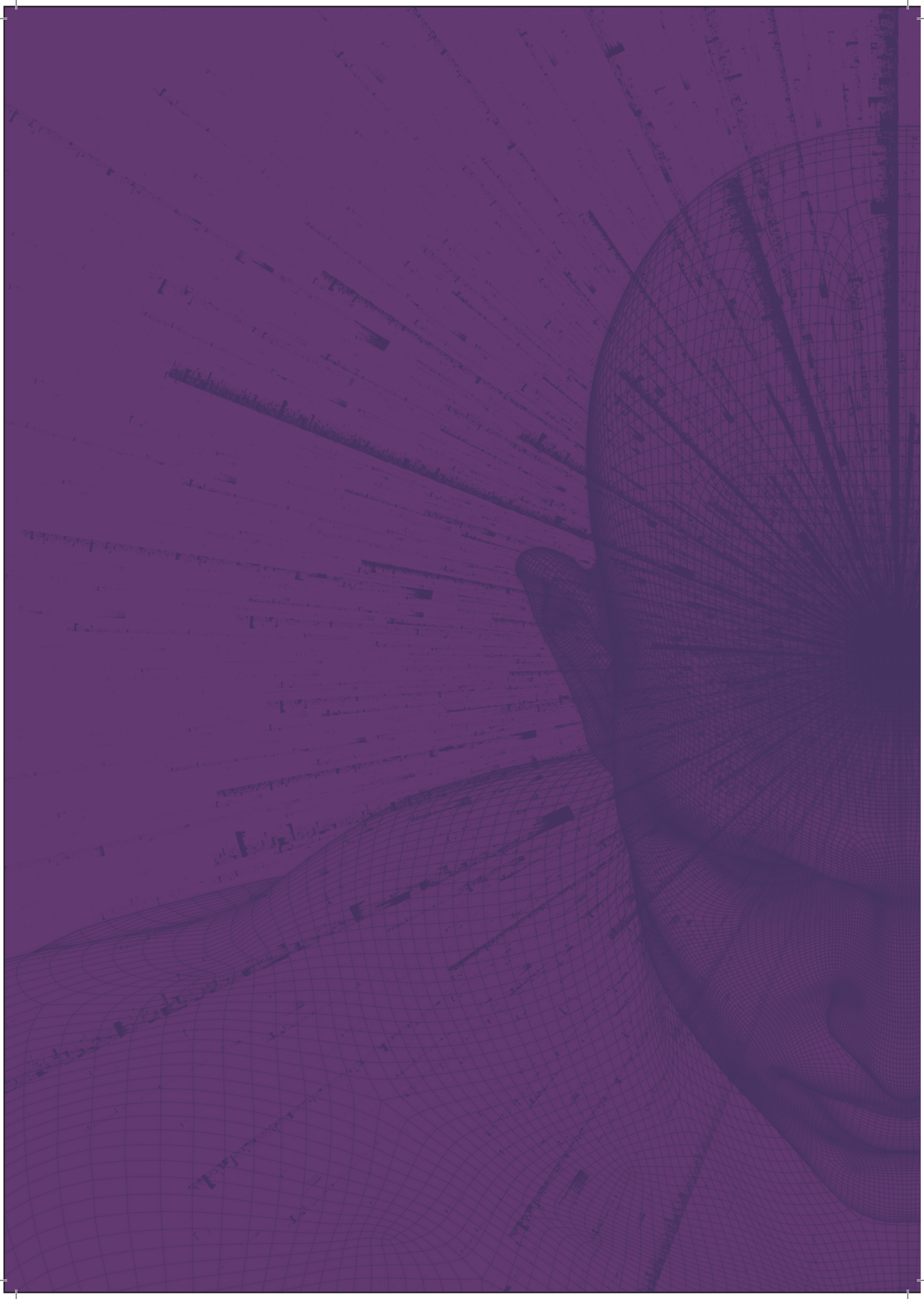
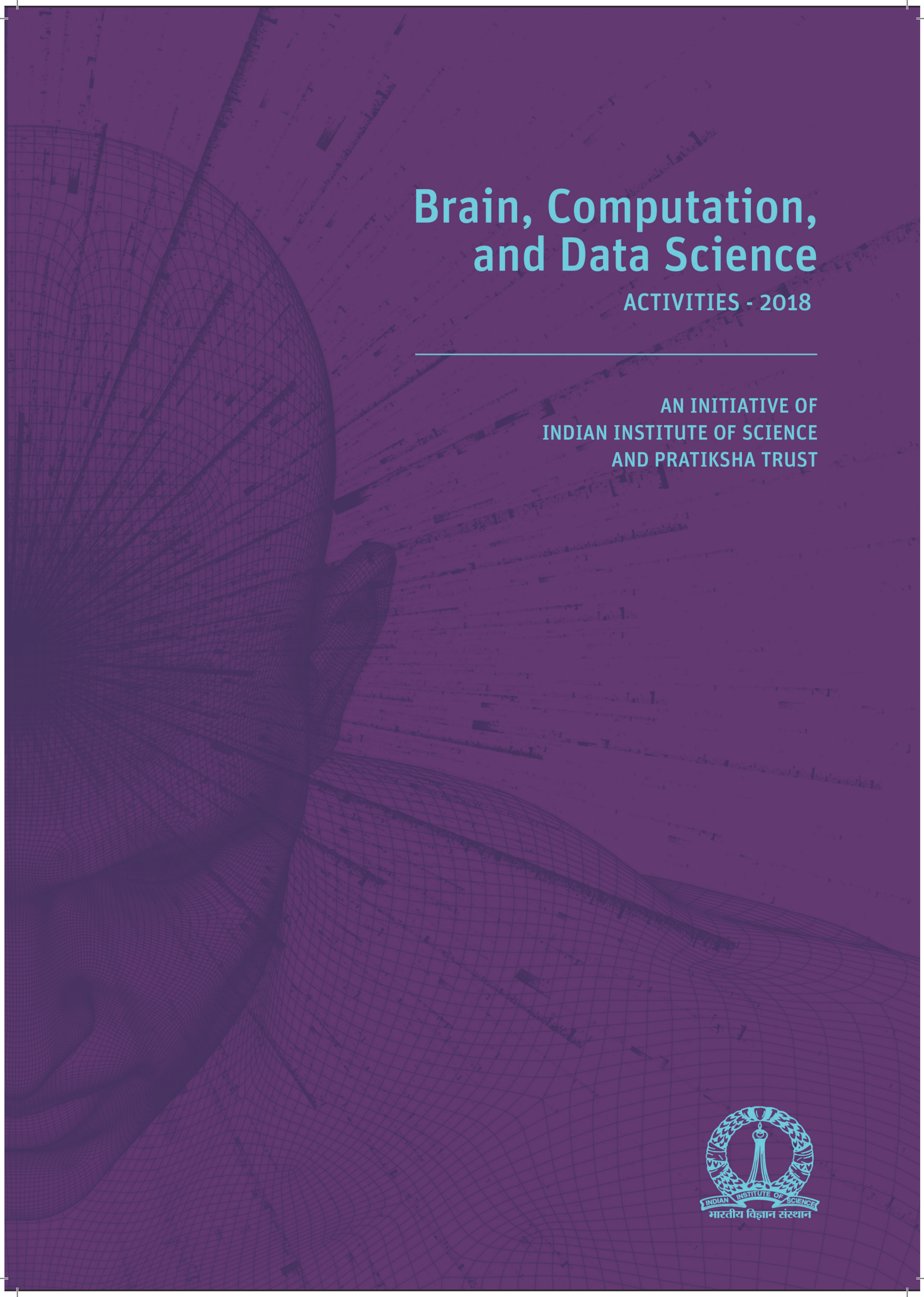
Brain, Computation, and Data Science

ACTIVITIES - 2018

AN INITIATIVE OF INDIAN INSTITUTE OF SCIENCE AND PRATIKSHA TRUST





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INDIAN INSTITUTE OF SCIENCE
भारतीय विज्ञान संस्थान

Contents

Overview

The Brain, Computation, and Data Science initiative is the brainchild of Mr. Kris Gopalakrishnan and Mrs. Sudha Gopalakrishnan, founders of the Pratiksha Trust, Bangalore. In June 2015, the Pratiksha Trust set up three Distinguished Chair Professorships at the Indian Institute of Science, Bangalore. The purpose of these Chair Professorships is to bring frontline researchers in the areas of neuromorphic computing, computational neuroscience, machine learning, and data science to the IISc campus to help strengthen research, and international collaboration in these important emerging areas. The mission of this initiative is to foster intense research collaboration leading to capacity building, ecosystem creation, and high impact research outcomes in brain, computation, and data science in IISc and India.

The participating departments and centres of IISc include:
Computer Science and Automation, Centre for Neuroscience, Electrical Communication Engineering, Electrical Engineering, Electronic Systems Engineering, Mathematics, Molecular Biophysics, and Computational and Data Science.

A parallel, complementary initiative has also been set up at the Indian Institute of Technology - Madras, Chennai, where also 3 chair professorships have been set up in this area.

This booklet provides a bird's eye view of the activities undertaken as a part of this wonderful initiative in IISc during 2018.

