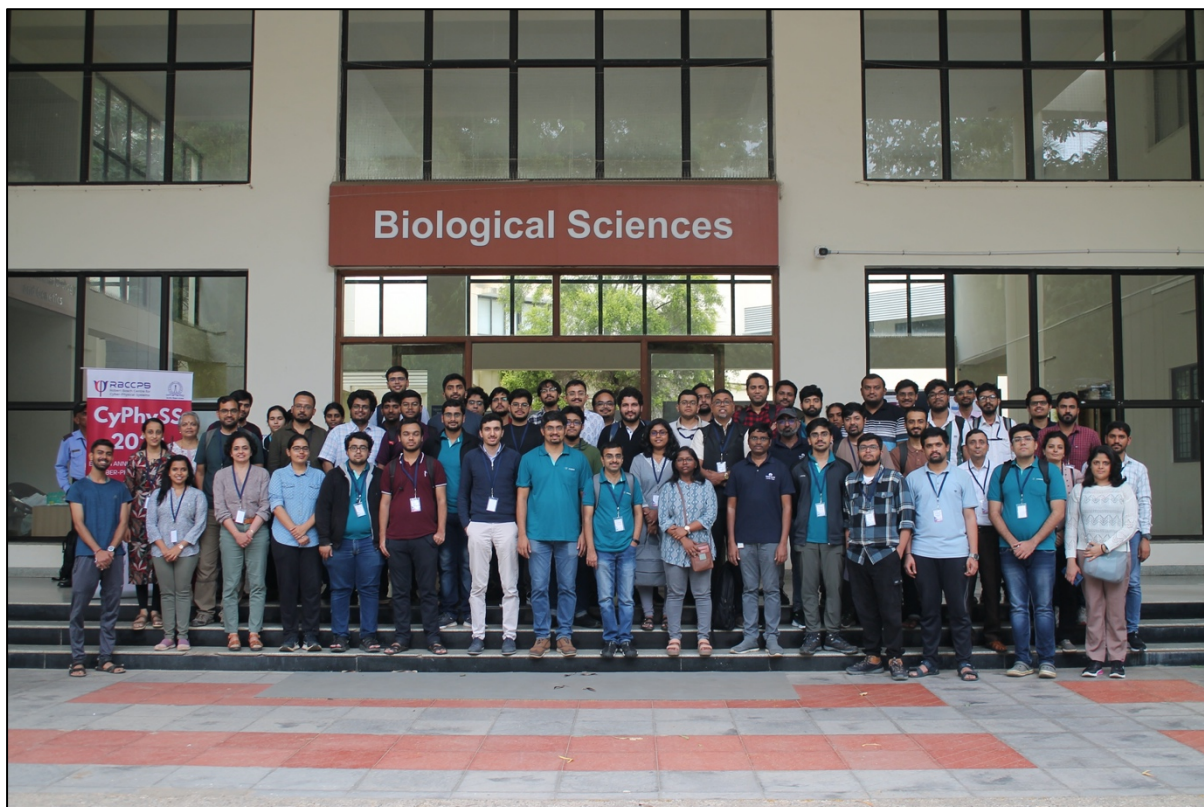
The Cyber-Physical Systems Symposium (CyPhySS), India's largest annual summit focussing on cyber-physical systems (CPS), serves as a pivotal platform for researchers, industry leaders, and academic professionals, both domestic and international, to discuss the latest advancements, research endeavours, and best practices in robotics, control, and artificial intelligence as applied to various sectors including industry, space, agriculture, and socio-technical systems such as energy, mobility, smart grid, and smart cities.

The theme of the eighth Cyber-Physical Systems Symposium (CyPhySS 2024) was 'Robotics, Control and AI' and was hosted by the Robert Bosch Centre for Cyber-Physical Systems at IISc during 25–27 July 2024. The three-day event had many talks, public lectures, tutorial sessions, student presentations, and poster presentations. The speakers were from around the world and from both academia and industry.

International Conference on Signal Processing and Communications
Date: 1–4 July 2024
Number of participants: 115

The International Conference on Signal Processing and Communications (SPCOM) provides a forum for researchers from academia, research laboratories, and industry to come together to share and learn about current developments in these emerging fields. SPCOM 2024 is the fifteenth in a series of biennial events that have been organised since 1990 at IISc. It was hosted by the Department of Electrical Communication Engineering, IISc during 1–4 July 2024.

This year's conference featured 3 plenaries, 5 tutorials, 20 invited talks, and around 75 contributed papers. There were six invited sessions featuring distinguished speakers in the broad areas of information theory, communications, networking, speech and language, applied machine learning and computer vision, and medical imaging. These sessions were conducted by experts from India and across the world.