Research Areas

Computational Neuroscience

Neuromorphic Computing and Engineering

Data Science

Machine Learning

Brain Inspired Algorithms

Signal Processing

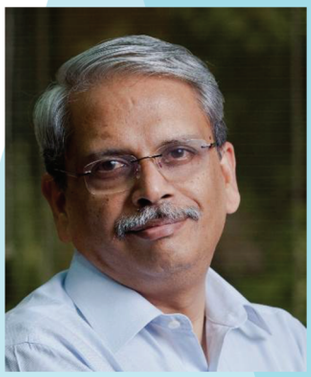
Image Analysis

From Director, IISc

"We are immensely grateful to Shri. Kris Gopalakrishnan and Smt. Sudha Gopalakrishnan for choosing the Indian Institute of Science for these generously endowed chair professorships. These chairs intend to invigorate and accelerate extremely important emerging interdisciplinary research areas. I am sure the chair professors will add a new dimension to research collaboration between IISc researchers and star contributors to these areas anywhere in the world."

Anurag Kumar
Director, Indian Institute of Science, Bangalore

From Pratiksha Trust Founders

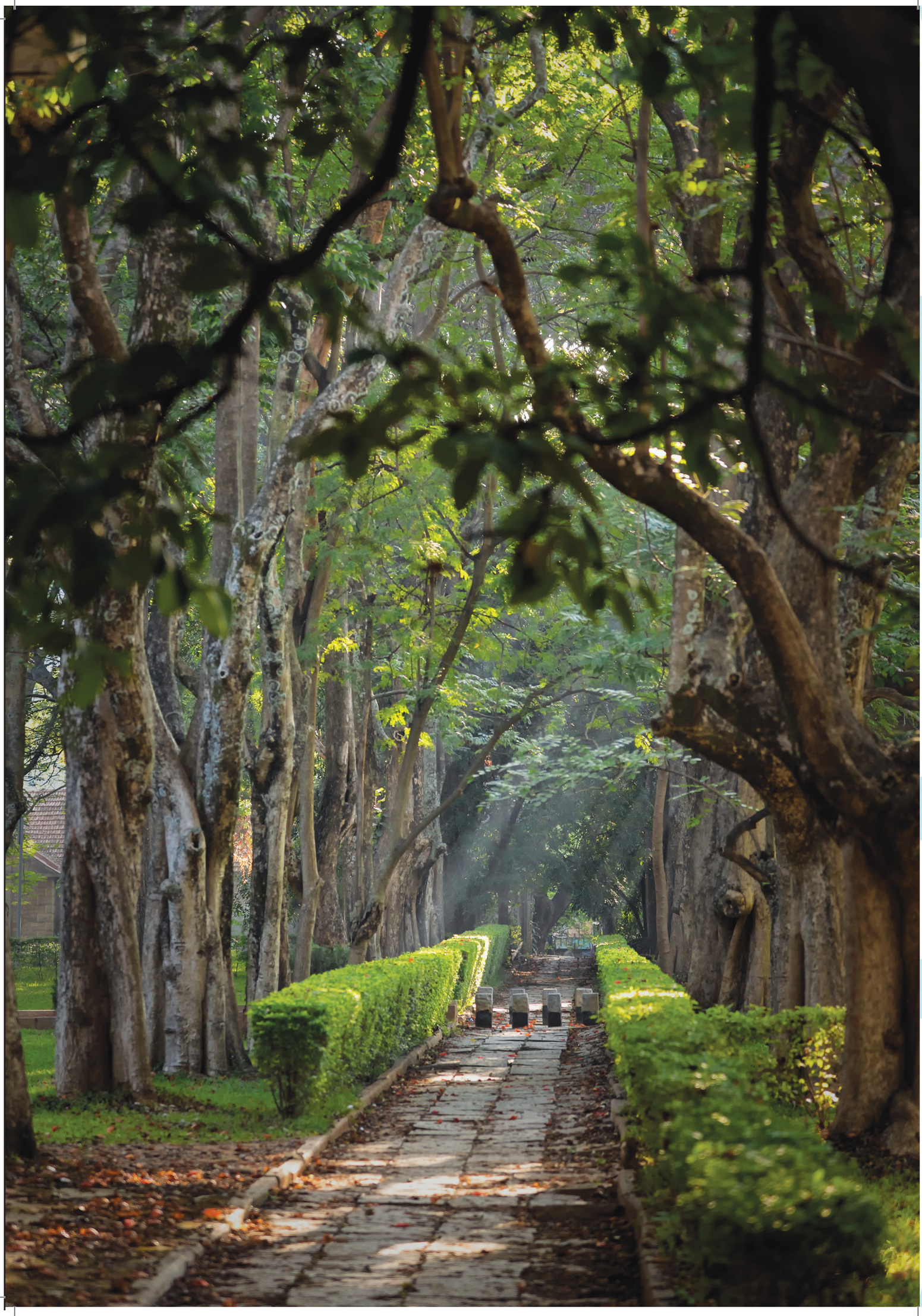


Kris Gopalakrishnan

Sudha Gopalakrishnan

"We hope the launching of these distinguished chair positions will help push the frontiers in brain inspired research. It would be excellent if the collaborations lead to highly creative new computing architectures and algorithms inspired by the functioning of the brain."

Kris Gopalakrishnan and Sudha Gopalakrishnan
Founders, Pratiksha Trust, Bangalore



The IISc Team

Admin Committee

K.V.S. Hari, ECE
Jayant Haritsa, CSA
Y. Narahari, CSA (convener)
G. Rangarajan, MATH
Vijayalakshmi Ravindranath, CNS
P.S. Sastry, EE

Scientific Advisory Committee

S. Bhatnagar, CSA
K.V.S. Hari, ECE
Aditya Murthy, CNS
M.N. Murty, CSA
Rishikesh Narayanan, MBU
P.S. Sastry, EE (Convener)
Rajesh Sundaresan, ECE

Faculty Team (Brain, Computation, and Data Science Group)

D. Ambedkar, CSA
Bharadwaj Amrutur, ECE
S.P. Arun, CNS
R. Venkatesh Babu, CD
Siddharth Barman, CSAS
Shalabh Bhatnagar, CSA
Arnab Bhattacharyya, CSA
Chiranjib Bhattacharyya, CSA
Anirban Chakraborty, CDS
Sridharan Devarajan, CNS
Sriram Ganapathy, EE
Santanu Mahapatra, ESE
Prasanta Kumar Ghosh, EE
K.V.S. Hari, ECE
Aditya Murthy, CNS
Chandra Murthy, ECE
Rishikesh Narayanan, MBU
Hardik Pandya, ESE
T.V. Prabhakar, ESE
A.G. Ramakrishnan, EE
Supratim Ray, CNSP.S. Sastry, EE
Chandra Sekhar Seelamantula, EE
Shirish Shevade, CSA
S.K. Sikdar, MBU
Yogesh Simmhan, CDS
T.V. Sreenivas, ECE
Shayan G. Srinivasa, ESE
Mayank Srivastava, ESE
Rajesh Sundaresan, ECE
Partha Talukdar, CDS
Chetan Singh Thakur, ESE
Phaneendra Yalavarthy, CDS
and
all other interested
faculty members

Pratiksha Trust Distinguished Chairs at IISc

Shri K. Vaidyanathan Distinguished Chair

Professor Shihab Shamma

Professor, Institute of Systems Research
University of Maryland

Education

BS – Imperial College - 1976
MS – Stanford University - 1977
Ph.D. – Stanford University - 1980

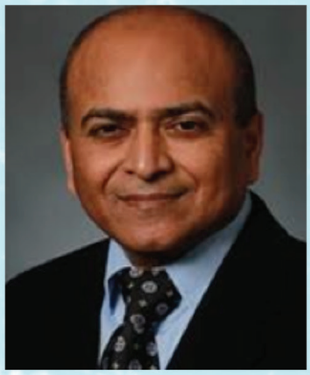
Expertise

Speech models of brain
Neural signal processing
Computational neuroscience
Robust control systems
Neuromorphic engineering

Awards and Distinctions

Fellow, IEEE
Fellow, Acoustical Society of USA
ISR Outstanding Faculty Award
NIH Advisory Board
Blaise Pascal Intl. Research Chair

Smt. Sudha Murty Distinguished Chair



Professor Vasant Honavar

Professor, Pennsylvania State University
Director: Center for Big Data Analytics
Director: Artificial Intelligence Research Laboratory

Education

BE – BMS College, Bangalore, 1982
MS – Drexel, 1984
MS, PhD – Wisconsin, Madison, 1990

Expertise

Artificial Intelligence
Machine Learning
Knowledge Representation
Bioinformatics
Data Science
Health Informatics Neurocomputing

Awards and Distinctions

National Science Foundation Director's Award for Superior Accomplishment
Edward Frymoyer Endowed Professorship
CRA Computing Community Consortium Council Member
Iowa State Univ. Regents Award For Faculty Excellence
Univ. Wisconsin ECE 125 People of Impact

Pratiksha Trust Distinguished Chair Professor

Professor Christos Papadimitriou

Donovan Family Professor of Computer Science
Columbia University, New York, USA

Education

B.S Athens Polytechnic, 1972
MS Princeton University, 1974
Ph.D., Princeton University, 1976

Expertise

Theory of algorithms and complexity, and its applications to optimization, databases, control, AI, robotics, economics and game theory, the Internet, evolution, and the brain

Awards and Distinctions

Member of National Academy of Sciences, USA
Member of National Academy of Engineering, USA
Member, American Academy of Arts and Sciences
Knuth Prize, Gödel Prize
von Neumann Medal
Kalai prize for CS in Game Theory
EATCS Award (European Association for Theoretical Computer Science)
Author of Novels: "Turing", " Logicomix" and "Independence"
Honorary Doctorates from Nine Universities

Pratiksha Trust Distinguished Chairs at IIT-Madras

Prof. H.N. Mahabala Chair

Prof. Partha Mitra
Cold Spring Harbor Lab

Dr. N.R.Narayana Murthy Chair

Prof. Mriganka Sur
Massachusetts Institute of Technology

Prof. Muthukrishnan Chair

Prof. Anand Raghunathan
Purdue University

Research Highlights

Research Highlights

Degeneracy in the concomitant emergence of place cell responses and intrinsic neuronal properties

A common thread across neuroscience research is on the deterministic one-to-one relationship between components that mediate a function and the function itself. However, there is strong evidence that this relationship is many-to-many where disparate structural components result in similar function. This degeneracy, as it has been called, may manifest across different animals (or cells, or networks as the case might be) or in the same animal at different time points. This constitutes a broad framework that encompasses heterogeneity, variability and plasticity in biological systems, and something that has been absent in artificial learning systems that try and emulate biological systems. The Cellular neurophysiology laboratory has been adding lines of evidence to demonstrate the expression of degeneracy in the hippocampal formation, a key mammalian brain region involved in learning and memory. We postulate that biological complexity, involving interactions among the numerous parameters spanning different scales of analysis, could establish disparate routes towards accomplishing the conjoint goals of encoding and homeostasis in the hippocampal formation. These disparate routes then provide several degrees of freedom to the encoding-homeostasis system in accomplishing its tasks in an input- and state-dependent manner.