EECS Research Students Symposium

<u>Date:</u> 4–5 April 2024

<u>Number of participants:</u> 300
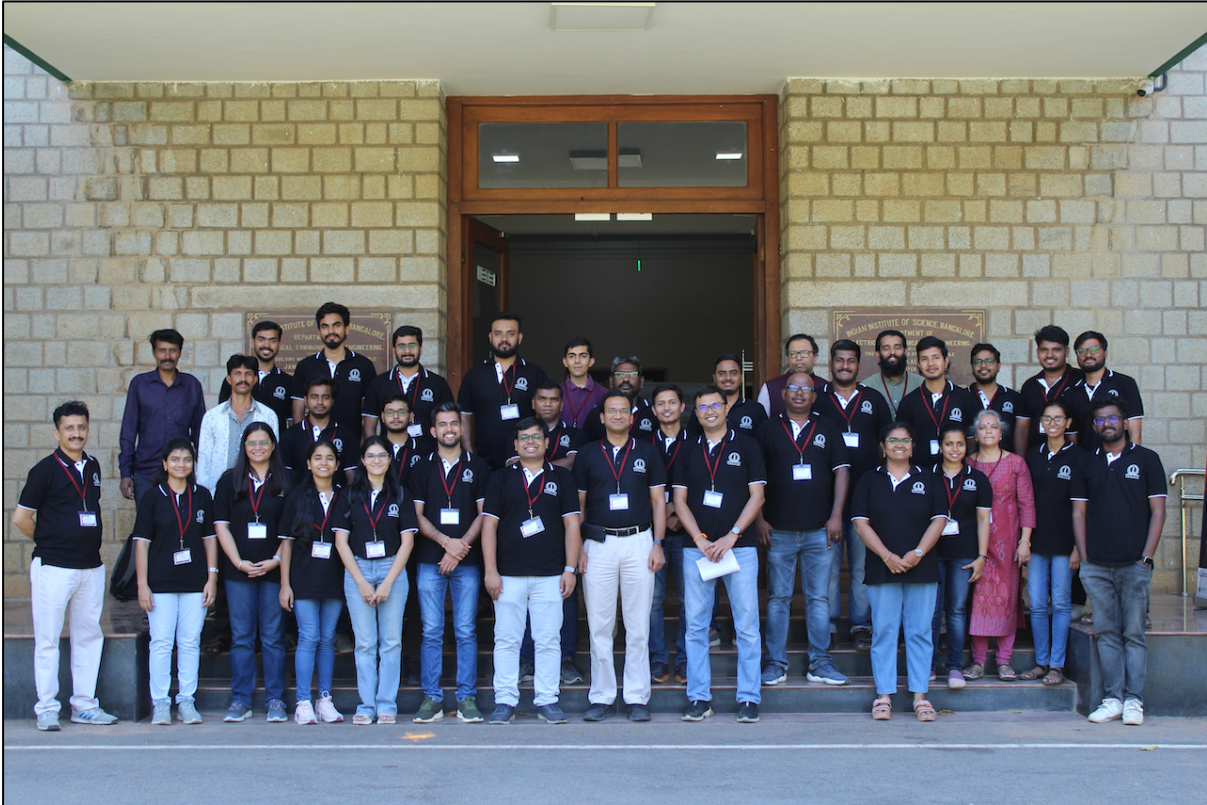
The 15th EECS Research Students Symposium (EECS 2024) was held during 4–5 April 2024 at IISc. This symposium is an initiative of the Division of Electrical, Electronics, and Computer Sciences at IISc. This annual event is organised by six departments/centres from IISc, namely, the departments of Computational and Data Sciences, Computer Science and Automation, Electrical Communication Engineering, Electrical Engineering, Electronic Systems Engineering, and the Robert Bosch Centre for Cyber-Physical Systems.

The symposium is primarily a forum for senior research students to present their work and receive feedback from an audience of students and faculty members from IISc, other academicians and industry participants. This year's programme featured student presentations under 11 research clusters, namely Artificial Intelligence and Machine Learning; Microelectronics, RF, and Photonics; Signal Processing and Communications; Computer Systems, Security, and Privacy; Visual Analytics; Theoretical Computer Science; Brain, Computation, and Data Sciences; Computer Systems; Cyber-Physical Systems; Power Engineering; and Networking and IoT. Best student presentation awards were presented in each of these research clusters. There

were also plenary talks by eminent speakers and talks by young faculty members from the six participating departments.

iGEM competition

In the iGEM competition, multidisciplinary student teams from across the world design, build, and test projects using cutting-edge synthetic biology. The IISc-Software team won a Gold Medal at the iGEM competition held in Paris. KIAC sponsored the team's project IMPROViSeD (Integrated Modelling of Protein-complexes Via Single-shot registration using DREAM).

The student team from IISc has 13 BTech students, with a PhD student as their student guide, Debnath Pal (IISc) as the principal investigator (PI) and secondary PIs as Shruthi Viswanath (National Centre for Biological Sciences, Bengaluru) and Manjula Das (Mazumdar Shaw Center for Translational Research, Bengaluru). Their project aims to use the integrative modelling platform (IMP) with the DREAM algorithm to build models of macromolecular assemblies using a bottom-up approach, overcoming existing bottlenecks [details at https://2024.igem.wiki/iisc-software/description]

Ideathon 2024

The Databased Club of IISc, a community of BTech students passionate about diving deep into the world of computer science and exploring the domain of mathematics, conducted 'Ideathon 2024' for the undergraduate first-year students, providing them with a platform to showcase their innovative problem-solving skills. Over 20 student teams participated in the two-day event, where they had to develop solutions for one of two intriguing problem statements: (i) sustainable campus transportation or (ii) AI-driven early warning system for natural disasters.