This constitutes a specific instance of degeneracy in neural coding, where the encoding assessed was tuning of place cell properties and homeostasis was with reference to intrinsic neuronal properties. The top left panel shows five

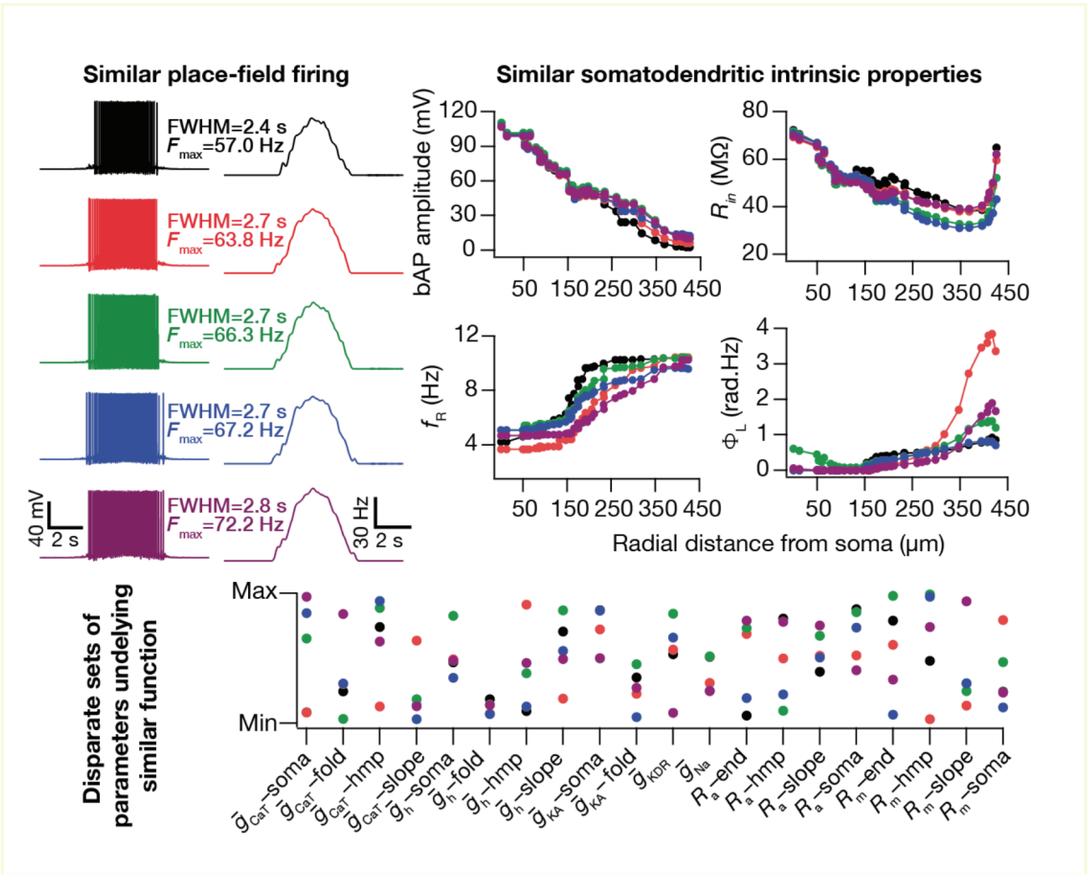


Fig. 1. Degeneracy: the ability of elements that are structurally different to perform the same function or yield the same output

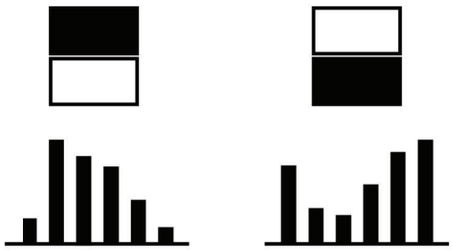
uniquely color-coded models showing very similar firing properties and firing rates that encode a specific place field location. The top right panel shows the same five models with the same color code showing very similar intrinsic properties, varying very similarly as functions of distance from the cell body. The bottom panel shows the parametric combinations that resulted in these similar models, with the same color coding continued. It may be observed that disparate combinations of parameters yield similar place-cell firing and similar intrinsic properties.

Faculty Member: **Rishikesh Narayanan (MBU)**

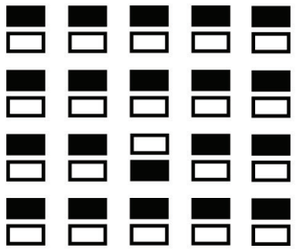
Rathour RK and Narayanan R, Homeostasis of functional maps in active dendrites emerges in the absence of individual channelostasis, *Proceedings of the National Academy of Sciences (USA)*, 2014.

Basak R and Narayanan R, Spatially dispersed synapses yield sharply-tuned place cell responses through dendritic spike initiation, *The Journal of Physiology (London)*, 2018.

Neural dissimilarity indices that predict oddball detection in behaviour



Firing rates of 6 neurons to two images in the monkey inferotemporal cortex.

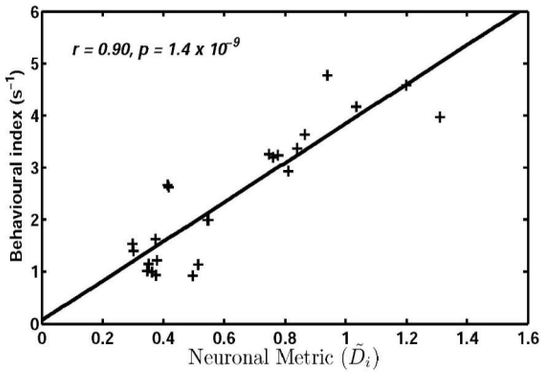


Do they predict the time taken by human subjects to find the oddball item?

How do we search for the oddball target using noisy neural firing in the brain?

Model search as a Markov decision problem.

A principled approach to optimal decisions under uncertainty.
- Optimal strategy to employ scarce attention resources.
- When to stop.
- Learn just enough to locate the oddball.



How different are the representations of two images in our brains? Understanding this will, for one, enable us to program machines to recognise objects and faces as well as we do.

Neuroscientists have two ways of telling how different are the representations of objects in our brains.
a) They obtain firing patterns in the inferotemporal cortex of macaque monkeys in response to object stimuli. The inferotemporal cortex is a region at the base of the brain where gross object features emerge. The more different these patterns, the greater the distance between the objects.
b) They perform behavioural experiments involving search. Subjects are presented with a picture with many objects of the first type and exactly one oddball of the second type. The inverse of the time taken (denoted by the letter s) is a measure of the distance between the objects.

What is the appropriate ‘distance’ between the two firing pattern profiles? Does it correlate well with the behavioural experiments?

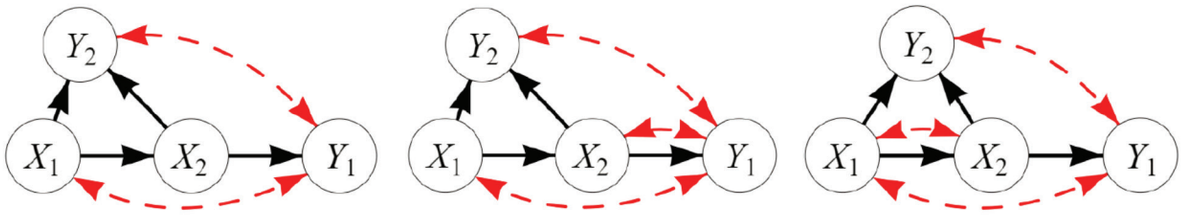
A neuroscientist and two electrical engineers have teamed up to model the way we search in resource constrained settings. They have used Markov decision theory, a framework that provides a principled way to make optimal decisions in the face of uncertainty. At each stage, one can obtain a near optimal strategy to employ scarce attention resources that tell where to focus on the picture, and decide if one has gained enough confidence to tell where the oddball is located and stop. For optimality, all of these need to be done by learning “just enough” about the two objects; just enough to meet the goal of telling where the oddball is located.

The plot shows a remarkable correlation between the pairwise distances of objects from the firing pattern data on 174 neurons (x-axis) and the pairwise distances of objects obtained from behavioural experiments on humans (y-axis). The distances are inverses of the average search times. The data is for twenty four pairs (denoted +).

The framework is applicable in a wide variety of search tasks which neuroscientists often design for their behavioural experiments. The paper has been recently published in the IEEE Transactions on Information Theory.