The winning presentation was given by the team ***Error 404 Team Not Found***. They took on the problem statement for 'AI-driven early warning system for natural disasters'. Their solution featured a parametrised approach to utilising a collection of datapoints such as seismic data, ionospheric data, and animal behaviour to predicting natural disasters. They also highlighted many lessons that can be learnt from studies on previous calamities faced by humanity and how existing networking infrastructure can be utilised to deploy better communication systems so that people can be informed of predicted disasters.
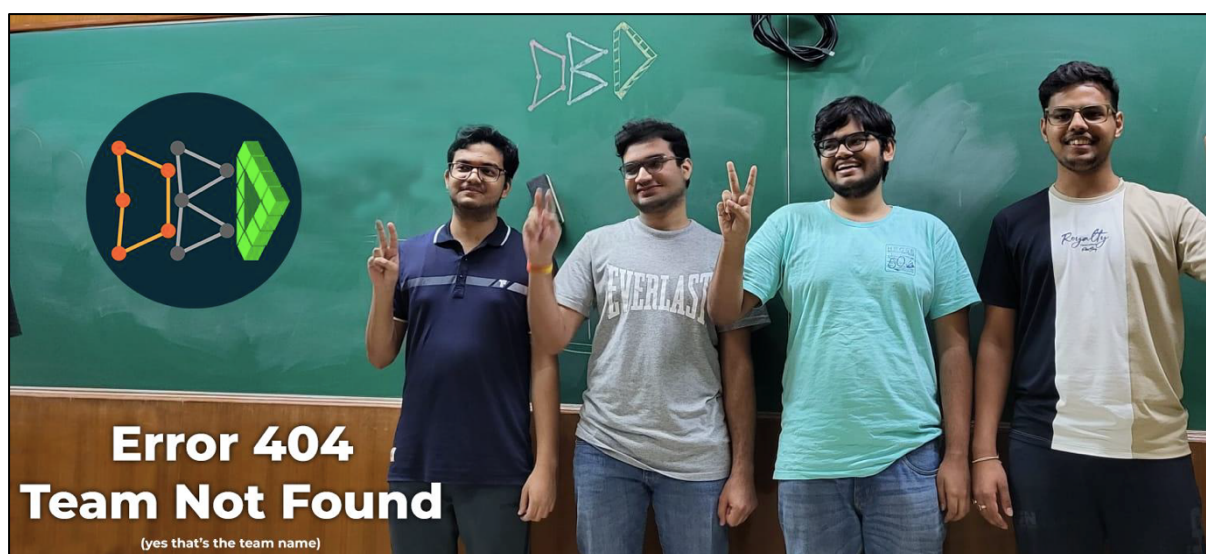
The event also featured two talks. One was by Pandu Rangan Chandrasekaran on 'What is Information?'; the talk sparked deep reflections on the nature of data, information, and how they intertwine with problem-solving and computational thinking. The second talk was by Sunny Manchanda, Director of the Young Scientist AI Lab at DRDO, on 'Applications of AI'. His talk emphasised the transformative potential of AI, helping participants appreciate the vast possibilities that AI can offer in creating innovative solutions for the real world.

IV. Professorships

In this financial year, one International Visiting Chair Professor and two International Visiting Professors were selected. These Professors are experts in artificial intelligence and machine learning and their applications in various practical domains. As part of the Professorships, these eminent researchers would give lectures/seminars and conduct courses at IISc.

KIAC International Chair Visiting Professor: Alan Bovik

Cockrell Family Regents Endowed Chair Professor, University of Texas at Austin

Alan Bovik's research interests land at the nexus of visual neuroscience and digital pictures and videos. His recent interests include immersive, virtual, and augmented visual experiences, and how they can be perceptually optimised. An elected member of the US National Academy of Engineering, the Indian National Academy of Engineering, the National Academy of Inventors, and Academia Europaea, his many honours include the John Fritz Medal, IEEE Edison Medal, Primetime Emmy Award, Technology & Engineering Emmy Award, RPS Progress Medal, and Edwin H Land Medal.

KIAC Visiting Professor: Srinath Sridhar

Assistant Professor of Computer Science, Brown University, Providence, Rhode Island

Srinath Sridhar leads the Interactive 3D Vision & Learning Lab (https://ivl.cs.brown.edu) at Brown University. He received his PhD at the Max Planck Institute for Informatics and was subsequently a postdoctoral researcher at Stanford. His research interests are in 3D computer vision and machine learning. Specifically, his group focusses on visual understanding of 3D human physical interactions with applications ranging from robotics to mixed reality. He is a recipient of the NSF CAREER award, a Google Research Scholar award, and his work received the Eurographics Best Paper Honourable Mention. He spends part of his time as a visiting academic at Amazon Robotics and has previously spent time at Microsoft Research Redmond and Honda Research Institute.