Faculty Members: **S P Arun (CNS and ECE) and**
Rajesh Sundaresan (ECE and RBCCPS)
Publication : IEEE Transactions on Information Theory, August 2017
Authors : N. K. Vaidhiyan (Ph.D. student, ECE), S. P. Arun, R. Sundaresan

What is the smallest number of probes needed to learn a system of causally interacting variables?



(a) Causal graph H (b) Causal Graph H' (c) Causal Graph H''

Variables : X_1 – Smoking, X_2 – Alcohol Consumption, Y_1 – Depression, Y_2–Sleep Disorder

Stochastic causal relationships

May exist unobservable confounders (dashed bidirected arcs in figure)

Directed acyclic causal graph known

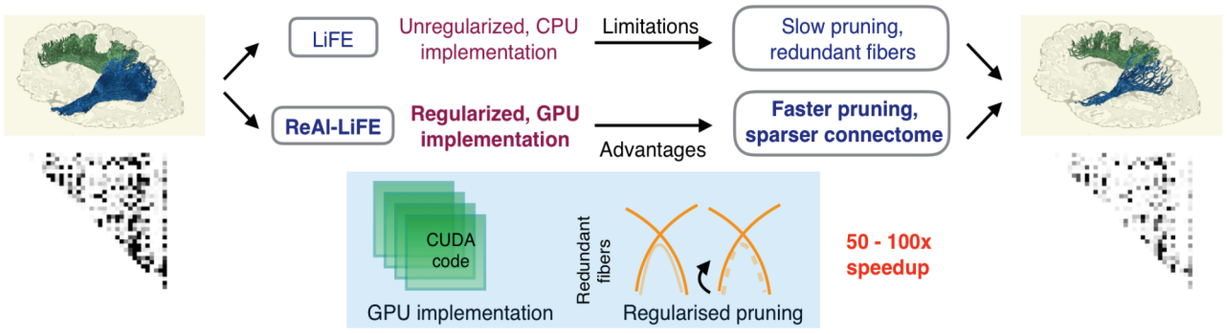
“Probe”: intervention, i.e., setting a subset of variables to fixed values

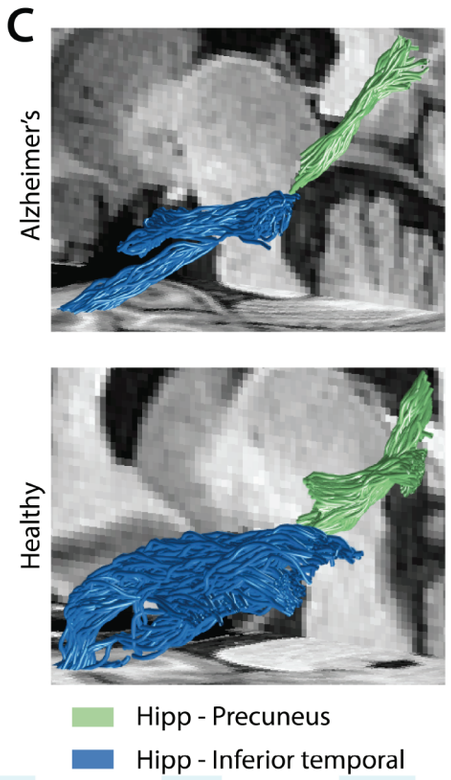
Our contribution: An algorithm to compute a minimal set of interventions that suffices to identify any causal effect in the system. The running time is polynomial if causal graph is of bounded degree and C-component size.

Faculty Member: **Arnab Bhattacharyya (CSA)**

Publication: “Minimal Intervention Cover of a Causal Graph” by Saravanan Kandasamy, Arnab Bhattacharyya, and Vasant Honavar. *33rd AAAI Conference on Artificial Intelligence. January 2019 (Honolulu, USA)*

ReAl-LiFE: Evaluating human brain connectomes





ReAl-LiFE: Regularized, Accelerated Linear Fascicle Evaluation algorithm

Impact:
We have developed a technique that enables rapid evaluation of human brain connectomes on GPUs.

Our technique achieves up to100x speedups over conventional CPU implementations.

With these speedups, we analyze a large corpus of data from Alzheimers disease patients, and discover characteristic neuropathological connectivity signatures of AD.

One of 1150 accepted papers among 7,700 submissions (~15% acceptance rate) to AAAI 2019.

Faculty Members: **Partha Talukdar (CDS and CSA) and Sridharan Devarajan (CNS and CSA)**

Sawan Kumar, Varsha Sreenivasan, Partha Talukdar, Franco Pestilli, Devarajan Sridharan. *ReAl-LiFE: Accelerating the discovery of individualized brain connectomes on GPUs. 33rd AAAI Conference on Artificial Intelligence. January 2019 (Honolulu, USA)*

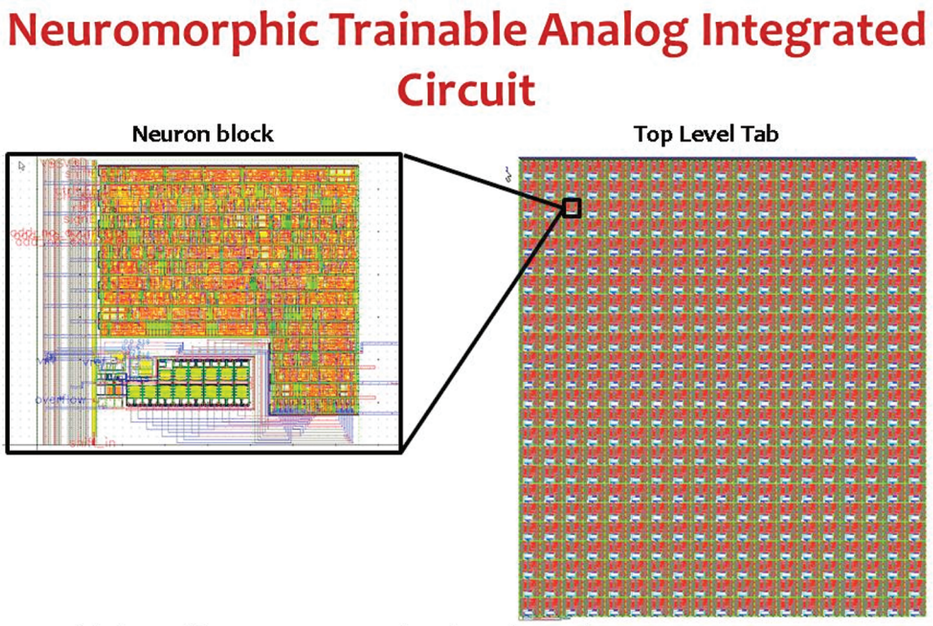
Red induces strong gamma oscillations in the brain

What changes inside the brain when one sees a colourful flower as opposed to a grayscale version of it? How do the brain signals change when one sees a green jackfruit versus a red tomato? Does the redness of the tomato matter? We studied such questions by recording signals from the primary visual cortex (an area of brain involved in visual processing) of monkeys while they were shown various natural images. To our surprise, we found that there were strong oscillations in the recorded signals at frequencies in the range 30-80 Hz whenever reddish images were shown. Oscillations in this range are traditionally known as gamma oscillations and have been previously linked to functions such as attention, working memory and meditation. To investigate this further, we presented uniform colour stimuli of different hues and found that gamma was indeed sensitive to the hue of the colour, with reddish hues generating the strongest gamma. In the visual cortex, gamma has been known to be induced strongly by gratings (alternating black and white stripes), but the gamma generated by colour stimuli was even stronger, almost 10-fold in some cases. The magnitude of gamma depended on the purity of the colour but not so much on the overall brightness. Importantly, it was related to a particular mechanism by which colour signals received by the retinal cone receptors are processed in the brain. These findings provide new insights about the generation of gamma oscillations and processing of colour in the brain.

Faculty Member: **Supratim Ray (CNS and EE)**

Publication: Vinay Shirhatti and Supratim Ray (2018). Long-wavelength (reddish) hues induce unusually large gamma oscillations in the primate primary visual cortex. PNAS, April 9, 2018. 201717334

An Analogue Neuromorphic Co-Processor That Utilizes Device Mismatch for Learning Applications



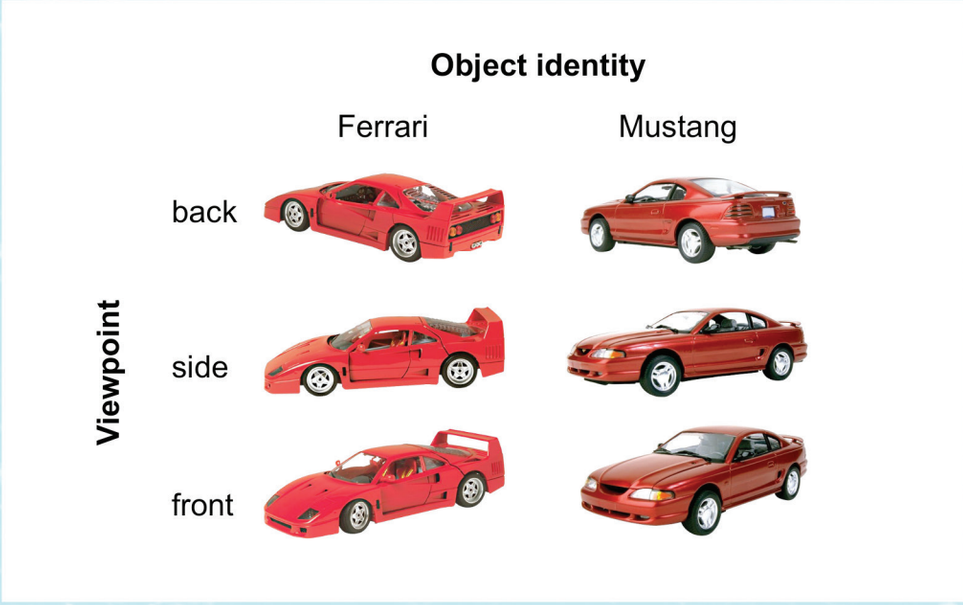
TAB IC fabricated in TSMC65nm technology (1 mm^2)
Total 456 neurons.

As the integrated circuit (IC) technology advances into smaller nanometre feature sizes, a fixed-error noise known as device mismatch is introduced owing to the dissimilarity between transistors, and this degrades the accuracy of analog circuits. We present an analog co-processor that uses this fixed-pattern noise to its advantage to perform complex computation. This circuit is an extension of our previously published train- able analogue block (TAB) framework and uses multiple inputs that substantially increase functionality. We present measurement results of our two-input analogue co-processor built using a 130-nm process technology and show its learning capabilities for regression and classification tasks.

Faculty Member: **Chetan Singh Thakur (ESE)**

Publication: Thakur, C. S., Wang, R., Hamilton, T. J., Tapson, J., R. Etienne-Cummings & van Schaik, A. (2017). An Analogue Neuromorphic Co-processor that Utilises Device Mismatch for Learning Applications. IEEE Transactions on Circuits and Systems I (TCAS-I)

Multiplicative mixing of object identity and image attributes in single inferior temporal neurons

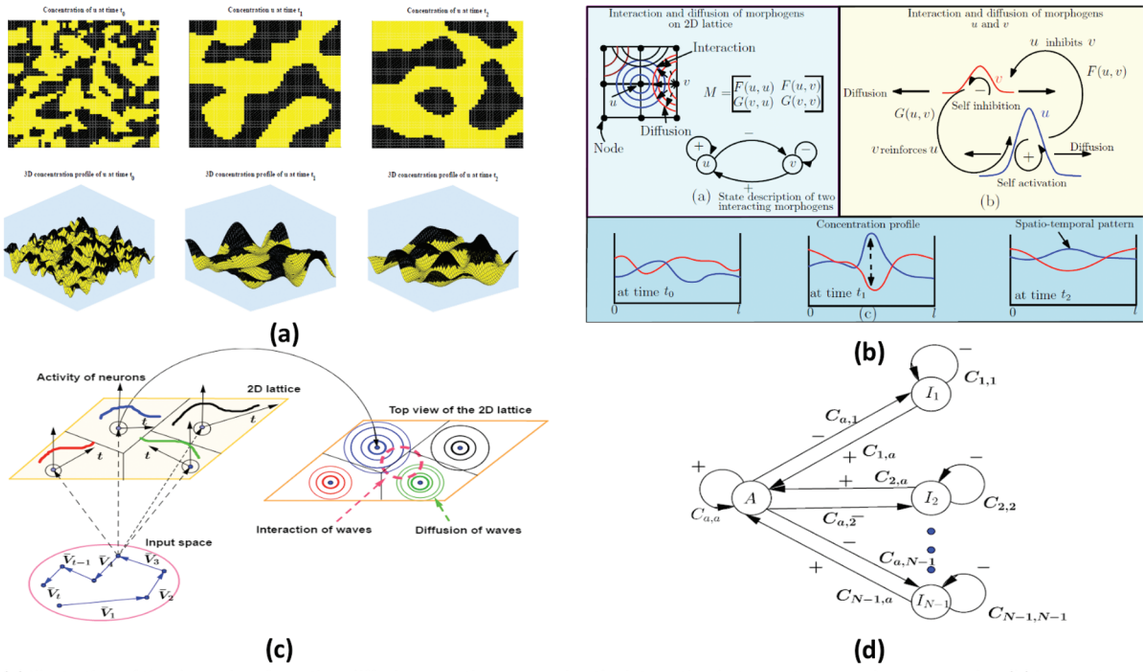


Knowing a Ferrari from a Mustang from an image can be hard because one has to detect their unique features while ignoring large image variations due to changes in view, size, position etc. Successful recognition requires both object identity and image attributes to be represented efficiently but precisely how the brain does it has been unclear. Recent work from our lab has shown that single neurons in high-level visual areas combine these two signals by multiplying rather than adding them, and that doing so enables efficent decoding of both signals

Faculty Member: **SP Arun (CNS and ECE)**

Publication: Ratan Murty NA & Arun SP, (2018), Multiplicative mixing of object identity and image attributes in single inferior temporal neurons., Proceedings of the National Academy of Sciences (PNAS).

Temporal Self-Organization: A Reaction-diffusion Framework for Spatio-temporal Memories

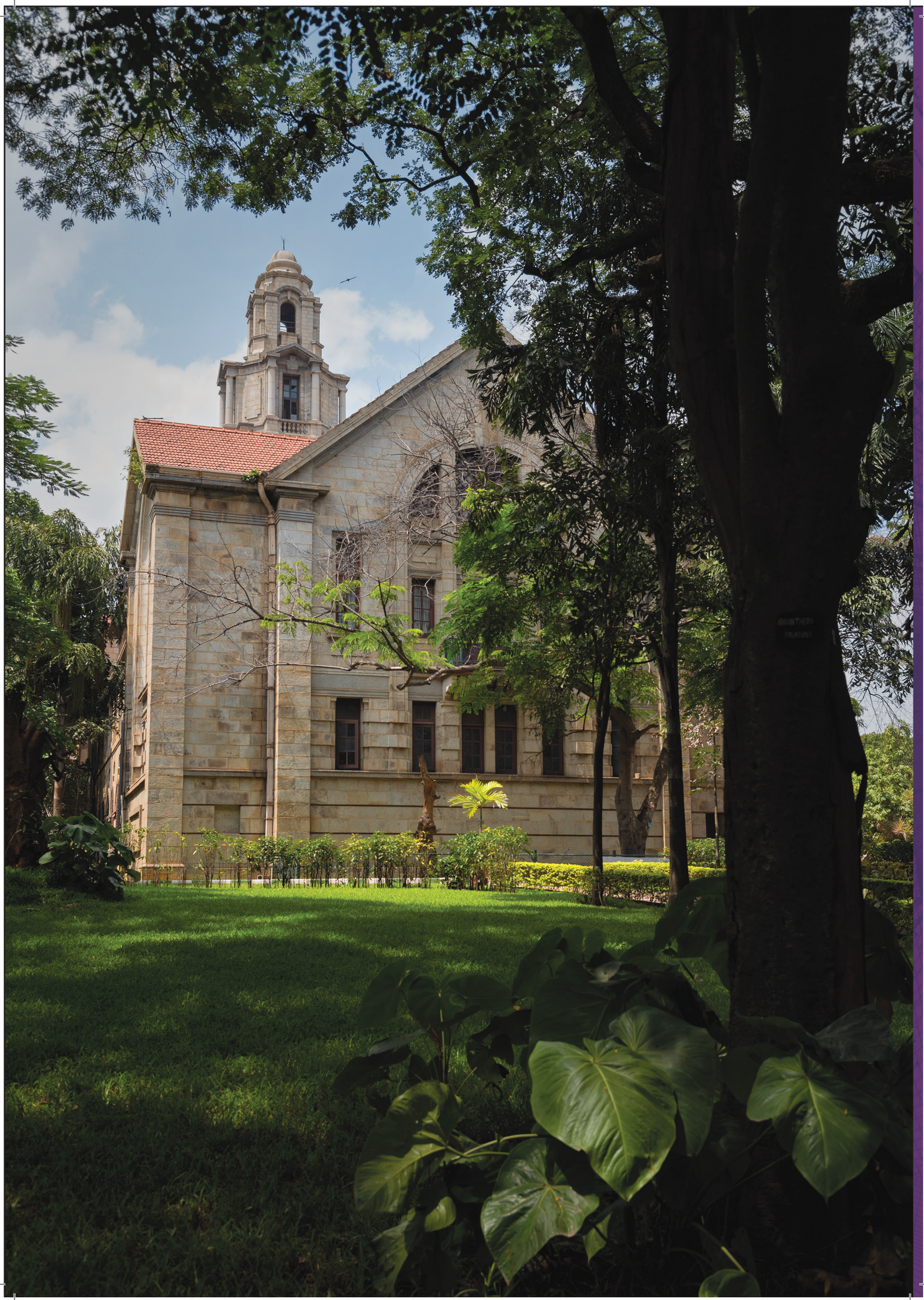


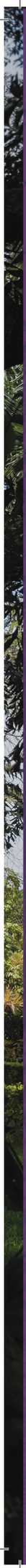
(a) Illustration of the dynamics of reaction-diffusion equations governing the interaction between two morphogens *u* and *v*. (b) Interaction and diffusion of morphogens on a 2D lattice. (c) The top view of the 2D lattice showing the activity waves (d) Competitive-cooperative model for the neurons.

Self-organizing maps find numerous applications in learning, clustering and recalling spatial input patterns. The traditional approach in learning spatio-temporal patterns is to incorporate time on the output space of a self-organizing map along with heuristic update rules that work well in practice. Inspired by the pioneering work of Alan Turing, who used reaction-diffusion equations to explain spatial pattern formation, we develop an analogous theoretical model for a spatio-temporal memory to learn and recall temporal patterns. The simulation results show that the proposed algorithm outperforms the self-organizing maps with temporal activity diffusion (SOMTAD), neural gas with temporal activity diffusion (GASTAD) and spatio-temporal map formation based on a potential function (STMPF) in the presence of correlated noise for the same data set and similar training conditions

Faculty Member: **Shayan Garani Srinivasa (ESE)**

Publication: P. Gowgi and S. S. Garani, Temporal Self-Organization: A Reaction-Diffusion Framework for Spatiotemporal Memories, in IEEE Trans. on Neural Netw. and Learning Syst., Jul. 2018.