KIAC Visiting Professor: Prabhat Mishra

Professor, Department of Computer and Information Science and Engineering, University of Florida, USA

Prabhat Mishra received his PhD in Computer Science from the University of California at Irvine. His research interests include AI for cybersecurity, design automation for embedded systems, hardware security verification, and quantum computing. He has published 9 books, 35 book chapters, 30 patents, and more than 250 research articles in premier international journals and conferences. His research has been recognised by several awards, including the NSF CAREER Award, IBM Faculty Award, three best paper awards, 11 best paper nominations, and EDAA Outstanding Dissertation Award.

He currently serves as the Chair of the IEEE CEDA Fellow Evaluation Committee as well as the Chair of the Editor-in-Chief Search Committee for ACM Transactions on Reconfigurable Technology and Systems (TRETS). He also serves as the Program Chair of the International Conference on Hardware-Software Codesign and System Synthesis (CODES+ISSS) and IEEE International Symposium on Hardware Oriented Security and Trust (HOST). He serves as an Associate Editor of ACM Transactions on Embedded Computing Systems (TECS) and ACM Transactions on Design Automation of Electronic Systems (TODAES). He is an IEEE Fellow, a Fellow of the American Association for the Advancement of Science, and an ACM Distinguished Scientist.

Objective 2: Cutting-edge research of international visibility

The Centre supports cutting-edge research in artificial intelligence and machine learning and their applications through the PhD scholarships, internships, predoctoral fellowships, and postdoctoral fellowships. Researchers are also encouraged to present their accepted papers at leading international AI conferences.

I. Research work supported by KIAC

A glimpse of the research projects supported by KIAC is shown here.

PhD scholarship awardees

Name	Research work
Aditya Shirwatkar	Developing a planning and control framework for contact-rich-legged locomotion. The goal is to enable legged robots to be 'contact friendly' and utilise their entire body to perform various locomotion tasks. This will contribute to more generalised mobility of these robots in real-world.
Priyam Dey	Research and exploring deep vision/multimodal models to understand properties such as robustness, generalisability, compositionality, and training efficiency from a data and model perspective.
Kumar Shubham	Designing methods for efficient and explainable training of machine learning models in noisy environments, with a primary application in healthcare, particularly in cancer research.
Rankit Kachroo	Human–computer interaction, computational sensorimotor learning, representation learning, and unsupervised learning. The aim is to contribute to the development of intelligent systems capable of performing tasks autonomously, reducing the need for human intervention and improving human-computer collaboration.
Tirthajit Baruah	Multimodal representation learning for healthcare; causality and interpretability in machine learning for healthcare applications.

Interns

Name	Research work
Aiman Aatif Bayezeed	Safety-based control and machine learning, specifically focussing on learning from demonstration and open-vocabulary mobile manipulation. This research has applications in enhancing human–robot collaboration, especially in environments that require safe and adaptable control systems, a growing necessity in many fields.
Anuj Attri	Predicting the carbohydrates and calories present in food items using deep learning and computer vision.
Puneeth S	(i) Learning from demonstration using spatio-temporal tubes, a technique that enables robotic systems to learn complex tasks through observation and mimicry. (ii) Open vocabulary mobile manipulation on the Hello Robot Stretch platform, focussing on creating a versatile robotic system capable of adapting to varied and dynamic tasks within unstructured environments.
Nitya Ahuja	Creating automated drone corridors, using AI/ML tools, in a 5G network, ensuring continuous and stable communication between UAVs and 5G base stations throughout the entire flight path.
Ram Samarth B B	Model large-scale GNNs (graph neural networks) for billion-node graphs and developing spatio-temporal GNNs for traffic flow analysis.
Rikhil Gupta	Sparse input novel view synthesis using 3D Gaussian splatting techniques.
Sanjana Kiran Tikare	Energy distribution analysis: developing user interfaces and data analysis frameworks using tools such as DashApp to visualise and analyse data effectively.
Tanishq Kekre	Contributions to literature on in-memory computing based 2.5D systems for DNN (deep neural network) training acceleration. Implementing preventive and recovery measures on these accelerators to avoid loss of effort in case of system failure.
Tashmoy Ghosh	Language-instructed low-level robot action representation and modification with large language models.

Predoctoral fellows

Name	Research work
Achin Parashar	Synthesise naturalistic 'super-stimuli' using deep generative models.
Aditya Gandhamal	Domain generalisation and open-vocabulary learning, with end applications in autonomous systems.
Akansha Sharma	Enhancing federated learning using pre-trained vision-language models and source-free domain adaptation.
Anurag Maurya	Improving human–robot interaction by using language as an interface, focussing on bi-manual object arrangement tasks and extracting explainable affordances for these problems.
Anuska Roy	Generalisability of deep fake image detection techniques.
Ayman Un Nisa	Developing an innovative tool for optimising 2.5D system configurations. The goal is to create a solution that delivers performance within a smaller percentage of the optimal, as estimated by a cycle-accurate simulator.
Bhakshi Mehul	Implementation of sequential ensemble models to predict computationally-expensive adjoint-based error estimator for expediting the metric-based mesh adaptation process.
Chiluveru Akhil	Learning-based control for unknown systems: specifically, creating robust control systems that can adapt in real-time to unexpected scenarios, thereby enhancing safety.
Hariharasai Mohan	Generative AI for the synthesis of two-dimensional materials: exploring AI-driven approaches in material science.
Harish Kumar S	Analysing the applicability of time series foundation model for energy load forecasting for various commercial and residential buildings.
Harshith Reddy Kaila	Developing deep learning and machine learning models to generate synthetic turbulence data that replicates realistic turbulent flow dynamics: specifically, models that capture both spatial and temporal dynamics of turbulence, aiming to generate velocity fields across varying Reynolds numbers.
Kinjawl Bhattacharyya	Improving zero-shot adversarial robustness in vision-language models.