Events Organized

The Second Workshop on Brain Computation and Learning (BCL 2018)

Computational approaches to understanding brain function constitute an important and growing area of interdisciplinary research. These approaches and associated techniques have acted as a melting pot for researchers from disparate disciplines to come together and address one of the grandest challenges of the 21st century, namely, understanding brain function. The grandness of the challenge and the requirement on diverse forms of expertise has deemed that such endeavours require synergistic interactions among neurobiologists and computer scientists.

The Brain, Computation and Learning (BCL) workshop series is started with the objective of promoting and nurturing such synergistic interactions between neurobiologists, computer scientists and electrical engineers. The workshops are aimed at motivating young researchers in India in these areas through talks and discussions with experts in these areas from India and abroad. The workshop also helps researchers in one area to get exposed to concepts and methodologies of other areas.

The second workshop in this series is held during 8-12 January, 2018 at the Faculty hall of Indian Institute of Science. This series of workshops is made possible by generous funding from Pratiksha Trust, which has been significantly promoting fundamental and translational research at the interface of neuroscience and computer science within the country.

The workshop saw participation of senior researchers from USA, UK, Germany, France, Australia and India. The speakers at the workshop include: Shantanu Chakrabarty, Washington University, St.Lois; Jonathan Fritz, University of Maryland, USA; Vasant Hanovar, Pennsylvania State University, USA; Mark Liberman, University of Pennsylvania, USA; Mayank Mehta, UCLA, USA; Samuel Norman-Haignere, Ecole Normal Superieure, France; Christos papadimitriou, Columbia University, USA; Manish Sahani, UCL, UK; Andre Van Schaik, Western Sydney University, Australia; Shihab Shamma, University of Maryland, USA; Patrick van der Smagt, Volkswagen Labs, Germany; Shalabh Bhatnagar, IISc; Srinivasa Chakravarthy, IIT, Madras; Sumantra Chatterjee, NCBS, Bangalore; Sriram Ganapathy, IISc; Joby Joseph, University of Hyderabad; Ravi Kannan, MSRI, Bangalore; Aditya Murthy, IISc; Supratim Ray, IISc; Rajesh Sundaresan, IISc; Prasanta Ghosh, IISc.

About two hundred students (selected from over 400 applicants) from all over India attended the workshop. In addition, about twenty faculty members from different institutions in India also participated in the workshop. Due to the generous funding from Pratiksha trust, all the participants were provided with free accommodation. The workshop provided an oppurtunity for young researchers to understand the diverse themes of brain research and to appreciate the close relationships that are developing between neuroscience and computer science. The workshop also featured some poster sessions by students from IISc and also some lab/demo sessions. From the feedback received from the participants, most of them felt that they benefitted a lot from the workshop.

IBRO-APRC School on Cognitive Neuroscience and 5th Bangalore Cognition Workshop (Co-Sponsored by Pratiksha Trust, Bangalore)

The 5th Bangalore Cognition Workshop was organized at IISc Bangalore from June 19 – 29th June, 2016. The workshop was organized in four modules: (1) Vision, (2) Attention: Signal at Multiple Scales (3) Motor Module (4) Memory and Space. The goal of the workshop was to promote systems and cognitive neuroscience in India by bringing together eminent neuroscientists in India and from around the world (Continental America, Europe, Asia) to teach prospective and present graduate students of all disciplines and share their research. Participants for the workshop were undergraduate, Masters, PhD students as well as postdocs, clinicians and faculty, from colleges all across India.

The Vision and Motor module lasted for 2 days each while the Attention module as well as Memory and Space module lasted for 3 days each. These modules had multiple lecture sessions (7 or 11) of 90 minutes each, with plenty of interspersed breaks to give time for discussions. In addition, there were multiple poster sessions were the participants presented their ongoing research. The presentations were arranged such that they can be viewed and presented during the lunch and tea break to encourage prolonged discussions of the participants with the resource persons. Each module ended with a final session of a panel discussion between all the speakers of the module and the students about the outstanding questions in the field. In addition, there were 4 lab sessions of half a day duration on (1) Psychophysics (Vision), (2) EEG and (3) fMRI where the students were given hands on training on different techniques used in cognitive sciences. The workshop was attended by 46 participants (41 outstation, 5 local) from colleges all over India, in addition to the student population at the Centre for Neuroscience and the IISc student community in general.

As part of the memory and space module there a public lecture was organized, and it was very well attended. Prof. Michael Fanselow from UCLA spoke on “Fear, Memory and Brain”. The notice for the public lecture is enclosed (Annexure II).

Informal feedback conducted at the end of the workshop revealed that participants had extremely positive reviews of the workshop. The feedback from workshop speakers was also outstanding, with many speakers appreciating the interactive nature of the students and added how they enjoyed their discussion with students. In short the workshop successfully achieved its primary goal of promoting systems and cognitive neuroscience in India. Finally many scientific interactions between the Indian and US speakers have the potential to become longer-term collaborations. The program had a pre-conference lectures given by the resident resource persons of the CNS to introduce the participants to the basics of cognitive neuroscience.

IBRO-APRC School on Cognitive Neuroscience:
5th Cognition Workshop 2018
Schedule

Introductory Lectures | 17th June

SP Arun | Supratim Ray | Shridhar Devarajan

Lunch

Aditya Murthy | Sachin Deshmukh | Balaji Jayaprakash

Daily Schedule Timeline

0900-1030 Session1 | 1100-1230 Session 2 | 1400-1530 Session 3 | 1600-1730 Session 4 | 1730-1830 Discussion

Vision Module

18 June

Shrikant Bharadwaj | L V Prasad Eye Institute
Tom Albright | Salk Institute
Rufin Vogels | University of Leuven
Winrich Freiwald | Rockefeller University

19 June

Kalanit Grill-Spector | Stanford University
Marius Peelen | Donders Institute for Brain
SP Arun | IISc
Panel Discussion

Motor Module

25 June

John Rothwell | University College, London
Pratik Mutha | IIT Gandhinagar
Shyam Diwaker | Amrita Vishwa Vidyapeetham
Pramod Pal | NIMHANS

26 June

Bapi Raju | IIIT,Hyderabad
Jeff Schall | Vanderbilt University
Aditya Murthy | IISc
Theresa Desrochers | Brown University
Panel Discussion

Lab Sessions

23rd June | Supratim Ray {EEG} | Shridhar Devarajan {MRI}
24th June | SP Arun {Vision}

Attention: Signal at Multiple Scales

20 June

Chris Moore | Brown University
Stefan Treue | German Primate Center
Matt Smith | University of Pittsburgh
Supratim Ray | IISc

21 June

Dipanjan Roy | NBRC
Theresa Desrochers | Brown University
Simon Kelly | University College Dublin
Carlo Miniussi | University of Trento

22 June

Narayanan Srinivasan | CBCS, Allahabad
Sridhar Devarajan | IISc
Simon Kelly | University College Dublin
Panel Discussion

Memory & Space Module

27 June

Barbara Knowlten | UCLA
Collins Assisi | IISER Pune
Rishikesh Narayanan | IISc

28 June

Yoganarashimha Doreswamy | NBRC
Upinder Bhalla | NCBS
Kaori Takehara-Nishiuchi | Univ of Toronto
Kyriaki Sidiropoulou | University of Crete

29 June

Cliff Kentros | Kavli Inst. for Systems Neurosci.
Balaji Jayaprakash | IISc
Sachin Deshmukh | IISc
Michael Fanselow | UCLA
Panel Discussion

Public Lecture by Michael Fanselow , Faculty Hall, IISc, 27th June 16:00- 1730 hrs

IBRO International Brain Research Organization | IUSSTF | Pratiksha Trust | BROADCOM connecting everything

Designed by: Vikram Pal Singh, CNS, IISc


IBRO-APRS School on Cognitive Neuroscience
5th COGNITION WORKSHOP-2018
IBRO
Pratiksha Trust
BROADCOM

A Report on the IISc-UCL workshop held during July 2018

A joint IISc-UCL workshop on the themes of Systems Neuroscience, Machine Learning and Artificial Intelligence was held during 8-10 July 2018 at the University College London (UCL). The workshop was organized by Prof. Maneesh Sahani, Director, Gatsby Computational Neuroscience Unit, University College London. The workshop had presentations by nine faculty members from IISc and ten from UCL. The travel and stay of IISc faculty was borne by the UCL. The financial support for the workshop is mainly provided by the UCL Global Engagement Office and Gatsby Computational Neuroscience Unit, UCL. Prof. Manish Sahani's interaction with IISc faculty in these areas started when he attended a workshop organized under Pratiksha Initiatives in 2016. He has also attended the workshopn on Brain, Computation and learning organized at IISc in Jan 2017 as well as in Jan 2018. The exchange of ideas during these visits is what motivated the Gatsby Computational Unit at UCL to organize this workshop and invite the IISc team.

The objective of the workshop is to foster better research collaboration in Machine Learning and Computational Neuroscience between IIsc and UCL. The workshop provided an oppurtunity for researchers in the two Institutions to exchange information about their current research and to explore possibilities of collaboration.

The participants from IIsc are: Dr. Chiranjib Bhattacharyya, Dr. Chetan Singh Thakur, Dr.Prasanta Ghosh, Dr. Sriram Ganapathy, Dr.Partha Talukdar and Dr. P.S. Sastry on the ML side; and Dr. Rishikesh Narayanan, Dr. Supratim Ray, Dr. Sridharan Devarajan on the Neuroscience side.

The participants from UCL are: Dr. Arthur Gretten, Dr. John Shawn-Taylor, Dr. David Barber, Dr. Lewis Griffin, and Dr. Mark Huckvale on the ML side; and Dr. Maneesh Sahani, Dr. Maria Chait, Dr. Nilli Lavie, Dr. Tom Otis, and Dr. Nick Lessica on the neuroscience side. The workshop has resulted in interesting exchange of ideas and some possibilities for pursuing a couple of joint research projects are currently being explored.

Research Colloboration Meeting
Indian Institute of Science, Bangalore, India
And
Western Sydney University, Australia
November 30, 2019

The Indian Institute of Science (IISc), Bangalore, and Western Sydney University (WSU), Australia signed a Memorandum of Understanding (MoU) for expanding their ongoing partnership to support cutting-edge research in the area of neuromorphic engineering. This alliance will enable collaborative research and exchange of students between the International Centre for Neuromorphic Systems (ICNS) at WSU and the Brain, Computation and Data Science (BCD) Group at IISc. ICNS constitutes a core research concentration within WSU's internationally renowned MARCS Institute for Brain, Behaviour and Development. It distinguishes itself from other neuromorphic engineering research groups through its core focus on the applications of neuromorphic technology. The research and capacity building that will be realized through this ICNS – BCD alliance will position both IISc and WSU at the forefront of this highly interdisciplinary endeavour.

The MoU was signed in the presence of Prof. André van Schaik, Director of the International Centre for Neuromorphic Systems, Western Sydney University; Prof. Barney Glover, Vice Chancellor of Western Sydney University; and Prof. Jayant Modak, Deputy Director, IISc.

Meeting at the council room IISc before the MoU signing ceremony, including delegates from Western Sydney University, Chairs of the IISc EECS departments, EECS Divisional Chair and the BCD group members

IISc-WSU agreement provides details of a specific program between International Centre for Neuromorphic Systems (ICNS) at WSU and Brain, Computation and Data Science group (supported by the Pratiksha Trust) at IISc Bangalore to develop academic collaboration by following activities:

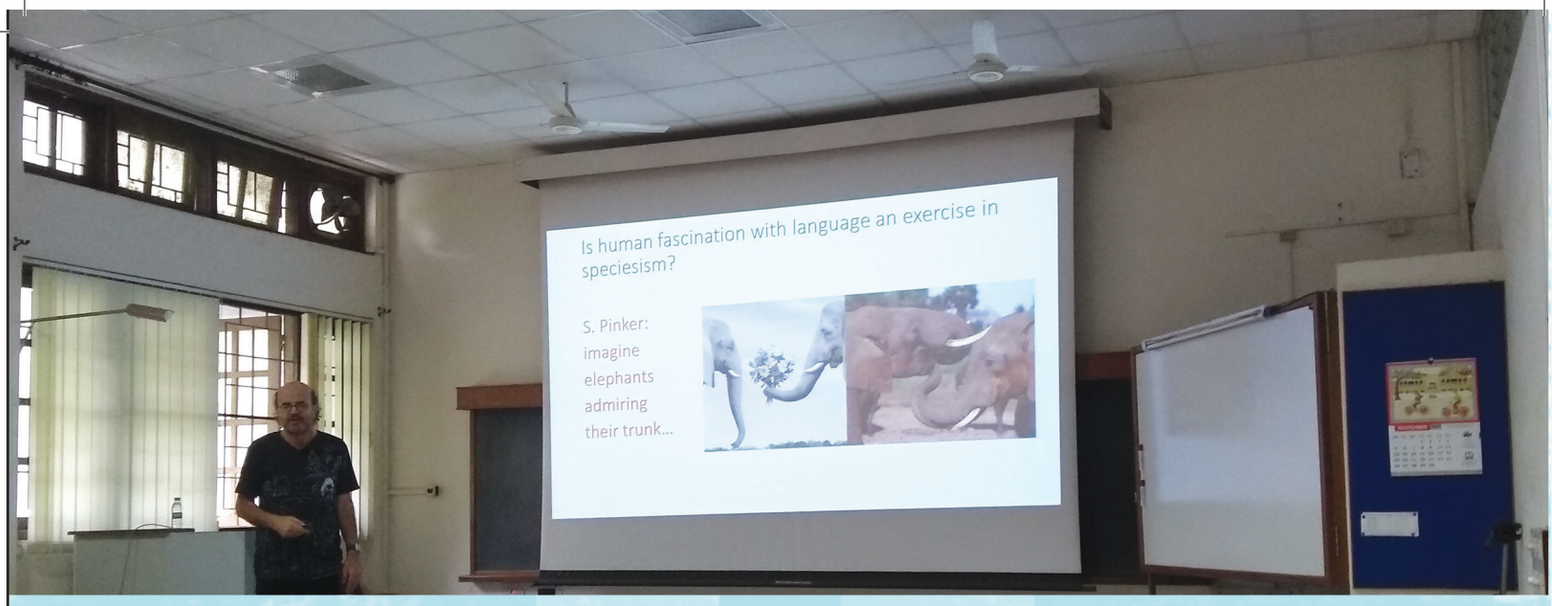
1. WSU to host IISc Masters projects.
2. WSU to host IISc PhD students.
3. IISc to host WSU PhD students.
4. WSU to establish the IISc-WSU Neuromorphic Systems PhD Scholarship.
5. Expand the program by involving international industry partners
6. WSU and IISc to consider establishing a regular regional academic meeting for neuromorphic systems.

A Report on the Meeting with Human Brain Project Team during August 2018

The Human Brain Project~(HBP) is an initiative of the European Union and its ambition is to significantly advance our understanding of human brain and to create break-through computational techniques based on the understanding gained. Started in 2013 it is envisaged as a ten year project with a total outlay of about 400 million Euros. It involves joint efforts at over 100 universities and research institutes spread over more than 20 countries.

The HBP involves many separate research teams. The team mainly involved in neuro-robotics has expressed an interest in seriously exploring collaborations between IISc and HBP. Based on some telephone conversations between some IISc researchers and this HBP team, it was decided to have a short workshop at IISc to discuss possible collaborations. While IISc provided the venue, catering and some incidental expenses for the workshop, the travel and other expenses of the visiting team were taken care of by the HBP.

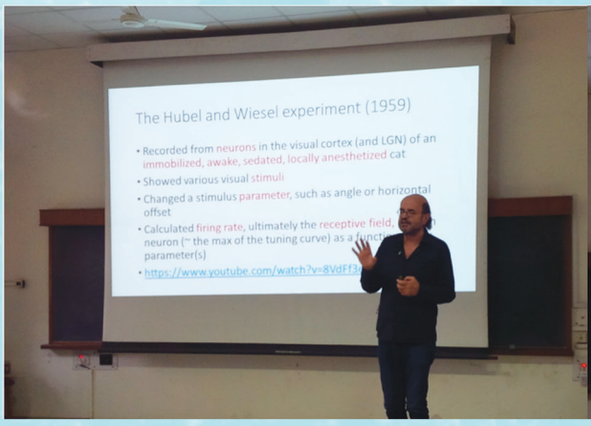
This workshop was held during 23-24 August 2018 and it was hosted in Centre for Neuroscience. There were three talks each from the visiting team and IISc researchers (including a talk by a research team from CBR). There were also a couple of break-away sessions where collaboration possibilities are discussed. It appears likely that some joint research projects in robotics and neuromorphic computing may materialize in the next couple of years.

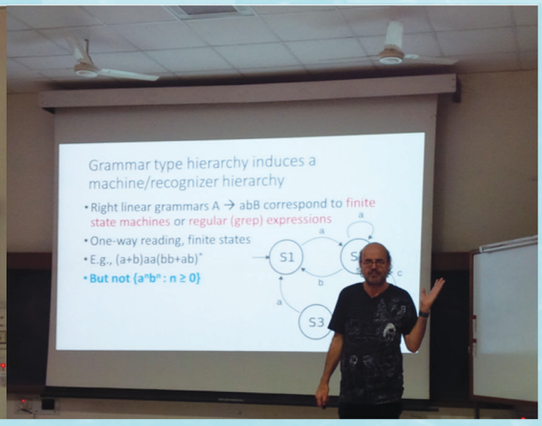


Brain and Computation: Lectures by Professor Christos Papadimitriou

Professor Christos Papadimitriou, the Pratiksha Trust Visiting Chair Professor at IISc, visited us from December 23, 2018 to January 4, 2019. He gave a series of three lectures on Brain and Computation at the Department of Computer Science and Automation, IISc. The lectures were held in CSA 254 on December 26, 27 and 28, 3 PM - 5 PM, and were extremely well attended with audience including students and faculty members from various departments/ centers in IISc such as CSA, CNS, CDS, etc. and from other institutes such as NCBS, etc. The abstract for his lectures is the following.

Abstract: Despite a deluge of exciting results in experimental and theoretical neuroscience over the past decades, some of the top researchers in the area agree that progress has been slow on the field's overarching question: How does the Brain (molecules, neurons, synapses) give rise to the Mind (cognition, behavior, learning, thought)? This is arguably one of the hardest and most fundamental challenges in science today. Many expect that computation will be an important workhorse, conceptual framework, and metaphor of this epic interdisciplinary scientific effort. On another front, advances in machine learning have often been inspired by the Brain, albeit in a pointedly tentative way. The purpose of this series of three lectures is to give the participants some of the necessary background for appreciating this fascinating interface between computation and neuroscience, and for making progress in it.