Predoctoral fellows

Name	Research work
Margamitra Bhattacharya	Leveraging automated speech recognition systems to enhance and build robust air traffic control (ATC) pilot communication systems and ATC training tools.
Natish Murugesh	Imparting throwing skills to robotic manipulators using self-supervised learning, where a robotic manipulator is trained to throw objects with varying properties, including differences in mass, mass distribution, and density into a defined target position. This work is a step toward developing adaptive, skilful robotic systems capable of handling complex and dynamic tasks.
Pranoy Varma	Optimal entry and exit problem for a financial asset that follows a mean reverting process.
Prateek Upadhya	Development of human preference-aware image quality assessment methods for AI-generated images.
Rikathi Pal	Understanding and improving neural network training processes through topological analysis techniques, such as persistent homology and Reeb graphs, to enhance model performance and interoperability.
Rishab Rajesh Sharma	Neural architecture search and contrastive learning.
Rishab Sabharwal	Creating scalable and efficient GNNs to detect fraudulent transactions (in collaboration with the National Payments Corporation of India (NPCI)).
Sachidanand V S	Generative models and image editing.
Shrikar Madhu	Class-incremental continual learning in neural networks.
Sai Teja Tangudu	Building efficient multi-modal LLM (large language model) architectures for AI-generated image quality assessment.
Saksham Bhutani	Fault detection and tolerance in autonomous and intelligent systems.
Sunny Bhati	Latent space exploration for generative AI.
Sushil Jangra	Applying neural operators to oceanography.

Postdoctoral fellows

Name	Research work
Surbhi Shaw	Post-quantum cryptography and zero-knowledge proofs, exploring advanced cryptographic protocols that can secure digital systems against quantum computing threats.
Akash Pareek	Online algorithms, data structures, combinatorics, and learning augmented algorithms: specifically, designing beyond worst-case algorithms using predictions.

II. Support to present accepted papers at leading international AI conferences

KIAC supports IISc students and faculty members to present their accepted papers in renowned venues such as AAAI, IJCAI, ACL, ECCV, ICML, CVPR, ICLR, NeurIPS, ICCV, KDD, EMNLP, NAACL, SIGIR, and WWW. Attending leading international conferences presents a great opportunity for researchers from India to collaborate with the global community of academicians in their respective fields and leads to collaborations in multiple projects. In this financial year, 21 persons were supported.

ACCEPTED PAPERS PRESENTED AT LEADING INTERNATIONAL CONFERENCES IN ARTIFICIAL INTELLIGENCE		
CONFERENCE	**PAPER TITLE**	**AUTHORS**
AAAI	Partially Blinded Unlearning: Class Unlearning for Deep Networks from Bayesian Perspective	Subhodip Panda, Shashwat Sourav, and Prathosh A P
	Two-Timescale Critic-Actor for Average Reward MDPs with Function Approximation	Prashansa Panda and Shalabh Bhatnagar
COMPUTE 2024	HinglishEval: Evaluating the Effectiveness of Code-generation Models on Hinglish Prompts	Mrigank Pawagi, Anirudh Gupta, Siddharth Rolla Reddy, and Kintan Saha
MobiSec 2024	An Efficient Sequential Aggregate Signature Scheme with Lazy Verification	Arinjita Paul, Sabyasachi Dutta, Kouichi Sakurai, and Chandrasekaran Pandu Rangan

ACCEPTED PAPERS PRESENTED AT LEADING INTERNATIONAL CONFERENCES IN ARTIFICIAL INTELLIGENCE		
CONFERENCE	**PAPER TITLE**	**AUTHORS**
ECCV 2024	Text2Place: Affordance-aware Text Guided Human Placement	Rishubh Parihar, Harsh Gupta, Sachidanand and R. Venkatesh Babu
	PreciseControl: Enhancing Text-To-Image Diffusion Models with Fine-Grained Attribute Control	Rishubh Parihar, Sachidanand, Sabariswaran, Tejan and R. Venkatesh Babu
ACL 2024	Evaluating Large Language Models for Health-related Queries with Presuppositions	Navreet Kaur, Monojit Choudhury, Danish Pruthi
SIGGRAPH 2024	Factorized Motion Fields for Fast Sparse Input Dynamic View Synthesis	N. Somraj, K. Choudhary, S. Mupparaju, and R. Soundararajan
ICML 2024	Testing the Feasibility of Linear Programs with Bandit Feedback	Aditya Gangrade, Aditya Gopalan, Venkatesh Saligrama, Clayton Scott
	Unsupervised Parameter-free Simplicial Representation Learning with Scattering Transforms	Hiren Madhu, Sravanthi Gurugubelli, Sundeep Prabhakar Chepuri
	Risk Estimation in a Markov Cost Process: Lower and Upper Bounds	Gugan Thoppe, Prashanth L. A., Sanjay Bhat
	WISER: Weak supervision and supervised representation learning to improve drug response prediction in cancer	Kumar Shubham, Aishwarya Jayagopal, Syed Mohammed Danish, Prathosh AP, Vaibhav Rajan

ACCEPTED PAPERS PRESENTED AT LEADING INTERNATIONAL CONFERENCES IN ARTIFICIAL INTELLIGENCE		
CONFERENCE	**PAPER TITLE**	**AUTHORS**
CVPR 2024	MRFP: Learning Generalizable Semantic Segmentation from Sim-2-Real with Multi-Resolution Feature Perturbation	Sumanth Udupa, Prajwal Gurunath, Aniruddh Sikdar, Suresh Sundaram
	Leveraging Camera Triplets for Efficient and Accurate Structure-from-Motion	Lalit Manam, Venu Madhav Govindu
	Leveraging Vision-Language Models for Improving Domain Generalization in Image Classification	Sravanti Addepalli, Ashish Ramayee Asokan, Lakshay Sharma and R. Venkatesh Babu
	Balancing Act: Distribution-Guided Debiasing in Diffusion Models	Rishubh Parihar, Abhijnya Bhat, Saswat Mallick, Abhipsa Basu, Jogendra Nath Kundu, R. Venkatesh Babu
	DeiT-LT: Distillation Strikes Back for Vision Transformer Training on Long-Tailed Datasets	Harsh Rangwani, Pradipto Mondal, Mayank Mishra, Ashish Ramayee Asokan, R. Venkatesh Babu
ICRA 2024	SKD-Net: Spectral-based Knowledge Distillation in Low-Light Thermal Imagery for robotic perception	Aniruddh Sikdar, Jayant Teotia and Suresh Sundaram
ICLR 2024	Selective Mixup Fine-Tuning for Optimizing Non-Decomposable Metrics	Shrinivas R., Harsh Rangwani, Sho Takemori, Kunal Samanta, Yuhei Umeda, and R. Venkatesh Babu

Objective 3: Developing innovative, deep tech solutions to meet current and emerging requirements

One of the objectives of KIAC is to develop deep technology solutions that meet the current and emerging requirements of the country and the world in the areas of artificial intelligence, machine learning, and their applications to practical domains.

A call for deep tech solutions was released on 1 October 2024. This call targeted IISc faculty and sought proposals on AI for public good – solutions that can be leveraged by the industry ecosystem or make it to Government missions. The idea was to identify and fund outstanding proposals for developing such solutions, the deadline for which was fixed as 31 March 2025.

The 23 proposals that were received were initially screened to check whether they met the requirements, and the shortlisted proposals were then reviewed by an external committee for approval. Three proposals were selected for funding, as follows.

1. CháksuAI: An open-source AI assistant for comprehensive ophthalmic diagnostics

2. Photoplethysmography video analysis on retinal blood flow patterns

3. Development of an LLM-powered phenotyping tool to streamline genetic disease diagnosis

To assist the faculty members with these projects, staff members have been appointed. As of date, two predoctoral fellows, one research assistant, six interns, one project associates, one research associate, and one administrative assistant have been appointed.

CháksuAI: An open-source AI assistant for comprehensive ophthalmic diagnostics

Principal investigator: Chandra Sekhar Seelamantula, Professor, Department of Electrical Engineering, IISc

Project overview: The CháksuAI project aims to develop an open-source, AI-powered assistant to support ophthalmologists in diagnosing and managing various eye diseases, including diabetic retinopathy, glaucoma, and age-related macular degeneration (AMD). Using state-of-the-art deep learning models, CháksuAI will provide functionalities including classification of retinal diseases (e.g., diabetic retinopathy, glaucoma), detection of abnormalities (e.g., microaneurysms,

haemorrhages), retinal segmentation (e.g., optic disc and cup), volumetric analysis of fluid in optical coherence tomography (OCT) images, and risk prediction for disease progression. These capabilities will be integrated into a unified platform to enhance diagnostic accuracy and efficiency, particularly in low-resource settings.

Photoplethysmography video analysis on retinal blood flow patterns

Principal investigator: Ambarish Ghosh, Professor, Centre for Nano Science and Engineering, IISc

Collaborators: Dr Kailash, IISc Health Centre and Dr Debayan, Theranautilus Pvt Ltd.

Project overview: The project proposes a novel approach to early detection of retinal vascular diseases using photoplethysmography (PPG) video analysis. PPG, a non-invasive optical technique, measures changes in blood volume in the underlying tissue. By analysing the blood flow patterns captured in PPG videos from retinal/fundus videos, the aim is to develop an accurate and efficient method for detecting early signs of retinal vascular diseases that may aid in the further evaluation and management of the same as well.

Current methods for diagnosing retinal vascular diseases often require invasive procedures or specialised equipment which are extremely costly. PPG, on the other hand, offers a non-invasive, more accessible and patient-friendly alternative. By leveraging advanced video processing and machine learning techniques, the project team seeks to extract meaningful information from PPG videos that correlates with retinal vascular health, potentially enabling early detection and intervention for diseases like diabetic retinopathy.