Pratiksha Trust Young Investigators

IISc has recently introduced Young Investigator awards to recognize and reward the accomplishments of young faculty members or prospective faculty members. The Pratiksha endowment now supports the award of several Young Investigator awards.

The awardees receive, for two years, a top-up salary of Rs 25,000 per month and a research grant of Rs 3 lakhs per year. The following faculty members were selected for the award during 2017 and 2018.

Sridharan Devarajan
Centre for Neuroscience

Sriram Ganapathy
Electrical Engineering

Siddharth Barman
Computor Science and Automation

Prasanta Kumar Ghosh
Electrical Engineering

Chetan Singh Thakur
Electronic Systems Engineering

Anirban Chakraborty
Computational and Data Sciences

Activities for 2019

Pratiksha Trust Workshop on Theoretical Computer Science organized by the Department of Computer Science and Automation with Plenary Talk by Prof. Christos Papadimitriou (January 2,3 - 2019).

IISc-Penn State Discussion Workshop on Data intensive Biomedical, Cognitive, and Brain Sciences (January 7,8 - 2019)

Workshop on Neural Systems Science and Engineering (January 23-25, 2019)

Third Workshop on Brain, Computation, and Learning, IISc Campus, Bangalore (June 24-29, 2019)

Monsoon Workshop on Experimental Neuroscience (https://monsoonwen.in), Indian Institute of Science, 21–25 July 2019. Organized by: Dr. Sachin Deshmukh, IISc and Mehrab Modi, HHMI Janelia research campus, USA.

Seed funding for several expedition projects

Organization of Compact Courses

Summer School for Graduate Students

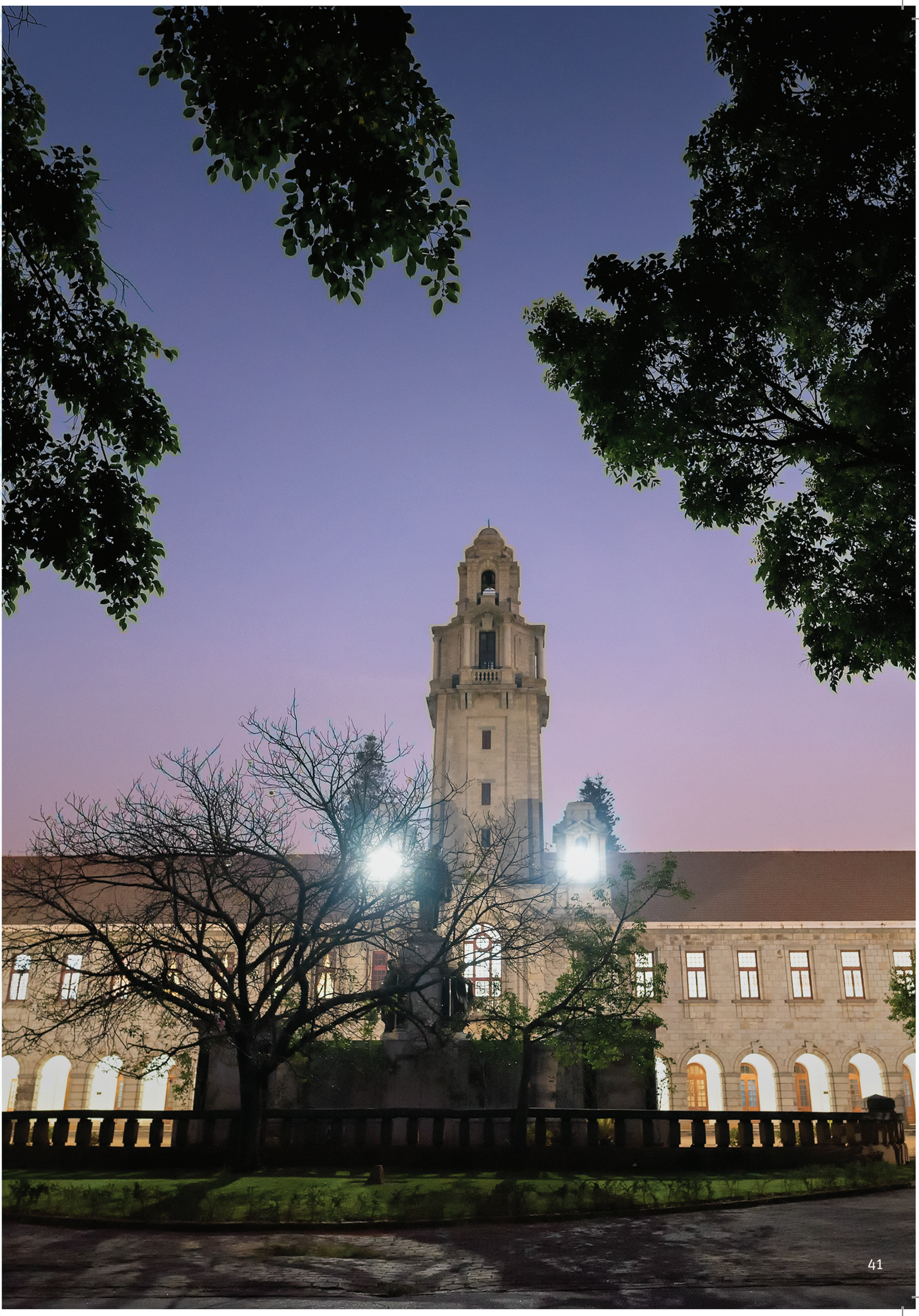
Organization of Brainstorming Workshops

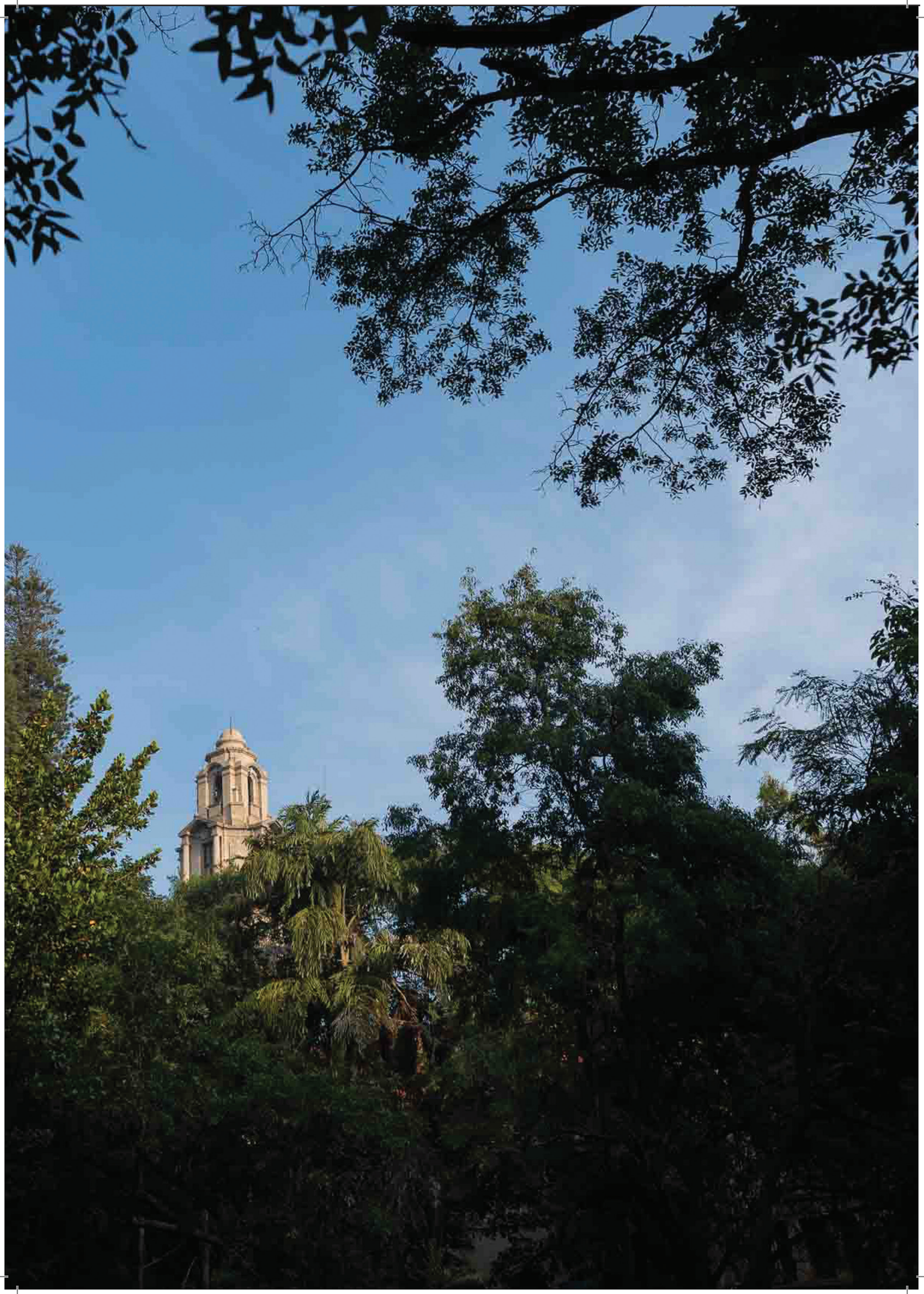
Recruitment of Post-Doctoral Fellows

Exchange of graduate student visitors between IISc and other universities

Initiating inter-disciplinary PhD program

The objective of all of the above activities will be to evolve and launch major, high impact initiatives in frontier topics in brain, computation, and data science.





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