Development of an LLM-powered phenotyping tool to streamline genetic disease

Principal investigator: Chirag Jain, Assistant Professor, Department of Computational and Data Sciences (CDS), IISc

Co-Principal investigators: Ramesh Hariharan, Adjunct Professor, IISc and Ramakanth Kavuluru, Visiting Professor, CDS, IISc

Project overview: Advances in natural language processing (NLP) have revolutionised the analysis of electronic health records. A crucial component of genetic testing is interpreting the doctor's clinical notes to construct a patient profile, that is, a summary of the observed phenotypes (symptoms). Each phenotype must be represented using

standardised terminology, such as the human phenotype ontology (HPO). HPO includes about 20,000 terms to represent various abnormalities. The phenotyping step is vital for tailoring disease diagnoses and follow-up treatments to individual patients.

Currently, trained professionals at genetic testing facilities manually extract HPO-based phenotypes from unstructured clinical notes. In the proposed project, the team seeks to automate this task to expedite genetic tests and reduce the associated costs. The proposed solution builds on the cutting-edge NLP techniques.

Meanwhile, the Centre's research work and collaborations have helped in the development of solutions to global problems and grand challenges. A few cases have been highlighted below.

AI Centre of Excellence in Health

- India has a third of the world's oral cancers. Oral cancer accounts for a third of all cancer deaths in India.
- Over 70% of the cases are diagnosed late due to reduced access to primary health centre (PHC) specialists.
- Two workshops (focussed on AI in oral cancer) were conducted in response to a call from the Ministry of Education for consortium proposals on AI for Health from higher education institutions.
- The IISc-led consortium is one of the four selected for support during the proof-of-concept Phase 1.
- Outcomes of Phase 1:
  - a white light imaging-based, mobile-phone based, AI tool for oral cancer screening for use at scale at the PHCs.
  - An application has been submitted for Class B certification for the Software as a Medical Device (SaMD), to ensure regulatory standards.
  - The open-sourced model and app will serve as digital public goods, fostering grassroot innovation in oral cancer screening.

Farmer Registration and Unified beneficiary InformaTion Systems (FRUITS)

- Work with the e-governance cell of the Government of Karnataka (GoK) to help develop solutions for muzzle print-based authentication of bovine animals (roughly around one crore).
- Technical advice to the AI/ML team at the Centre for e-Governance, GoK.
  - Feature design for robust muzzle print based authentication/identification
  - Design of experimental set up to evaluate solutions

Quality assessment (QA) of AI-generated images

- Multiple e-commerce companies use generative AI to display catalogue content, but the image quality is often poor, leading to poor user experience in online shopping.
- KIAC supported projects on this topic are being adapted to diverse domains such as e-commerce (for use by Flipkart) and virtual try-on (for use by SpreeAI) respectively.
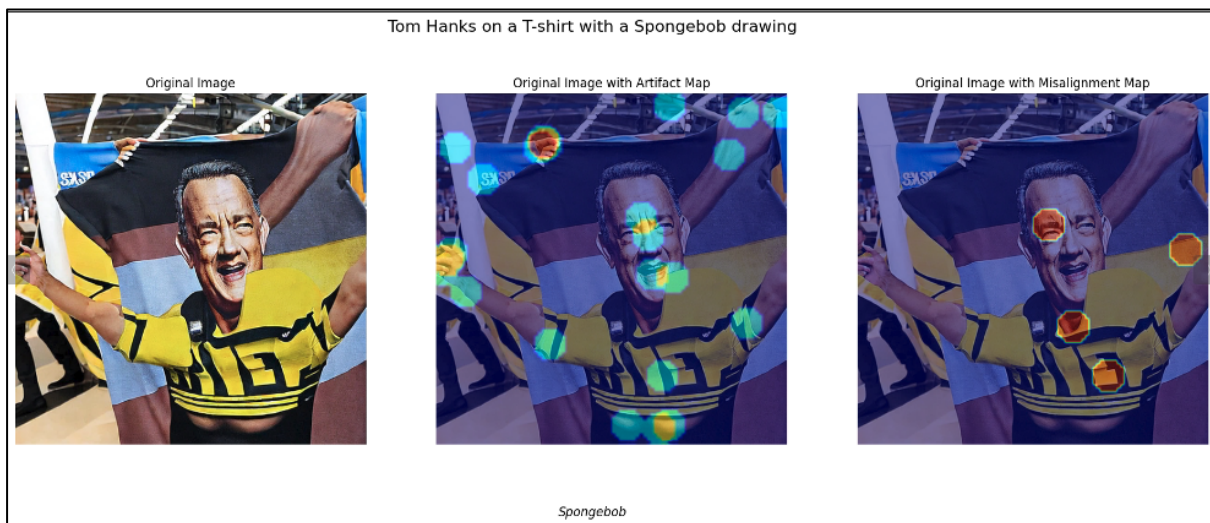

Picture credit: Liang et al., CVPR 2024

Activities and their impact

The beneficiaries and impact of the activities conducted by KIAC in this financial year (April 2024–March 2025) are presented in the table below.

ACTIVITY		BENEFICIARIES	OUTPUT INDICATORS
Student support	BTech scholarship	7	education, training human resources
	MTech scholarship	7	
	PhD scholarship	6	
Research support	Internship	17	training human resources, developing solutions for current global requirements
	Predoctoral fellowship	36	
	Postdoctoral fellowship	2	
Lectures, courses and training sessions (by KIAC faculty)	Courses for IISc students	386	education, teaching, skill development
	For persons from IISc and outside	3838	
KIAC distinguished seminar series	Seminars = 5	301	education, collaboration, outreach
Kotak IISc AI–ML talk series	Talks = 12	560	education, collaboration, outreach
Courses/training sessions/workshops/ events/competitions	Total number = 13	1852	skill development, education, capacity building
Support to present accepted papers at A*conferences	Conferences = 10	21	skill development, visibility, enabling publications in prestigious journals and participation in top-level conferences
		TOTAL BENEFICIARIES = 7033	

Testimonials
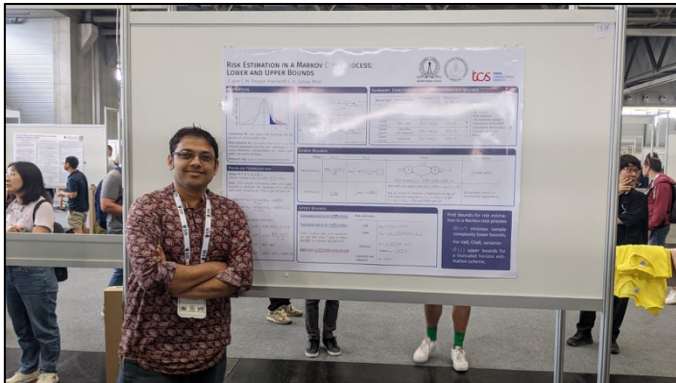
"I want to thank KIAC at IISc for their exceptional support in fostering high-quality research. The immediate availability of funding upon achieving an A* publication allows researchers like me to focus entirely on advancing our work without the constant worry of securing financial resources. The funding application and utilisation process is seamless and efficient, ensuring quick access to the resources needed to propel our research forward. This proactive approach significantly strengthens IISc's research ecosystem and inspires researchers to strive for excellence."

Gugan Thoppe, Assistant Professor, Indian Institute of Science
Support to present at the International Conference on Machine Learning (ICML 2024

"We are extremely grateful for the support of KIAC for supporting our research. The paper tackles an important problem of how well large language models handle false assumptions. (The short answer is not well enough). Through the KIAC travel support, the authors could present their findings to a large community of scholars, engineers, and practitioners."

Danish Pruthi, Assistant Professor, Indian Institute of Science
Support to present at the Findings of the Association for Computational Linguistics (ACL 2024)
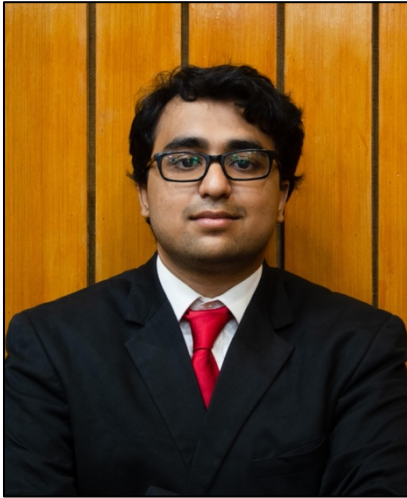
"The KIAC internship has been instrumental in advancing my understanding of robotics and artificial intelligence. It has provided me with hands-on experience in developing both manual and autonomous control methodologies, deepening my expertise in a real-world research environment. Working at IISc has allowed me to engage in state-of-the-art research in robotics, which has profoundly enhanced my technical capabilities and broadened my perspective on the future of robotics and intelligent systems."

Puneeth S
KIAC intern

"KIAC scholarship has provided me with the financial freedom to focus on research, allowing me to dive deeper into complex problems in machine learning and deep learning. It has also provided me access to high-end compute resources, which has helped facilitate my research endeavours, enabling me to develop novel solutions by leveraging state-of-the-art techniques and tools. I look forward to making impactful contributions to the field, thanks to the support and recognition from KIAC."

Priyam Dey
PhD scholarship awardee

"I would like to express my gratitude to KIAC for awarding me the predoctoral fellowship, which has significantly supported my research endeavours. This fellowship has not only allowed me to delve deeper into my research interests but has also helped me refine my goals for pursuing a Master's and PhD in the future. The numerous seminars and workshops organised by KIAC have been helpful in broadening my knowledge across various domains in AI and ML, as well as providing valuable networking opportunities with experts from both academia and industry."

Rishabh Sabharwal
KIAC predoctoral fellow

"Being a part of the Kotak IISc AI-ML Centre as a postdoctoral fellow has been an immensely rewarding experience. The fellowship has provided me with a unique opportunity to engage in cutting-edge research in a highly supportive academic environment. Access to world-class facilities, collaborative opportunities, and mentorship has significantly enhanced my research capabilities and professional growth. I am deeply grateful for the fellowship, which has played a pivotal role in my academic journey and continues to shape my aspirations for contributing meaningfully in my field."

Surbhi Shaw
KIAC postdoctoral fellow